Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

VOLUME LXXIV

MAY to OCTOBER, 1906

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

London
MACMILLAN AND CO., LIMITED
NEW YORK: THE MACMILLAN COMPANY

INDEX.

Reviews and Our Bookshelf.

LITERARY SUPPLEMENTS.

Index to Literary Supplements.

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

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE

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

THURSDAY, MAY 3, 1906.

RADIOBES AND BIOGEN.

The Origin of Life: Its Physical Basis and Definition. By John Butler Burke. Pp. xiv+350; with illustrations. (London: Chapman and Hall, Ltd., 1906.) Price 16*s*. net.

MR. J. B. BURKE describes, under the name of "radiobes," minute bodies which appeared in sterilised bouillon when small quantities of radium chloride or bromide were brought into contact therewith.

"A minute quantity of the salt contained in a small glass tube, one end of which was drawn out to a fine point, was introduced into an ordinary test-tube containing bouillon. The test-tube was plugged with cotton-wool in the usual way with such experiments, and then sterilised at a temperature of 130° C. for about thirty minutes at a time. On cooling, as soon as the liquid had coagulated, the fine end of the inner tube containing the radium was broken by means of a wire hook in a side tube. The salt was thus allowed to drop on the surface of the gelatin. After twenty-four hours signs of growth were already visible."

The radiobes had appeared! They were at first like diplococci, and varied considerably in size from mere specks as seen with a $\frac{1}{12}$-inch lens. There is a lack of precise measurements.

"The growth is from the minutest visible specks, which develop into two dots, then into a dumb-bell shaped appearance, later a biscuit-shape, and later still more like frog's spawn, through various stages, as in the figures, until a shape is reached different from its previous forms, when it divides and loses its individuality, and ultimately becomes resolved into minute crystals."

Some of them show a nucleated structure, which may exhibit subdivision "as in karyokinesis"; they are stainable; they are credited with "assimilation"; there is a "stoppage of growth at a certain stage of development"; there is a peculiar segmentation, like that in yeast-cells, said to be quite different from any cleavage due to surface tension; and, finally, there is a disintegration. The author speaks of them as intermediate between crystals and bacteria, and as possessing $n-1$ of the n properties of living bacilli.

The author is somewhat vacillating in his description of his "radiobes," but he does not regard them as living things in the ordinary sense. They "obviously lie altogether outside the beaten track of living things" (p. 109), but they may bridge over the apparently insuperable gap between the organic and inorganic world (p. 110).

"Forms we have obtained are analogous to living types and may be called artificial forms of life, but they are not the same as life as we know it to-day: they may help, however, to fill in some of the gaps between living and dead matter" (p. 187).

"These bodies are neither crystalline nor colloid in disguise, though colloids, as aggregates, but something more: and crystals in their constituent parts. The point which distinguishes them from both of these is perhaps the fundamental principle which marks them out at once as possessing the elements of vitality in a primitive and most undeveloped state" (p. 112).

The author started with proteid material, which we know to be an essential constituent of organisms, which has not as yet been artificially synthesised, and he brought into contact with this a stimulus provocative of molecular change, namely, a radium salt; he thus obtained radiobes, and the interesting point is whether these do in any way approximate in their behaviour to simple organisms. As we have not studied radiobes we can only judge from the evidence the author adduces, and it seems to us entirely inconclusive. We find no convincing evidence of assimilation, cyclic development, or reproduction in the ordinary sense of these terms; and we do not think the author succeeds in showing that radiobes are essentially different from the minute aggregates or mimic cells produced by many other experimenters. We cannot bring ourselves to believe that little bodies which are soluble in water will throw light on the nature or origin of living organisms. The evidence of anything approaching the behaviour of an organism seems to us so flimsy that we cannot but wonder at such a paragraph as this :—

"The structure and composition of such artificial cells is sufficient to enable them to perform the functions of organic life, as distinct from such simpler forms of vitality which we at first supposed inorganic matter to possess. Thus they can assimilate, grow, pass into higher types, subdivide, multiply, and finally, having gone through the whole cyclic process, disintegrate and lose their structure in the course of time, being sensitive all the while to external stimulation, both electrical and chemical, in various degrees" (p. 133).

The explanation of the author's apparent oscillation between scientific caution and imaginative hope is to be found in the fact that he has re-defined the ordinary biological terms. Life, for instance, is

"the specialised mode of motion of a complex system of molecules in a dynamically unstable state, so that there is a continuous or continual change, or flux of its substance, between the individual aggregates of molecules and their surroundings" (p. 49).

"An organism has a structure, a nucleus, and an external boundary or cell-wall, and its vitality may be described as being a continuous process of adjustment between its internal and its external relations" (p. 102).

There is metabolism in the phenomena of flames, fluorescence, and phosphorescence—"a physical process which is not merely analogous to, but essentially of the same kind as, even if incomparably simpler than, organic metabolism" (p. 179). It is this re-editing of the biological dictionary that enables the author to write regarding his radiobes :—

"We can say perhaps that we are witnesses at last to the first beginnings of life in its higher sense; but though apparently a case of abiogenesis, to our mind it seems to be a case of biogenesis, from the view of matter which we take, of biogenesis indeed carried to its logical extreme."

We sympathise with the author's vigorous protest against the libel implied in the phrase "dead matter," but we do not think the apartness of vital sequences is diminished by giving a more elastic definition to "life" and "metabolism." As to the bearing of radiobes on the problem of the origin of living creatures upon the earth, we do not think that it amounts to much, not only because Mr. Burke started with proteid material (the natural synthesis of which it is at least difficult to imagine), but also because it seems to us too short and easy a disposal of problems simply to suppose that the coordination and regulation of organic metabolism, the power of effective response, and other insignia of living creatures are secondary acquisitions gradually wrought out in the course of selection. Our business is to try to make the hypothesis of primitive abiogenesis more plausible, and we can only do this by condescending to discuss the detailed difficulties in a concrete fashion.

Mr. Burke's method is different; he elaborates a new theory of vitality which seems to us quite in the air.

"For anything we know there is no such thing as really dead matter, and there may be in all matter a certain amount of energy stored up which would entitle it to be regarded as possessing a certain amount of potential life" (p. 186).

He postulates original units of life, bio-elements. biogens, or ultimate nuclei, possibly consisting of cyanogen (as suggested by Pflüger's well-known hypothesis), more probably of something with a larger store of energy—"an element possessing many of the chemical properties of carbon and the radio-active properties of the more unstable elements."

"Life-activity is a phenomenon of matter as much as radio-activity, although really of a more complex kind, and the manner in which the energy is stored up in the ultimate nucleus is probably pretty much the same. Such nuclei may have existed, like the chemical elements themselves, throughout the universe for an almost indefinite time. To account for their formation would be the same as to account for the formation of the elements" (p. 166).

They may have existed in the nebula which formed the earth or they may have been borne to the earth by meteors, as has been previously suggested.

"The formation of cellular life as we see it to-day was the result of the subsequent interaction of this radio- or bio-element with organic compounds," and of course there was an elimination of failures when nature was trying her prentice hand at organism-making. One of these failures Mr. Burke may have been on the track of when he made his radiobes. In ordinary cell-life the bio-element persists as the vital spark, the nucleus within the nucleus, the *n*th or ultimate nucleus, the real source of vital energy. It is also the hereditary substance, and it "may be all of us that survives when we have shuffled off this mortal coil."

The author tells us much more about biogens than about radiobes, soaring in a region where verification and contradiction are alike impossible. He supports his theory by arguments from analogy, mainly drawn from his studies on the "physical metabolism" seen in the phenomena of fluorescence and phosphorescence, and he shows that the theory is the natural outcome of his discovery of radiobes, to which the bouillon supplies the soil or constituents, but the radium the seed or vital spark. It is difficult for a biologist to follow the details of this physicist's theory of vitality, *e.g.* when we read of two kinds of biogens —the "characterless nebulous biogen" which corresponds to an ovum, and the concentrated biogen which corresponds to a spermatozoon. But Mr. Burke's general view may be indicated by quoting a few more sentences.

"Life is as much a phenomenon of matter as electricity is. More clearly, life and matter are merely different phenomena of electricity, matter being merely the fossilised state of biogen, and life of the phenomena which take place in biogen in that stage through which electronic aggregations have to pass before they are converted into the crystalline forms of electrons which we call the chemical atoms of matter" (p. 192).

If this is what the author calls "more clearly," his standard of lucidity must be very divergent from that of the mean of the biological race. Biogen is "nothing more or less than *matter in the process of becoming*."

"Biogen may be regarded as the intermediate state between free electricity and condensed electricity which we call matter—the hiatus between electricity as we know it and matter as we know it; the missing link that bears

'The heavy and the dreary weight
Of all this unintelligible world.'"

We cannot follow the author further with his new "Naturphilosophie," but it is interesting to point out that, although he says life-activity is a phenomenon of matter, he is far from being a materialist. For matter, he tells us, is really *mind-stuff*, and "atoms are nothing more than ideas." We have always suspected that this would turn out to be the case.

As an interesting book on a perennially interesting theme "The Origin of Life" will probably soon pass into a second edition, and we therefore note a few errata. "Wiesmann" (p. 56), "Debois" (p. 175), "Luduc" (p. 208), "nucleosus" (p. 136), "mytosis" (p. 137), are obvious misprints. We suppose that the "chlorophyll" referred to thrice on p. 135 is a misprint for chromatin, but the author seems confused in his picture of a typical cell. Mitosis is not "the multiplication of the chromosome"; the centrosome is not "the inner portions of the nucleus, or nucleolus"; and we cannot speak of "the karyokinesis of the centrosome." There are several such errors indicative of haste, and there is a disconcerting lack of correspondence between some of the figures and the references to them in the text.

The author is so enthusiastic over his radiobes and *n*th nuclei that we almost wish we could believe more in the importance of either of them. The former seem to us very far from possessing $n-1$ of the n properties of the simplest living creature we know; the latter seem to us ingenious fictions too remote from everyday physiology to have even suggestive value. But these are merely our opinions, and it may be that Mr. Burke will, by more precise observations and more restrained theorising, justify the views of those who have hailed him as a pioneer and a prophet.

J. A. T.

PRINCIPLES AND PRACTICE OF POTTERY.

La Ceramique industrielle. Chimie-Technologie. By A. Granger. Pp. x+644. (Paris: Gauthier-Villars, 1905.) Price 7 francs.

THIS is an excellent example of the technological handbooks which the young Frenchman and German find ready to their hands when they proceed from school or college to take up industrial work, and which, in so many businesses, the young Englishman just as conspicuously lacks. At the present moment there is no English book on pottery manufacture, other than indifferent translations of a French and a German book, to which a student of the principles of pottery manufacture can turn, and these deal most accurately with processes unknown or unused in England.

The volume in question is, as is perhaps inevitable, stronger on the theoretical than on the practical side. The first nine chapters, comprising about half the book, give a clear and logical account of the physical and chemical properties of the materials used in the preparation of pottery paste and glazes of all descriptions, together with laboratory methods of chemical analysis and such methods as have been devised for testing the degree of fineness, plasticity, and tensile strength of the various natural clays and clay mixtures, as well as a theoretical discussion of the behaviour of complex mixtures of silicates (clays and glazes) when fired at varying temperatures up to their fusion point. All this is put forward with that clearness of expression and logical precision of arrangement that seem to come so naturally to the French teacher.

The feeling cannot be resisted that the author, with the very best intentions, has covered too much ground. It would seem as if he had attempted to describe every known process, apart from its merits or demerits, with the result that the student is overwhelmed with methods, and at the same time left without a clue as to the suitability of particular methods in special circumstances. In the section on silicate analysis, for example, the ordinary methods of treatment are given for silicates soluble in strong acids, and the methods of attack with carbonate of soda, lime, baryta, oxide of lead, boracic acid, and hydrofluoric acid for the insoluble silicates, yet not one of the processes is described in such detail as would enable the student to conduct an analysis, and the refinements and corrections introduced into the ordinary methods of silicate analysis by Hillebrand, without which it is impossible to guarantee one's results, are never mentioned. In the same way, in the sections dealing with the various methods used by potters for determining the temperature of their kilns, a long account is given of Wedgwood's pyrometer, Seger cones, and all the later forms of electrical pyrometers, including the Féry radiation pyrometer, but there is no adequate discussion of the relative value of these different methods in the actual working of a pottery, the observations on the employment of pyrometers (pp. 257–261) being simply a one-sided account of the merits and demerits of Seger cones.

The second half of the book contains a reasonably detailed account of the processes of manufacture, firing, glazing, and decoration of bricks, tiles, terracotta, refractory pottery, stoneware, earthenware, and porcelain. Again the method is excellent, but, of course, too much has been attempted, and it seems obvious that the student would have been better trained or assisted by a more complete treatment of one or two sections only. From the English point of view, the greatest failure of the book is the ignorance shown of actual English methods in those branches of pottery manufacture where this country is supreme. Thus the account given of the manufacture of English earthenware is not merely incomplete, but is full of misapprehensions—even of mistakes. The mixtures said to be used for English bodies and glazes are such as no first-rate potter would dream of using; the description of our ovens and kilns is singularly incomplete, and the statement is made that, owing to the nature of the English earthenware bodies, the firing of on-glaze decorations in the continuous kiln has been a failure, when, as a matter of fact, many of these kilns are in successful operation. The treatment accorded to our English bone-china is just as incomplete.

The accounts of French and German processes are naturally much better, not only because the author is better acquainted with them, but no doubt because so much more has already been published about them.

The author had the excellent idea of adding to his volume a vocabulary of technical terms in German, English, and French, and tables showing the relative importance of the industry in various countries. Unfortunately, the idea has been very imperfectly executed. In the vocabulary many of the English terms are such as no potter would use, while some few of them are nonsense; and the figures given as to the extent of the industry in various countries are so incomplete and incomparable as to be positively misleading. On the whole, however, the book must be described as excellent for its purpose; and the English potter might well wish that he had such a book to put into the hands of the young men who are likely to occupy responsible positions on his works.

William Burton.

THE SOIL AND ITS TILLAGE.

Agriculture Générale. Le Sol et les Labours. By Paul Diffloth. Pp. xii+490. (Paris: J. B. Baillière et Fils, 1906.) Price 5 francs.

THIS is the first book of a new French agricultural encyclopædia, which is being published in forty volumes, under the direction of M. G. Wéry, assistant director of the Institut National Agronomique. It is written by Prof. Paul Diffloth. The aim of the encyclopædia is expressed in an introduction by Dr. Paul Regnard, successor to the late M. Eugène Risler as director of the institute. It is to extract from the present teaching of agricultural science all that is available for immediate application by the practical farmer, making him acquainted at the same time with the scientific facts upon which actual practice is based.

Dr. Regnard pays a compliment to English agriculturists by stating that they have never accepted the notion which he attributes to his own countrymen that agricultural science is antagonistic to practical experience. We fear the compliment is not altogether deserved, and that French and English farmers have much in common in this respect; yet the remarkable progress in the direction of higher agricultural education during the past ten years in this country may be regarded as both cause and effect of the gradual disappearance of the idea that the practice of agriculture can derive no advantage from the labours and teachings of science.

With the love of logical analysis which characterises French scientific literature, M. Diffloth's work is divided and subdivided almost *ad infinitum*. An idea of its completeness may be gathered from a summary of these divisions. The book comprises two main branches, viz. "Agrologie" and "The Preparation of the Soil," the former being defined as the study of land in relation to agriculture and of the relationship which subsists between the nature of a soil and its produce. The first branch treats of the soil, the subsoil, their physical and chemical properties; water in relation to fertility, its distribution, rainfall, permeability, impermeability, water levels, wells, watercourses, &c.; the analysis of soils by processes physical, mechanical, geological, chemical, &c.; the relations of the soil with the plant, comprising the subjects of nitrification, denitrification, humus, fertility, and the nature of the soil suited to different plants. The second branch of the book, "The Preparation of the Soil," treats of cultivation, the clearing of land, peaty and brackish soils, and the improvement of soils by warping, tree planting, levelling, removal of rocks, stones; tillage operations, including digging, drainage, and the various systems of ploughing; semi-tillage, so called, consisting of scarifying, cultivating (in its technical sense), extirpation of weeds, &c.; harrowing, rolling; and, lastly, of manures and artificial fertilisers.

We do not remember ever before to have read any precise definition of what agriculture is. The author defines it as the art of obtaining from the soil the maximum of substances useful to man at the minimum cost. We do not quarrel with such a definition, though it represents the ideal rather than the actual.

Full justice is done to the part played by the soil in the sustenance of plants, and in particular to the nitrogen problem, which has been the subject of so much scientific investigation and discussion during the past twenty years. The author indicates briefly the discoveries made by de Saussure, Dumas, Boussingault, and others as to the action of carbonic acid of the air and of nitrogen in the soil in the nourishment of plants; the work of mineral salts as demonstrated by Berthier, Sprengel, and Liebig; the experiments of Schlœsing and Müntz showing the action of ferments in transforming organic nitrogen into nitric acid and of micro-organisms in nitrification; and, lastly, the experiments of Hellriegel and Wilfarth revealing the existence of bacteria in the nodules found on the roots of leguminous plants and the absorption by their agency of nitrogen from the free and unlimited supplies present in the air.

M. Diffloth refers to the great developments in France and other Continental countries of the principle of agricultural cooperation. Its successful application to Ireland is well known, and in Great Britain, too, it is now making some headway. The future of agriculture, writes the author, may be summed up in two words as living symbols of its progress and prosperity, "Science et Association." We agree that if "Practice with Science" have been the agricultural watchwords of the nineteenth century signs are not wanting that "Science with Cooperation" may be those of the twentieth.

The practical operations of French husbandry are carefully described, with their scientific significance;

but as they differ in many respects from the English, the chief interest of the book for English readers of French agricultural literature will lie in its admirable exposition of the scientific principles underlying practice. The book is well illustrated on the whole, but in some cases the photographic reproductions can hardly be regarded as truly illustrative. Otherwise we have nothing but admiration for the manner in which Prof. Diffloth in this first volume has given effect to the aim of the new French agricultural encyclopædia.

INORGANIC CHEMISTRY FOR STUDENTS.

Outlines of Inorganic Chemistry. By Frank Austin Gooch and Claude Frederic Walker. Pp. xxiv+514. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1905.) Price 7*s.* 6*d.* net.

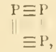
THE authors say in the preface that their aim is "to introduce the student to chemistry by consideration of the simplest and fewest things." Their intention is laudable enough, but it may be questioned whether their plan of entering into a long discussion of "the consecutive development of the principles upon which systematic chemistry rests," before taking up the descriptive part of the subject, is one which can be commended.

The first 233 pages of the book are entirely devoted to theoretical matters, and a wide range of subjects is included. Beginning with an exposition of the outward characteristics and quantitative laws of chemical combination, the authors pass on to discuss balanced actions, chemical equilibrium, and the phase rule. Then follows a short chapter on specific heats and thermochemistry, after which the student is "introduced" to atoms, molecules, ions, and electrons. Finally an attempt is made to teach him something about the kinetic theory of gases, the properties of solutions, the theory of valency, constitutional formulæ, physical isomerism, and stereochemical relationships. Whatever fault the reader may have to find with the mode of presentment in this part of the book, he will have no reason to complain of lack of variety. The authors have attempted too much, and have sacrificed clearness to the exigencies of space. The beginner will, we fear, be confused, and the more advanced student will find the treatment of the subject inadequate and superficial.

Without attempting any detailed criticism of these theoretical chapters, which would indeed serve no useful purpose, we may give one or two examples of what we think an unsatisfactory way of presenting ideas to the beginner. In speaking of chemical changes, the authors make use of the term "*factor*" to denote "substances which enter into reactions"; thus we read of "the change of the factor mercuric oxide into the elementary products mercury and oxygen by heat," and so on. Nor do we think their invention of the clumsy expression "*mass-unit weight*" of an element will at all help the student to grasp the idea of "*atomic weight.*" The beginner will probably be at a loss to understand why the compound NO is called "nitrogen dioxide," whilst CO is called "carbon monoxide."

The descriptive part of the book (493 pages), which is arranged in accordance with the periodic system, calls for little comment. Much valuable space is wasted on elaborate constitutional formulæ, the majority of which are advanced without the slightest attempt at proof or criticism. When, however, the authors do discuss such matters they are not always convincing, as the following example will show:

"The possible constitution of phosphorus pentoxide may be made a matter of discussion. If we assign to phosphorus the symbol



suggested by the specific gravity of phosphorus in vapour condition, we might conceive phosphorus pentoxide, formed by the complete oxidation of phosphorus, to have a similar constitution.

Of the molecular weight of phosphorus in solid condition, or of phosphorus pentoxide, we have no knowledge, so we find it convenient to represent both substances by the simplest possible equivalent symbols, P and P_2O_5."

We thought that the once prevalent idea of the preferential combustion of hydrogen in hydrocarbon flames had long since been discarded; the authors however, still believe in it, for in discussing the luminosity of the acetylene flame they tell us that the gas "burns from an ordinary gas jet with a flame which is luminous, but very sooty from finely divided free carbon, the hydrogen burning first

$$2C_2H_2 + O_2 = 2C_2 + 2H_2O."$$

In short, we find much in this book which would deter us from recommending it as a clear and trustworthy exposition of chemical facts and theories.

W. A. B.

OUR BOOK SHELF.

Collodion Emulsion. By Henry Oscar Klein. Pp. 95. (London: Penrose and Co., 1905.) Price 5*s.* net.

THE advent of gelatin plates has almost driven collodion out of the photographic world. The wet collodion process has all along retained its position in some kinds of photo-mechanical work, but collodion emulsions seemed to have no place left for them until a few years ago their advantages for certain technical purposes were insisted on, and the publishers and author of this volume did a good deal towards reintroducing them into this country on a commercial basis. As collodion emulsion can now be purchased the author has very little to say about the preparation of it; he only quotes two or three formulæ from other workers. The volume must be regarded as a guide to the practical user of commercial emulsions. Their applications in the making of ferrotypes, lantern slides, opals, and transparencies, and for photographing on wood are concisely described; but the principal part of the work, and by far the most important, deals with the colour sensitising of emulsions, and the applications of such sensitised emulsions to the production of negatives in the many methods of dealing with and reproducing colour that are now in vogue.

The applications of the newer sensitisers are described in many scattered communications, and often with very little discrimination between the practically useful and the merely theoretically interesting. Mr. Klein states that he has included only those that have passed the test of time and been found to be thoroughly practical. It is in this that the value of the work lies, and we think that it would have been better to have restricted the volume to this aspect of the subject. The occasional references to the underlying scientific facts will not help the practical man, nor would they if they were free from the errors that now disfigure them. A volume of practical instructions is not the place for a page or two of chemical equations or the expression of theoretical views that have often been called in question. However, these occupy but little space, and scarcely interfere with the use of the book as a strictly practical manual.

Der Gegensatz zwischen geographischer und nicht-geographischer Variation. By Karl Jordan. Pp. 59; with 73 figures in the Text. (Leipzig: W. Engelmann, 1905.)

THE present treatise affords an excellent example of the light that may be thrown on questions of biological interest by the scientific use of entomological data. Dr. Jordan here presents a valuable *résumé* of some of the most important results of the elaborate investigation of the chitinous sex-organs of insects, more particularly the Papilios and Sphingidæ, carried on by him for many years past at the zoological museum at Tring. These researches, the detailed results of which have already appeared in the pages of "Novitates Zoologicæ," are of high interest, not only to entomologists, but also to all students of the methods of evolution.

It must, however, be confessed that the author's interpretations are less acceptable than his facts. Starting from the position that "species" have a real objective existence, he endeavours to show that new species could only have arisen from geographically isolated variations, not from variations occurring side by side with the parent form. The main fact on which he relies is that while "individual" or "seasonal" variation of forms inhabiting the same locality is never accompanied by a variation in the sex-organs (with the single known exception of *Papilio xuthus*), the diverse geographical forms of a species are in very many cases found to be distinct from one another in sex-organs as well as in aspect. There is thus a correlation in the latter case which does not exist in the former, and which seems to the author to warrant the conclusion that these geographical forms only can occupy the position of incipient species. Some of the obvious objections to this view are dealt with by Dr. Jordan, others are left unnoticed.

A slight inaccuracy occurs on p. 177, where a figure of *Byblia goetzius* is said to represent *B. ilithyia*, while the true *B. ilithyia* bears the legend *B. anvatara*; both mistakes being repeated in the text. A more serious matter is the absence of any detailed reference to Mr. G. A. K. Marshall's work on this genus and his remarkable discoveries in the genus Precis. Some special recognition of these should have found a place, even in a treatise of general nature like the present. It will be gathered from what has been said that Dr. Jordan's conclusions are open to criticism. There can, however, be no doubt as to the value of the researches so ably carried on by himself and others in connection with the ample material of Mr. Rothschild's museum at Tring.

F. A. D.

Butter-making on the Farm and at the Creamery. By C. W. Walker-Tisdale and T. R. Robinson. Sixth edition, revised and enlarged. Pp. 162. (London: Office of the *Dairy World*, 1906.) Price 2*s*. 6*d*. net.

WE import into the United Kingdom perhaps twice as much butter as we make, and pay twenty millions yearly for it. Some, at least, of these millions would have been saved to the agricultural industry if our farmers and dairymen had given as much intelligent study to the principles of butter-making as, for instance, the Danes have done. Unfortunately, however, in such matters as the use of centrifugal cream-separators, the employment of pure bacterial cultures for "starters," and the general organisation of the industry, we did not lead the way; we were content to follow, and that, too, with somewhat halting footsteps. Even now the small butter-maker is often a sad empiricist. If cleanliness, for example, is an article of faith with him—and frequently it is not—he holds it as a dogma, not as reasoned knowledge.

The little book under notice may help in the recovery of some of those lost millions. It gives an outline of approved present-day practice in butter-making, though it does not purport to offer much in the way of theoretical explanation and discussion. Mainly it is an account of how best to conduct the operations of a small modern dairy. It is practical and simple; well suited for the elementary dairy-student, for the farmer's son who wishes to know something more than mere rule-of-thumb work, and for the private maker who supplies his own household from his own cows. The first few pages deal with the design, construction, and equipment of the dairy. Then cream is considered, and its separation and "ripening" are described, after which we pass to the churning and subsequent operations. A number of simple arithmetical examples are worked out to illustrate various points that arise. The last thirty pages deal, briefly and in a more technical manner, with the operations of a fully-equipped creamery, including "pasteurisation" and refrigerating.

The book does not profess to be much more than a useful note-book and practical guide, but as far as it goes it is excellent.

C. SIMMONDS.

The Deinhardt-Schlomann Series of Technical Dictionaries in Six Languages: English, German, French, Italian, Spanish, Russian. By Kurt Deinhardt and Alfred Schlomann. Vol. i. The Machine-Elements and Tools for Working in Metal and Wood. Together with an Appendix, edited by P. Stülpnagel. Pp. 403; 823 illustrations. (London: Archibald Constable and Co., Ltd., 1906.) Price 5*s*. net.

THIS volume is the first of a series intended to aid engineers and others in reading technical works in any of the principal modern languages. Terms of general importance only are included; they are classified into subjects and many are accompanied by an explanatory sketch. Formulæ and symbols, serving as they do the purpose of an international language, are introduced wherever possible. The translations have been tested in workshops and offices in the various countries represented; so the work ought to prove of service in reading technical literature. The convenient pocket size of the dictionary, the systematic arrangement of its matter, and the full alphabetical index of words in each of the six languages should gain for it a sphere of usefulness among technical students.

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.]*

Osmotic Pressure.

THE publication of a paper by Mr. Spens in vol. lxxvii. Proc. Roy. Soc., p. 234, in which he criticises a relation between the vapour and osmotic pressures of a solution which Mr. Hartley and I had deduced (see same volume), seems to be an opportune moment for directing the attention of physical chemists to the necessity for an agreement as to what is meant by the term osmotic pressure.

Mr. Spens, following Duhem, points out that the osmotic pressure, defined as the difference between the pressure on the solvent and the pressure applied to a solution to keep it in equilibrium with the solvent, when the two are separated by a semi-permeable membrane, varies according to the pressure on the solvent. He suggests using a definite pressure on the solvent, say its vapour pressure, as the standard.

I would point out that, by accepting this definition, one is necessarily bound to compare two solutions when they are under different conditions—not only on account of the different vapour pressures of different solvents, but also on account of the different pressures on the solutions themselves.

The following consideration will, I think, make this clear, and at the same time will suggest a more scientific standard.

There seem to be two methods of examining directly the osmotic phenomena of a solution.

(1) One, which I may call the osmotic "force" method, depends essentially on the determination of the rate at which the solvent will flow through a semi-permeable membrane into an infinite mass of solution when there is no pressure on the latter.

It is evident that if one knew the frictional resistance to the flow, the heat developed, &c., one could calculate the osmotic "force" in absolute units.

I would mention, in parenthesis, that Mr. Hartley and I have made some comparative experiments in this direction with results which were not entirely unsatisfactory.

(2) All other direct methods give what may be called equilibrium pressures; they depend on the measurement of the pressure necessary to bring about a balance between the solution and the solvent. These equilibrium pressures cannot, on account of the compression of the solution, be measured under the same conditions.

An example will show this plainly. The equilibrium pressure between a solution of 540 grams of cane-sugar in the litre of solution and the solvent (water) under atmospheric pressure is, in round numbers, 70 atmospheres. The equilibrium pressure for 750 grams in the litre is 134 atmospheres. In the actual measurements each solution had been compressed, in one case by 71 atmospheres and in the other by 135 atmospheres. The conditions were therefore not comparable.

If we could measure the osmotic "force" of these two solutions as in (1) then comparable results would be obtained, for in both cases the solution and the solvent would be under the same pressure (gravitational).

Up to the present, so far as I am aware, no serious attempts to measure the osmotic "force" have been made, but I would suggest that, pending these, the relation between the vapour and osmotic pressures of a solution as deduced by Mr. Hartley and myself may be useful for the purpose of comparing *the* osmotic pressures of different solutions.

This relation gives the osmotic pressure of a solution when it is under no pressure but its own vapour pressure. A knowledge of the vapour pressure, together with the density of the solvent, is all that is required for calculating that pressure; while to apply the standard that Mr. Spens proposes, it is necessary to determine the increment in volume of the solution when unit mass of solvent enters it, and in some cases it may be necessary to obtain the coefficient of compression of the solution.

The experimental work saved by the adoption of the standard here proposed is apparent when it is remembered that, owing to the want of suitable semi-permeable membranes, the measurement of equilibrium pressures is confined to but a few substances dissolved in water.

Foxcombe, near Oxford. BERKELEY.

The Eruption of Vesuvius.

YESTERDAY I ascended the cone of Vesuvius up to the crater, being, I suppose, one of the first climbers after the eruption. The ascent was made from Torre Annunziata without any difficulties, but care had to be taken to avoid the courses of the avalanches of stones and ashes rushing from the cone and spreading over the slopes more than half a mile from the foot of the cone.

I estimated the new crater to have a diameter of about 3000 feet; the bottom was not visible, but the walls could be seen to a depth of about 1000 feet. The inner walls are nearly perpendicular, partly overhanging, and I saw pieces of the very narrow crater edge breaking down, in this way still enlarging the crater. The very regular stratified construction of the crater walls was visible. The height of the crater edge is very different from what it was before the eruption, being greatest on the west side, and diminishing in irregular steps to the north and east. At the point to which I ascended the aneroid showed an elevation of 3760 feet. From this point, which was on the southern side, the Somma was clearly visible over the lower northern edge of the crater. This shape of the crater may account for the fact that the showers of lapilli and other fragmentary products which destroyed the villages of Ottajano and San Giuseppe were given a direction to the north and east over the Somma.

The crater now closely corresponds to the descriptions of the great crater formed in 1822, and described by Forbes and Scrope. From the throat of the crater I heard a constant roaring, and saw that white clouds of vapour filled the huge hollow, but I did not see any ejections of stones or dust.

On descending I visited the points where the lava streams started from the foot of the cone. The first lava reached the surface on the morning of April 4 a little west of the Casa Firenze, but it soon stopped. Another stream started from Casa Firenze, destroying the buildings, and flowed half the way toward Bosco-Trecase. The lava which damaged a part of Bosco-Trecase started on April 6 a little lower on the slope, and divided into two parallel branches. The quantity of lava during this eruption was on the whole comparatively small. No lava came from the crater. The general characteristics of the eruption are the immense amount of volcanic ash, lapilli, and other fragmentary material ejected, and this makes the eruption of April, 1906, very similar to that of the year 79 A.D.

Visiting the destroyed village Ottajano on April 19, I made the following curious observation. A great number of the window glasses are broken, but among the others there are many regularly penetrated or pierced by circular holes one or two inches in size. These holes are as common on the northern and eastern sides of the houses as on the other sides, and they can therefore not have been caused by the showers of lapilli, which only came from the south-west. Some people ascribed these holes to the very heavy lightning which accompanied the fall of the lapilli, but I am not aware that electrical discharges may produce such effects.

It may be of interest to note that when visiting the volcanic vents of the Phlegræan Plain to investigate if any kind of volcanic activity was shown in connection with the eruption of Vesuvius I heard that the emanation of steam from the Solfatara diminished greatly during the days of the strongest eruption of Vesuvius: normal conditions set in later. HJ. SJÖGREN.

Naples, April 23.

Lightning Flashes.

In your issue of January 14, 1886 (vol. xxxiii., p. 245), Mr. T. Mackenzie reported lightning from a bank of cloud to the clear sky, but, as it was quite dark, one cannot be certain that there were no indistinct outliers. In Hann's "Lehrbuch der Meteorologie" (ed. 1, p. 632) other cases of lightning from a cloud to the clear sky are referred to.

On the evening of March 26, at 6.30 p.m., before dusk had set in, there was a large thunder cumulo-nimbus cloud about eight miles north of Johannesburg. The summit of this cloud was very sharp against a clear dark blue sky. There was no false cirrus. Six flashes of lightning darted from near the summit of the cloud into the clear sky. The longest path was about ten degrees. One flash returned to the cloud, the others finished in the clear sky. Before dusk set in this phenomenon ceased to occur. All the flashes were directed to that part of the sky from which the cloud moved.

In a well-known book on meteorology we read "it is impossible to say whether a flash of lightning moves from a cloud to the earth or in an opposite direction," and further that the lightning is instantaneous. Hann does not confirm these statements, and it is time that they were modified in English text-books. Quite frequently I have observed lightning flashes leaving a cloud for the earth, but fading away before reaching it; the opposite phenomenon has not been observed. The paths of lightning shown by photographs taken in the Transvaal all indicate discharges from cloud to cloud, and from cloud to earth. The enclosed photograph, taken by Mr. T. N. Leslie at Vereeniging, is typical. Some flashes of lightning are instantaneous, the majority are not, but I do not think any exceeds a duration of a third of a second. The revolving wheel has been used, and shows that the duration is often certainly much longer than 1/40th of a second.

Fig. 1.—Lightning at Vereeniging, 1903.

Johannesburg, April 2. R. T. A. I.

Diurnal Variation of Ionisation in Closed Vessels.

Until Messrs. Campbell and Wood give us some more definite information as to the magnitude of the daily variation which they have found in the natural ionisation of air in closed vessels (Nature, April 19, vol. lxxiii., p. 583), it is somewhat premature to go into a detailed discussion as to how this discovery will affect theories of atmospheric electricity. Still, the letter in Nature of April 26 (vol. lxxiii., p. 607) on this question from Dr. O. W. Richardson calls for some remarks.

The facts are shortly:—(1) Messrs. Campbell and Wood discover that the natural ionisation of air in a closed vessel has a double daily period, the maxima being between 8 a.m. and 10 a.m. and between 10 p.m. and 1 a.m., the corresponding minima being at 2 p.m. and 4 a.m.; (2) the potential gradient in the lower atmosphere has, at most places, also a double period, the maxima being at about 8 a.m. and 8 p.m., and the minima at about 4 a.m. and midday. Thus, allowing for a certain amount of uncertainty in the exact determination of the times of the maxima and minima, we may say that the daily variations of the natural ionisation and the potential gradient are similar.

In order to discuss a possible dependency of these two factors, Dr. Richardson assumes that "the distribution of the earth's field reduces itself to a case very similar to that between two plane electrodes immersed in a gas and maintained at a constant difference of potential." It is more than questionable as to whether this assumption is justifiable or not, for in atmospheric electricity we are dealing with constant quantities of electricity, and not with constant potentials. But, rather than follow up this objection, I would prefer to look at the problem from a different point of view, and show that the exact contrary conclusions can be deduced.

In discussing this problem, it is usual to accept that there is a negative charge on the earth's surface, and that the corresponding positive charge is a volume charge distributed in the atmosphere. Now all the measurements which we have of the daily variation of potential gradient have been made within a few metres of the surface. Within these few metres there can be, relative to the charge on the earth, very little volume charge, so what our measurements actually refer to is the charge on the surface, the relation being $dv/dh = -4\pi\sigma$. The point to notice in this is that, with a given charge on the surface and the corresponding charge in the atmosphere above, the vertical distribution of the charge and the conducting state of the upper atmosphere do not in the slightest affect the potential gradient within a few metres of the surface. If the potential gradient changes there it can only be by a change in the surface charge on the earth.

If there is a penetrating radiation which, besides ionising the air in closed vessels, also ionises the air in the atmosphere, we should expect from Messrs. Campbell and Wood's experiments the ionisation of the air in *all parts* of the atmosphere to have a daily variation. Thus the air quite near the surface would twice a day be exceptionally conducting; one would expect that at these times there would be a greater loss of the surface charge, and so the remaining charge to be diminished, and with it the potential gradient. The consequence would be a daily variation of the potential gradient corresponding to the variation of ionisation, but the maxima of one corresponding to the minima of the other.

That such a relation does exist between the ionisation of the lower atmosphere and potential gradient has been shown by many observers situated in most parts of the globe. Thus from Messrs. Campbell and Wood's results one would expect minima of the potential gradient to occur at about 8 a.m. and 10 p.m.; this is the exact reverse of what really occurs.

Thus it would appear as if Messrs. Campbell and Wood have added one more to the many puzzling factors connected with atmospheric electricity.

Manchester University. George C. Simpson.

August Rainfall.

According to Greenwich experience, August has been a very dry month considerably oftener about sun-spot *maxima* than about *minima*. This fact may be of some practical interest.

Using Mr. Nash's table (from 1815), let us confine our attention to the three years about the eight maxima and the three about the eight minima, *i.e.* twenty-four years in each division.

The driest August in the *minima* division was in '55, with 1·40 inches. But in the *maxima* division there are ten cases of lower values, ranging from 1·25 inches down to 0·45 inch, viz. '38, '49, '50, '61, '69, '71, '82, '83, '84, '93. Since 1837 no three-year group of this division has been without at least one such very dry August, two have had two, and one three.

The total August rainfall in those twenty-four-year groups is, in the sun-spot *maxima* division, 50·25 inches, in the *minima* division 66·50 inches, the higher value thus showing an excess of 16·25 inches (nearly one-third of the lower).

The sun-spot maximum we are now near (1905?) has not been here considered, but I may remark that in 1904 we had one of those low August values (1·24 inches).

Alex. B. MacDowall.

AT THE HEAD OF LOCH FYNE.[1]

A LARGER number of contributors even than those mentioned on the title-page have conspired to make this memoir authoritative and complete. It is descriptive of Sheet 37 of the 1-inch geological map of Scotland, an attractive work published in 1903, in which the north-east and south-west lines of the Caledonian earth-folding predominate, and are followed out in the trend of the intrusive masses. The memoir is illustrated by excellent plates, one of which is here reproduced; and the fact that part of the ground is familiar to the tourist gives it an additional interest.

The region described is cut, from corner to corner, by the noble inlet of Loch Fyne. The parallel reach of Loch Awe lies in the north-west, and Loch Eck, banked out by gravel terraces from the sea, comes in near Loch Long in the south-east. The traveller by land usually enters the region by the steep and rugged fastnesses of Glencroe, and leaves it by Glen Aray, if he is willing to face the rain-swept moorland above which Cruachan towers in the north. The geological surveyors, however, have become familiar with a wide area practically untrodden by any visitor. Mr. Hill's appreciative introduction should be read with the aid of the hill-shaded Ordnance map, Sheet 37, one of the most beautiful products of a draughtsman who surely possessed a sentiment for landscape. The fundamental rocks of the district are metamorphic, and formed a part of the Caledonian continent, on which the Old Red Sandstone gathered; and Mr. Hill points out how denudation is removing the Devonian lavas and lake-deposits in the north-west, and is revealing, in the sculpture of the old continent, a highland much like that of modern days. The ice-flows of the Glacial epoch, however, have moulded the present surface in many of its details, have left erratic blocks in quaint positions on the hills, and have deposited moraines and banks of gravel across the edges of the ancient schists.

The metamorphosed series is mainly of sedimentary origin, with many bands of limestone. The albite-schists (p. 15), which are "highly micaceous or chloritic rocks with grains or crystals of clear secondary albite," are of special interest. Dr. Teall supplies an analysis, showing 3·2 per cent. of soda and an equal amount of potash. This allows 28 per cent. of the rock to be formed of albite. "Green beds," which are hornblendic, and yet are not the intrusive epidiorites so familiar in Dalradian areas, occur in a band south-east of Loch Fyne, and may have been derived clastically from some preexisting basic igneous series (p. 18). True sills of epidiorite occur, however, plentifully among the metamorphic rocks between Loch Awe and Loch Fyne. In the same region there are numerous later intrusions of quartz-porphyry and other igneous rocks, probably post-Silurian in age. "Kentallenite," described in detail by Mr. Hill in 1900 (Quart. Journ. Geol. Soc., vol. lvi., p. 531), and first known from the Appin promontory, occurs here and there, as a link between

FIG. 1.—The summit of the Pass of Glencroe, with Loch Restil. The rugged hill scenery is formed by the Ben Bheula schists. From "The Geology of Mid-Argyll."

[1] "The Geology of Mid-Argyll." By J. B. Hill, with the collaboration of B. N. Peach, C. T. Clough, and H. Kynaston, with petrographical notes by J. J. H. Teall and J. S. Flett. Pp. vi+166. Memoirs of the Geological Survey, Scotland. (Glasgow, for H.M. Stationery Office: J. Hedderwick and Sons, Ltd., 1905.) Price 8s.

the masses rich in alkalies and the biotite-peridotites. Mr. Kynaston (p. 102) regards this rock, with the granites and diorites of the north-west area, as contemporaneous with the Ben Cruachan granite, that is, as later than the Lower Old Red Sandstone lava-flows. The regional metamorphism of the older rocks of mid-Argyll is not due to these numerous intrusive masses, nor to any concealed dome of granite. It increases in intensity from north-west to south-east, and also along the strike of the ancient sedimentary series in a north-easterly direction, so that comparatively unaltered rocks of the "Loch Awe group" (p. 76) pass, outside the limits of Sheet 37, into schists of a very pronounced degree of crystallisation. Local thermal alteration tends to mask both the original clastic structures and the subsequent foliation (p. 39).

The form of the lake-floors in connection with the passage of ice across them is interestingly discussed in chapter xiii. At the time of maximum glaciation, the upper portion of the Loch Fyne ice moved out westward towards the Sound of Jura, the general south-westerly course being resumed as the ice thinned down again and became guided by the topographic features. It is held that Loch Awe at one time drained southward, when the level of its waters was nearly 200 feet higher than at present.

The economic resources of the district, which are neither conspicuous nor generally accessible, are referred to at the close of the memoir. If petrographic details naturally predominate in such a work, they only testify to the scientific thoroughness with which the Geological Survey is encouraged to explore the Scottish highlands.

THE EGYPTIAN HEAVEN AND HELL.[1]

IN his "Egyptian Heaven and Hell" Dr. Wallis Budge has contributed another work to his already long list of books dealing with the subject of ancient Egyptian religions. It appears in three-volume form in the useful little series of "Books on Egypt and Chaldæa," written by Dr. Budge and Mr. L. W. King, and published by Messrs. Kegan Paul. Those who are interested in the subject are familiar with Dr. Budge's edition of the "Book of the Dead" in the same series. These volumes form a companion work, being an edition of the two subsidiary collections of funerary texts, "The Book of the Am-Tuat (that which is in Hades)" and "The Book of the Gates," which accompanied the great "Chapters of Coming Forth into the Day," the "Book of the Dead" proper. As in the former work, Dr. Budge gives the text, translation, and illustrations from the original papyri.

The two subsidiary books differ somewhat in purpose and scope from the "Book of the Dead" itself. The latter is a collection of spells and "words of magic power" to be learnt by the dead in order to win their way past the dangers of the unseen world into the presence of Osiris. The individual dead man, identified with Osiris, "the Osiris N," is the central figure of every chapter of the "Book of the Dead." "Chapter so-and-so. I, the Osiris so-and-so, say," and so on. But in the Book of That which is in Hades, and in the Book of the Gates, the dead man is not the principal figure. In fact, in the first-named (hereinafter called "The Book of the Tuat") he hardly appears at all; the book is merely a description of the other world as it appears to the beatified spirits who follow the bark of the sun-god in its passage through Hades (the Tuat) from west to east, from his setting to his rising. During the night the dead sun-god, known as Auf ("his limbs," *i.e.* the carcass of the sun), sails through the regions of the underworld to give light to the dwellers therein, and during his voyage the souls of the blessed rise up and join themselves to his boat. It is a weird conception, and the description of these regions of the dark beyond, as given in Dr. Budge's book, is still more weird. The Tuat is divided into several distinct Tuats, each corresponding to one of the great Egyptian necropoles, Abydos, Thebes, Sakkara, and Heliopolis. Each has its peculiar features, and appears to be tenanted by demons and spirits with unpronounceable names and of strange appearance, some of whom are good and help the bark of the god on its way, while others are bad and seek by every means in their power to oppose its progress. These are vanquished in succession as the sun passes their territories. The "Book of the Gates" is so called on account of its chief feature being the successive mention of the gates of the Tuats, each of which has its demon-guardian, who is passed by means of the appropriate spell. In it the

FIG. 1.—The Boat of the Sun towed by Gods of the Tuat. From "The Egyptian Heaven and Hell," vol ii., The Book of Gates.

god Osiris appears, but not to the extent to which he appears in the "Book of the Dead," the chapters of which seem to have originally emanated from the original seat of his worship at Busiris in the Delta. Indeed, the "Book of the Tuat" may be a much later invention of the Theban priests, designed to divert the attention of the faithful from the northern Osiris to the sun-god of Thebes. It is homogeneous in plan, which the "Book of the Dead" is not. Dr. Budge gives a parallel version of both subsidiary books in his third volume, so that they can conveniently be compared. In the same volume are to be found his introduction and a most compendious index.

The pictures of these two books are extremely remarkable. Their general appearance will be well known to those who have visited the tombs of the kings at Thebes, or have seen the wonderful alabaster sarcophagus of King Seti I. in Sir John Soane's museum in Lincoln's Inn Fields. Under the eighteenth and nineteenth dynasties the walls of the royal tombs were decorated with scenes from the "Book of the Tuat" and "Book of the Gates," so that the dead monarchs could see in pictures at least the weird forms which the imagination of the

[1] "The Egyptian Heaven and Hell." By E. A. Wallis Budge, Litt.D. Vol. i., The Book Am-Tuat, pp. viii+278; vol. ii., The Book of Gates, pp. viii+306; vol. iii., The Contents of the Books of the Other World described and compared, pp. xviii+232 (London: Kegan Paul and Co., Ltd., 1906.) Price 6s. net each volume.

Egyptians conceived as inhabiting the tomb-world; and occasionally sarcophagi were ornamented in the same manner. Some of the best illustrations in Dr. Budge's book are taken from the sculptures of Seti's sarcophagus.

The conceptions of the rewards and punishments

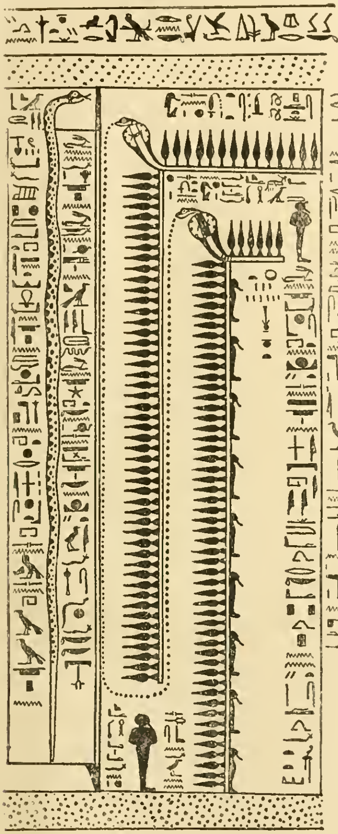


FIG. 2.—The Gate of the Serpent Agebi. From "The Egyptian Heaven and Hell," vol. ii., The Book of Gates.

of the dead in the next world as given in these two books are also well worth the attention of the anthropologist.

ANCIENT ECLIPSES.

THE results of recent discussion of ancient eclipses may for convenience be divided into three sections. The conclusion of each section depends upon the truth of the conclusions of the preceding sections, but not vice versâ, that is to say, the results of the last section may be rejected without in the least impairing the validity of the earlier conclusions. The results are as follows:—

(1) If an astronomer had been asked a year ago by a historian or a chronologist whether the tables of the sun and moon accurately accounted for the recorded phenomena of ancient eclipses, he could only have replied that the tables failed altogether to account for the solar eclipses; that they had been empirically altered so as to account for the observed *times* of certain lunar eclipses; and that the question whether the tables so altered accounted for the *magnitudes* of the same lunar eclipses had not even been examined. There seemed to be no possible modification of the tables that would bring them into harmony with the recorded solar eclipses, and it was therefore the received opinion that the historical accounts of these were untrustworthy. The first result is that two slight modifications of the existing tables will cause them to satisfy the records.

The modifications in question may be stated as follows:—Define the nodical month as the mean period between one passage of the moon from south to north of the ecliptic and the next passage, and define the nodical year as the mean period between one passage of the sun from south to north of the plane of the moon's orbit and the next passage, purely periodic variations being left out of account. Then the eclipses show that the rate of change of length of both the nodical month and nodical year as given in the tables must be altered.

(2) The second section of the results is concerned with the question, "In order to alter the rate of variation of the nodical year, are we to alter the acceleration of the node or of the sun?" Now the motion of the node depends upon theory, and the same theory which accounts for its motion at the present time will suffice to calculate its motion at any time during the last few centuries. The motion of the sun, however, is purely a question of observation. Unknown causes may easily be conceived as altering its motion. The second result is therefore to ascribe an acceleration to the sun's motion to account for the variation in the nodical year inferred from ancient eclipses, or in other words, we may leave out the word "nodical" in our statement and say, "The ancient eclipses indicate certain definite rates of change in the lengths of the month and year."

(3) We lastly require some physical explanation of the sun's acceleration. Here there are many possibilities. The æther may offer a sensible resistance to the passage of the earth; or an electro-magnetic theory of gravitation may compel us to take account of the small, but not infinitesimal, ratio between the velocity of a planet in its orbit and the velocity of light; or again, electrical theories of matter somewhat modify the old conception of mass, and with it the fundamental equations of motion on which planetary theory rests. But the explanation tentatively put forward at the April meeting of the Royal Astronomical Society is as follows:—Let us suppose the acceleration of the sun to be due to a change in the length of the day caused by tidal friction. The tides check the rotation of the earth, lengthen the day, and therefore apparently increase all diurnal movements by the same fraction of their whole amounts. Introducing numbers for greater definiteness, let us suppose that in a century the day increases in length by a two-hundredth part of a second of time. Then in a century the sun's apparent rate of motion will increase by one part in seventeen million, which is exactly the change indicated by the eclipses. If, however, the moon's apparent rate of motion also increased by one part in seventeen million the acceleration would be ten times larger than that indicated by the eclipses.

But if the tides are checking the diurnal rotation of the earth, it follows from the principle of conservation of angular momentum that the moon must be receding from the earth, and absorbing the spin lost by the earth. This implies that the moon is really moving more slowly. It is impossible to make accurate calculations, for the action of the tides on an earth with oceans and continents of irregular shape cannot be computed, and it is impossible to say how the tidal action varies for different positions of the moon in its elliptic orbit. Hence we cannot say how far the action of the tides is distributed between changes in the length of the month and changes in the eccentricity of the moon's orbit. But it seems a plausible hypothesis that the large eccentricity of the moon's orbit was evolved somehow, presumably by tides, and that the eccentricity is therefore increasing, and calculation shows that if the rate of increase assigned to the eccentricity be about one-hundredth of a second of arc a century, the consequent change in the absolute angular velocity of the moon is such as to cancel nine-tenths of the apparent decrease in the length of the month, leaving the remaining one-tenth in agreement with the change inferred from ancient eclipses. This explanation, it should be clearly understood, only shows that certain correlated quantities are of the right order of magnitude: it is unable to prove or disprove an exact numerical relation.

In the remaining part of this article the basis of the conclusion of the first section is examined. That is the foundation, which must be rendered secure before interest can attach to any superstructure.

Let us select a definite eclipse, for instance, the eclipse of Thucydides in the first year of the Peloponnesian War. The record states that stars appeared. It is certain on the other hand that the eclipse, at the most, could only have been annular. There is therefore a strong presumption that Athens was not far from the central line of the eclipse, or in other words, at the time of conjunction in longitude as seen from Athens, the difference of apparent latitudes must have been small. The hypothesis that Athens was the place of observation has been objected to. This however is the natural interpretation of the passage in Thucydides; let us adopt it for the present and see where it leads. For Athens, therefore, let the difference of apparent latitude for the instant of apparent conjunction in longitude be computed from the present tables. The result is so large as absolutely to negative the possibility that stars could have been seen. Reserving the hypothesis that the record is untrustworthy as a last refuge in case of trouble, let us suppose for the present that the tables require alteration.

What kind of alteration is permissible? It has been argued in *Ast. Nach.*, No. 3682, on physical grounds, that only one unknown quantity may be introduced. Now against physical reasoning of this kind, strong objections may be urged. It proceeds necessarily on the assumption that the general nature of the problem of the apparent motions of the sun and moon is fully understood. It absolutely limits the investigation to the numerical determination of quantities connected with a preconceived theory, and it prevents, at the outset, the attainment of results of a new character. Now as the preconceived theory was entirely based upon two centuries of observation, there is no improbability in our knowledge being widened, when the period of observation is largely increased. In the whole of astronomy there is not a single case of a theoretical value of a secular term, that is to say, a term proportional to the square of the time, being confirmed by observation. This is because the series of modern observations is not yet long enough. Is it not possible that one or two centuries hence the observed values of these terms will lay bare a whole series of new phenomena? Physical considerations of the kind alluded to absolutely prevent the achievement of such a result. They may advantageously be replaced in the following manner by considerations of a purely geometrical character.

It being, for a time at least, granted that the eclipse of Thucydides suggests that the existing tables require large modifications, geometrical considerations tell us, that in order to diminish by 200″ or thereabouts the difference of latitude at conjunction, we must alter the mean distances of the sun and moon from the node as given by the tables for the year −430 by quantities of the order of 2000″. The only geometrical alternative is to assume alterations ten times as large in some other quantity such as the position of the perigee, and this alternative may be put aside. Now the mean distances can be expanded in powers of the time, the origin of time being taken near the present day. Then modern observations forbid the correction of the mean motions or of the terms independent of the time. The corrections are therefore necessarily thrown about the coefficients of the square of the time, that is to say, upon what are called the secular terms, in the mean distances of the sun and moon from the node. Geometrical considerations therefore, combined with a becoming modesty as to our powers of applying physical considerations, present us with two unknown quantities for correction, one of which is the quantity admitted in *Ast. Nach.*, No. 3682 to be arbitrary, while the other is a new one.

If the preconceived theory is correct and the records are trustworthy the value of the second variable will on solution turn out to be zero or so nearly zero as to suggest that zero is the true value. If no values satisfy all the equations of condition, then some of the records are untrustworthy or the geometrical considerations have been carelessly thought out. If the equations can be satisfied simultaneously, and the value of the second variable is not zero, a very strong case is established against the physical considerations of the preconceived theory.

If we write down five simultaneous linear equations in two unknown quantities x and y, all satisfied by the same values of the variables, and if we then put y equal to zero, or in other words, rub out the terms in y, we shall of course find the equations in x are inconsistent. If the equations represent historical data, and if, as men of science, we have a proper contempt for literature, we shall no doubt proceed to quarrel with our evidence. This is exactly the way in which astronomers have in the past treated ancient solar eclipses. When, however, equations of condition involving two unknown quantities are formed for all the solar eclipses in which the place of observation appears to have been fairly near the central line, whereas modern tables give residuals of the order of 200″, that is to say, make the apparent differences of latitude at conjunction in longitude of the order of 200″, values can be found for the unknown quantities, which will make all the residuals less than 50″; in other words, whereas the present tables would leave about ten per cent. of the sun's diameter visible, the alterations proposed never leave so much as two per cent. visible.

Let it be here stated that no solar eclipse is an exception to the above statement. The conclusions rest, not upon the evidence of a majority but upon the unanimous evidence of all eclipses used. A list of these is given in Monthly Notices, lxv., p. 861, and a reference is given on p. 867 to the eclipse of Agathocles. The eclipse of Thales has not been worked up as it occurred a hundred years before the birth of Herodotus; its evidence, whether for or against, is held to be inadmissible.

A confirmation of these results is supplied by the lunar eclipses of the Almagest. On working them up, it is found that the residuals are so large as to show that they are entitled to far less weight than the solar eclipses. Their value lies in the fact that the separate determinations from the lunar eclipses group themselves round the values derived from solar eclipses. The lunar eclipses are given in Monthly Notices, lxvi., pp. 6–7; they are nineteen in number, and in only ten cases is a numerical estimate of the magnitude recorded. These ten cases alone therefore test the newly-discovered fact which, in language that becomes appropriate only if the second section of results is admitted, states that the earth's orbital motion is subject to a secular acceleration of $4''$. Now of the ten lunar eclipses available, seven give accelerations lying between $2''$ and $6''$. It is therefore hard to believe that zero and not $4''$ is the correct value. The times of the lunar eclipses are equally striking in their confirmation of the result. Nearly thirty years ago a correction was introduced into Hansen's Tables based upon these eclipses. The main question is one of evidence. It is no use to point out in the third section of this paper how certain changes may be accounted for, if they are not shown to exist. On the other hand, no objections to a particular explanation of the physical reason can weaken the case for the observed fact that these changes are taking place. What is sufficient evidence? Two eclipses would suffice, if they had been described with a wealth of detail that established complete confidence in the records. A hundred eclipses of the actual sort would probably satisfy the most sceptical, even though the place assigned were always "tacitly assumed (to be) the capital where the record was made, or the place where the poet or historian lived." The smaller number of eclipses, which it has alone been possible to produce, should suffice to make a case almost if not completely amounting to certainty.

P. H. COWELL.

VARIATIONS OF DOMESTIC POULTRY.[1]

THE book under notice is one of an original character. It is an attempt to describe all the different races of domestic poultry that exist in various parts of the world, and as such is not without its value, as it gives us a description of the races of fowls as they exist, not only in Asia, but in the various States of Europe and the United States of America. The book treats almost solely of the races of fowls from a fancier's point of view. The plumage and external characters which would be noticed in a show-pen are those that are dwelt upon, and as a scientific treatise the work cannot be regarded as having any special value, and would be unfairly treated if it were regarded from the same standpoint as Darwin's "Variation of Animals under Domestication."

The illustrations, which are very numerous, are not original, but taken from the fancy poultry journals, where the birds are drawn with the usual exaggeration of the points valued by the fancier, and bred for securing prizes. The consequence is that some of them are good and others quite the reverse, but the plumage in many is exaggerated. To scientific ornithologists this history of the location of colour in the different parts of the plumage of birds, and the fixture of the patterns in the races, is one of considerable interest. To those acquainted with the details of poultry breeding it is well known that any variation of the colour or texture of feathers which appears in any particular specimen can, by careful selection of the offspring, for a series of generations, be readily perpetuated, and by crossing with other varieties almost any pattern or disposition of colour can be obtained, and what is called a new breed formed. This is illustrated by the engraving, which we borrow from the work, of a German race at present but little known in this country, called the Lakenfelder. In this the colours are transposed from their general position, and a remarkable looking fowl is produced, which is correctly represented in the engraving.

It is of much scientific interest to trace the extent of the variation which can be induced by careful breeding. In the fowl, these variations have been almost exclusively confined to the plumage, which in some instances has been increased to an enormous extent, as in the production of quill feathers 8 inches long on the feet of the show Cochin, and the general

FIG. 1.—Lakenfelders. From "Races of Domestic Poultry."

increase of the plumage to a great extent, so that the modern show Cochin does not at all resemble the original birds brought from Shanghai. In other cases the plumage has been partially abolished, as in the Nackthälse or Transylvanian naked necks, in which the head and neck are entirely denuded of feathers, and the skin assumes the red colour of the comb. These variations are permanent, and are intensified by long-continued breeding. The production of spangles or dark markings at the end of the feathers, of bordered margins of black on a light ground in the whole of the body feathers, and of regular transverse bars across each feather of the plumage, have all been accomplished and perpetuated by careful selection.

The various breeds of ducks, geese, and turkeys are also treated of.

The work contains in an appendix a very elaborate and useful list of the names of the races in all the European languages, which will prove of great value to all investigating the subject of variation.

W. B. TEGETMEIER.

[1] "Races of Domestic Poultry." By Edward Brown. Pp. xi+234; illustrated. (London: Edward Arnold, 1906.) Price 6s. net.

NOTES.

THE gentlemen's conversazione at the Royal Society will be held on Wednesday next, May 9.

THE summer meeting of the American Chemical Society will this year be held in Ithaca, N.Y., on June 28–30.

IT is announced that the German Government has issued invitations for an International Conference on Wireless Telegraphy to meet on June 28.

THE sixth International Congress of Applied Chemistry was opened at Rome on April 26 by the King and Queen of Italy in the presence of the Diplomatic Body, the members of the Cabinet, high officials of the State, and about two thousand delegates. Speeches were delivered by Prof. E. Paternò, president of the congress, Signor Boselli, Minister of Public Instruction, Prof. O. Witt, and delegates of the chief nations represented at the congress. The British delegates are Prof. W. A. Tilden, F.R.S., Prof. W. N. Hartley, F.R.S., and Dr. J. J. Dobbie, F.R.S.

A REUTER telegram from New York states that the new French liner *La Provence*, when 1800 miles from Poldhu and 1700 miles from Cape Cod, on April 25 at 2 p.m., simultaneously communicated by wireless telegraphy with both stations, and received answers from both.

ACCORDING to the *Chemiker Zeitung* there were 183,532 persons connected with chemistry who were insured against accident in Germany in 1904: of these, 1535 cases received compensation from the insurance companies. This number includes 109 cases of death, 14 completely and 1040 partially incapacitated from following their vocation in life, whilst 372 were only for a time unable to work; the amount paid to the injured or the relatives of the deceased was nearly 2,200,000 marks.

IN honour of the International Medical Congress to be held in Lisbon this year, there has been opened a small exhibition of the products of the Portuguese colonies in the rooms of the Colonial Museum. The exhibits, which are chiefly from Cape Verde, Mozambique, the Portuguese Indies, Angola, Timor, and Guinea, deal almost exclusively with wool, coffee, cocoa, and india-rubber; palm oil, &c., and other raw materials of the fatty and oil industries, although important exports of the Portuguese colonies, are not represented.

ARRANGEMENTS are being made to hold a "Country in Town" exhibition at the Whitechapel Art Gallery in July. The object of the exhibition is to show East Londoners what can be done to bring into the neighbourhood something of the beauty of nature. It is proposed to show living things, pictures and models, materials and appliances, plans for the improvement of certain areas in London, and exhibits explaining city life in Japan and other countries. Contributions towards the necessary expenses are asked for, and these may be sent to the Rev. Canon Barnett at Toynbee Hall, E.

THE ninth annual meeting of the Childhood Society will be held on Tuesday next, May 8, at the residence of the president, Earl Egerton of Tatton. Sir Edward Brabrook, C.B., will deliver an address. The chief object of the society is to promote the study of educational methods and of the environment of children during school life, best suited to ensure satisfactory mental and physical development of children. The society numbers among its members representatives of educational science, teachers, medical experts, and others interested in the investigation of mental and physical conditions of childhood.

EARTHQUAKE shocks have again been common during the past week. Reuter's messages show that on April 25 a disturbance was felt at 3.15 p.m. at San Francisco, and lasted nearly a minute. This shock was also felt at Oakland and Berkeley. On April 26 shocks were felt at Salinas, 100 miles south of San Francisco, at 8 p.m. and 9.50 p.m., and these were followed by a third on April 27 at 2 a.m. Each of these three disturbances lasted about four seconds. A later telegram reports that earthquakes were felt at Salinas every day from April 18 to 27. On April 27, too, four disturbances of increasing intensity were felt at Dresden, and on April 28 in Schönberg, Brambach, and other places in the Vogtland district. Two slight shocks were felt at San Francisco on the morning of April 30.

IT is arranged that the International Association for Testing Materials, which holds its congresses about every three years in industrial centres in various countries, shall this year meet in the Academy of Science at Brussels on September 3–8. The King of Belgium has accorded the congress his patronage, while Prince Albert of Belgium will be one of the honorary presidents, as also will the Ministers of Finance, Railways, War, and Trade, and the Mayor of Brussels. Among the papers to be read will be one on the industries of Belgium, by Baron E. de Laveleye and M. Camerman. It is expected that a considerable number of members and delegates from this country will be present at the congress. Mr. J. E. Stead, F.R.S., Middlesbrough, is the English secretary of the association.

AT the annual general meeting of the Institution of Civil Engineers, held on April 24, Sir Alexander B. W. Kennedy, F.R.S., was elected president of the institution. The council has made the following awards for papers read and discussed before the institution during the past session:—A Telford gold medal to Mr. J. A. Saner, a Watt gold medal to Mr. G. G. Stoney, and a George Stephenson gold medal to Dr. T. E. Stanton; Telford premiums to Mr. Leonard Bairstow, Mr. H. S. Bidwell, Mr. J. J. Webster, Mr. Cathcart, Mr. W. Methven, Mr. H. A. Mavor, Sir Frederick R. Upcott, K.C.V.O., C.S.I., and a Manby premium to Mr. D. E. Lloyd-Davies. The presentation of these awards, together with those for papers which have not been subject to discussion, and will be announced later, will take place at the inaugural meeting of next session.

IN Tennyson's "Palace of Art" occur the lines:—

> "She saw the snowy poles and Moons of Mars,
> That mystic field of drifted light
> In mid Orion, and the married stars."

This at first sight looks like a literary parallel to Swift's well-known fortuitous forecast of the discovery of the Martian satellites, and Mr. J. S. Stevenson, writing from Blairavon, Norwood, Ceylon, points out that Prof. H. H. Turner quotes it in "Modern Astronomy" as having been written in 1835. This, however, appears not to have been the case; for Mr. Stevenson, on reference to the biography of the late poet laureate by the present Lord Tennyson has found the note, "The 'Moons of Mars' is the only modern reading here, all the rest are more than half a century old." Scientific discovery was thus not anticipated by Tennyson in the mention of Martian satellites.

THE Paris correspondent of the *Times* made the following announcement in a message on Monday night:—"The Prince of Monaco formally announced to the French Minister of Education to-day his decision to establish in Paris the Oceanographic Institute that he has founded. He will endow the institute with the magnificent museum now existing at Monaco, including its laboratories, collections, aquaria, &c. The Prince has set apart 4,000,000 francs (160,000*l.*) for the maintenance of the institute. It will be established on grounds recently bought by the University of Paris with the assistance of the Prince in the rue Saint-Jacques and the rue d'Ulm. The scientific direction of the institute is vested in an international committee of specialists in oceanography. The French Government has expressed its formal thanks for this really princely gift."

The first of a series of four lectures on atmospheric circulation and its relation to weather was delivered by Dr. W. N. Shaw at the University of London on Tuesday, May 1. Dr. Shaw referred to the valuable contributions to meteorology in the last fifty years by Dr. Buchan, Abercromby, and Clement Ley, and he pointed out that, so far as the forecasting of the weather is concerned, no great advance has been made in recent years, and that it is necessary to take into consideration the atmosphere in the upper regions and to deal with the general circulation as a whole. Great advance has been made recently in that way by the use of kites and balloons, and the direction of the air currents in the higher regions can be determined from the records of the barometer, thermometer, and hygrometer obtained in those ascents. Some very interesting diagrams were thrown on the screen, showing the circulation at a height of 4000 metres, from charts constructed by M. Teisserenc de Bort, and also showing the results of international upper-cloud observations as deduced by Dr. Hildebrandsson for various parts of the globe.

The contents of Irish Fisheries Scientific Investigations, 1904, No. 6 (1905), includes a paper on "plankton" collected at light-stations, by Dr. L. H. Gough, and hydrographical observations made at the same. In connection with the plankton, it is noticeable that when this comprises a large number of copepod crustaceans, the vegetable organisms are much less numerous than usual, and *vice versâ*.

The four articles in the April issue of the *Zoologist* are equally divided between birds and fishes. In recording the rare birds seen in Norfolk during 1905, Mr. John Gurney again notices the occurrence of quite a number of avocets on Breydon Flats. The birds of Derbyshire, as observed in 1904–5, form the subject of an article by the Rev. Mr. Jourdain. Mr. L. E. Adams describes his own observations on the mode of flight of flying-fishes, while Prof. McIntosh discusses certain Japanese food-fishes.

Six new fishes from Japan, described by Messrs. Jordan and Seale, form the subject of No. 1445 of the Proceedings of the U.S. National Museum; while the succeeding number of the same journal (No. 1446) is devoted to descriptions of new American Palæozoic ostracod crustaceans, by Messrs. Ulrich and Bassler. In No. 1447 of the Proceedings Mr. J. W. Gidley describes the skull of a ruminant allied to the musk-ox from Pleistocene strata in New Mexico. The new generic name Liops is proposed for this ruminant, which is of special interest on account of its southern habitat.

The trustees of the Indian Museum, Calcutta, according to the report for the past financial year, have decided to charge an admission-fee of 8 annas on Sundays between the hours of 3 p.m. and 5 p.m., in order to give the educated classes an opportunity of studying the contents of the galleries under more favourable opportunities than has been hitherto possible. As a rule, the galleries are absolutely crowded with members of the illiterate class throughout the time when they are open to the general public. It is proposed greatly to enlarge the museum, at an estimated cost of 2½ lakhs of rupees a sum apparently already at the disposal of the trustees.

Mr. F. A. Lucas, curator of The Museum, Brooklyn Institute of Arts and Sciences, Brooklyn, N.Y., desires to direct attention to a photograph of Laysan Island, issued several years ago, showing on the beach a large turtle, and, what is more important, a large seal, which appeared to be of the genus Monachus. He points out that if this seal really belongs to the genus Monachus, the fact is of great scientific interest, as it would make the seal circumtropical. Mr. Lucas would be glad to know if anything has been published regarding this seal, specimens of which he believes were taken to Europe.

A pamphlet has reached us containing an address delivered by Dr. Paul Kronthal before the Berlin Psychological Society in October of last year on the idea of the soul (Jena: Gustav Fischer). The lecturer, continuing the investigation of which notice has already been taken in these columns, elaborates his account of the soul as the sum of reflexes. This definition, he claims, does justice to all the facts, *e.g.* of inheritance of physical characteristics, of mental disease, of memory, and the like. He occupies several pages with a discussion of the freedom of the will, a conception which, it appears, is abandoned by all consistent theologians, men of science, historians, and jurists. But it appears also from the later half of the lecture that to define the soul as the sum of reflexes satisfies only natural science; from the standpoint of metaphysics we must speak of the soul as sensation. Apparently, too, the metaphysical view leads directly to solipsism, and the metaphysical world consists of abstractions like love, hate, joy, sorrow, good, bad. The world of the scientific man, on the other hand, is made up of five entities, which at first sight appear very real as compared with these abstractions, but which are ultimately admitted to be five metaphysical ideas—time, space, matter, energy, number. It is further admitted that the fundamental law of causality is for natural science undemonstrable. Dr. Kronthal concludes his somewhat paradoxical lecture with two dicta—that the honourable metaphysician must grant that the conceptions of natural science are the more justifiable, and that no thoughtful man of science can deny that the conceptions of natural science are in the last resort only matters of faith.

A catalogue of microscopical objects and accessories has been received from Mr. R. G. Mason; a special feature is made of geological and stained botanical sections that can be mounted by purchasers. A section of limestone sent as a sample of the mounted objects shows a variety of Foraminifera, and is otherwise a desirable specimen, also a double-stained section of pine stem is a thoroughly satisfactory preparation.

The second number of the *Journal of Economic Biology* contains papers on the effects of metazoan parasites on their hosts, by Messrs. Shipley and Fearnsides; on the bionomics of grain weevils, by Mr. F. J. Cole; on the deposition of eggs and larvæ in *Œstrus ovis*, by Mr. W. E. Collinge; and on the ox-warble flies, by Mr. A. D. Imms. The reviews and current literature, with notes, which complete the number are a valuable feature of the journal.

A SERIES of identifications of Philippine plants is published in Publication No. 35 of the Bureau of Government Laboratories, Manila. Mr. H. N. Ridley has worked out the Scitamineæ, describing three new species of Amomum; Mr. C. B. Clarke has named the Acanthaceæ; Dr. E. Häckel has identified a collection of grasses; and Mr. E. D. Merrill contributes some notes on Cuming's Philippine plants, as well as the fourth series of diagnoses of new or noteworthy plants. Among the latter are two new species of Rhizophoraceæ, a Gynotrochea growing in forest at an altitude of 4000 feet, and a Pellacalyx, also new species of Eugenia and of Saurauia.

THE original habitat of the coconut palm has often been the subject of speculation. In a paper read before the Ceylon branch of the Royal Asiatic Society, Mr. J. Ferguson, tracing the early history of the cultivation of the coconut palm in Ceylon, accepts the general dictum that the plant is not indigenous, and attributes its origin to nuts washed up by the sea. It is recorded that, at the instigation of a Singhalese king, a plantation was formed on the south coast as early as the middle of the first century, and subsequently King Prákrama Báhu the Great also interested himself in extending its cultivation.

IN the Journal of the Royal Horticultural Society (vol. xxix., part iv.) Mr. E. S. Salmon describes a white mildew disease that has been prevalent on shrubs of *Euonymus japonicus* in the south of England. From the mycelium on the surface of the leaf, hyphæ are produced that pierce the cuticle of the epidermis and form haustoria in the epidermal cells, thus enabling the fungus to maintain its parasitic life. The mycelium persists on the leaves through the winter, so that perithecial resting spores are not required and are not formed. The disease can be checked by collecting and burning in the winter all leaves that bear the white patches of hibernating mycelium; also treatment with sulphur or other fungicides is recommended.

THE paper on ramie read by Mrs. E. Hart before the Society of Arts, and printed in the Journal of the Society (April 6), is interesting, not only as it indicates some of the difficulties that had to be overcome in spinning and weaving, but also because it bears out the opinion that, given cooperation between producer and manufacturer, the cultivation, preparation, and weaving of ramie can be profitably undertaken. In the matter of decortication, Mrs. Hart advocates hand-stripping in preference to machines wherever cheap labour can be obtained, and recommends that the degumming process should be carried out under expert supervision in the mills. The fabrics that have been woven of pure ramie, warp and weft, vary from the lightest gossamer to a heavy cloth.

IN Hawaii, root disease of the sugar-cane produced by a species of the basidiomycetous fungus Marasmius—not improbably *Marasmius sacchari*—is so prevalent that a Bulletin (No. 2 of the Division of Pathology and Physiology) has been issued to provide information on the subject. The writer, Mr. L. Lewton-Brain, traces the connection between the fungus that attacks primarily the growing point of the root and the symptoms, similar to those caused by drought, of rolled-up leaves, matted leaf-sheaths, and undeveloped roots; also he indicates how the plant can be strengthened by judicious irrigation and by liming the soil. A variety possessed of a certain power of resistance to the disease has been found in the Yellow Caledonia, but a variety that is perfectly immune has yet to be discovered.

THE *Naturwissenschaftliche Wochenschrift* (vol. v., No. 8) contains a long paper by Dr. W. R. Eckardt on the climatic conditions of past geological times. The author deals specially with the climate of the Carboniferous and Tertiary periods, and concludes that the explanation of all changes of climate is to be sought in variations in the distribution of land and sea.

WE have received a copy of the tide tables for Charlottetown, Picton, and St. Paul Island, C.B., for the year 1906, issued by the Department of Marine and Fisheries of the Dominion of Canada. The tables are based on direct observations made at eleven localities in the south-western portion of the Gulf of St. Lawrence and in Cabot Strait. It has been ascertained that the tides can best be deduced from St. Paul Island, for which continuous records extending over four years are available.

DR. WALTHER VON KNEBEL contributes a paper to the *Naturwissenschaftliche Rundschau* (vol. xxi., No. 12) on the hot-spring areas of Iceland. A careful comparison of the conditions occurring in the regions of geysers and of solfataras leads the author to the conclusion that only a small part of the water ejected by the geysers is "juvenile," the bulk of it coming from the ordinary ground water. Geysers occur, in effect, where ground water is abundant and volcanic action relatively feeble, and solfataras where volcanic action is more vigorous and the amount of ground water deficient.

WE have received a copy of the meteorological records for 1905, published in the second annual report of the Agricultural Department of the British East Africa Protectorate, which extends, roughly speaking, from 5° N. to 5° S. latitude, the sea coast north of the equator forming part of the Italian Somaliland. The report contains rainfall observations at a large number of stations, and general observations at eight stations, several of which exceed 6000 feet in altitude. The work is a valuable contribution to meteorological knowledge, and will be found most useful when arrangements can be made for dealing with the meteorology of all our colonies according to some regular and properly organised plan. A good beginning was made in this direction by the Meteorological Council in a work entitled "Climatological Observations at Colonial and Foreign Stations, I., Tropical Africa," published in 1904, from tables prepared by Mr. E. G. Ravenstein. This work contained results from several of the stations included in the report of the Nairobi Agricultural Department.

IN his last report as secretary of the Smithsonian Institution of Washington, the late Dr. S. P. Langley dealt with the work of the Astrophysical Observatory for the year ending June 30, 1905. The evidence of solar variability is not in the report considered as conclusive. However, two lines of investigation have become very prominent in the work of the observatory, and these will almost certainly lead to a conclusion regarding this important question. The first of these is the almost daily bolometric examination of the large solar image formed by the great horizontal telescope, for the purpose of detecting changes in the transparency of the solar absorbing envelope. This work depends so little on the transparency of the earth's atmosphere that it can be done almost as well in Washington as at a station more favoured as regards atmospheric transparency. The year's work did not give evidence of very marked variations either in the transparency of the sun's envelope or in the supposedly dependent mean temperature of the earth, but, on the contrary, the results of the observations continued most of the time near the mean in both respects. The second line of investigation is the determination of the total solar radiation outside our atmosphere, by observations with the bolometer and pyrheliometer at a station situated in a relatively clear and cloudless region and at a considerable altitude. This work is being done on Mount Wilson, in southern California, and it seems that the estimates it is hoped to obtain there will be so close an approximation to the truth that if a notable variation of solar radiation outside our atmosphere occurs the results will show it.

THE much-debated n-rays form the subject of a short note by Dr. P. Stefanelli in the *Rendiconto* of the Naples Academy, xi., 12. Referring to Meyer's experiments on the decrease of phosphorescence in sulphide of lime when placed in the glass receiver of an air pump, Dr. Stefanelli considers the effects to be attributable to the fall of temperature produced by the expansion of the air, and not to depend on the existence of n-rays for their explanation.

IN NATURE of January 11 (vol. lxxiii., p. 246) Mr. C. E. Benham pointed out that Swedenborg in his "Principia," published in 1733, constantly regarded both heat and light as ethereal undulations. Mr. I. H. H. Gosset, of St. Aubyns, Hove, now informs us that, as a matter of fact, in the year 1719, fourteen years before he published his "Principia," Swedenborg wrote a treatise "On Tremulation," in which he advanced the theory of ethereal undulations as applicable to our vital forces, light, heat, sound, &c.

IN the *Philosophical Magazine* for April, Prof. Alfred W. Porter discusses the inversion points of the Joule-Kelvin effect for a fluid passing through a porous plug. The paper is a simple and straightforward deduction from the laws of thermodynamics. The condition that an infinitesimal difference of pressure on the two sides of the plug should give rise to no "cooling" or "heating effects" is given by the equation $\mathrm{T}dv/d\mathrm{T}-v=0$, and when the pressure-volume-temperature equation is given, this condition determines a curve in the p,T or v,T diagram formed by the inversion points. Prof. Porter's paper is mainly taken up with examining the form of this curve corresponding to various assumed equations of state, such as that of van der Waals or Dieterici. From the form of the curves it is shown that in general two inversion temperatures exist for the same pressure, between certain limits of pressure; in the case of van der Waals's equation, the maximum limit is nine times the critical pressure. Finally, the author points out that the experimental study of these inversion curves affords a very valuable method of testing the relative validity of different equations of state. Theoretically also a knowledge of the inversion curve and the equation of state referred to any given thermometric scale afford sufficient data to determine the relation between that scale and the absolute temperature.

ACCORDING to the annual report of the Badische Anilin- und Soda-Fabrik, the price of artificial indigo is now one-third less than that of the natural product, the yield of which was last year so small that the requirements of the eastern markets could not be satisfied.

IN the *Far Eastern Review* (vol. ii., No. 9), a monthly engineering journal published at Manila, Shanghai, and Yokohama, Mr. A. C. Hobble gives some excellent illustrations of the largest hydroelectric installation in southern Asia, at the Cauvery River Falls, in Mysore. There is a fall of 400 feet. Power is transmitted at a pressure of 35,000 volts over duplicate 3-phase lines a distance of 92 miles to the Kolar gold mines.

IN the *Chemiker Zeitung* we read of a serious laboratory accident to Dr. Franz Wartensberger, a German chemist, who is credited with having discovered a new explosive considerably more violent than dynamite, and to whom it is said that the American Government offered to pay one million dollars for the explosive, provided its discoverer were able to suggest a suitable method of firing it electrically instead of using a fuse. As Dr. Wartensberger was experimenting with this idea in mind an unexpected explosion is supposed to have taken place, and he was so badly hurt that it is doubtful whether he will recover.

THE ash of the Vesuvius eruption contained, according to Prof. Zinno's analysis, various quantities of silica, alumina, lime, magnesia, iron, and manganese; traces of ammonium chloride were frequently found, but these may possibly have been formed after the ash had fallen. No indications of either free sulphur or of free acid were detectable. The deposit of the ash is held to have been beneficial to vegetation rather than the reverse, especially in the growth of vines, grass, and vegetables, a fact that has been observed on other occasions.

IN an interesting note to the *Chemiker Zeitung* for April 21, Dr. M. C. Schuyten, of Antwerp, directs attention to the differences of temperature which are observable in chemical drying cupboards. Dr. Schuyten was led to consider the question experimentally from the fact that mercury phenyldimethylpyrazolone bromide was found to melt in a drying cupboard when the thermometer did not register a temperature so high as its melting point. The temperature of the air in the cupboard was observed in the great majority of cases to be very much less than that of the walls and shelves; a volatile liquid placed in a vessel in direct communication with the case evaporated much more quickly than when suspended by threads. From the numerical data given variations of 20° C. and more are noticeable.

WE learn from the *Chemist and Druggist* that the Committee on Ways and Means, which sat at Washington on March 30, authorised a favourable report on the Free Alcohol Bill, which removes the internal revenue duty from denaturised alcohol for use in the arts and sciences. The Bill has the approval of Commissioner Yerkes, and it is estimated that the annual loss in revenue will not exceed 100,000*l*., and may not be more than 60,000*l*. It is held that the Bill will be of great benefit to manufacturers, and will afford an enlarged market for farm products from which alcohol is made. The sale of denaturised alcohol as a beverage or for liquid medicinal purposes is forbidden by the measure.

THE following particulars of two prizes offered by the French Government may prove of interest to industrial chemists:—(i.) The methylation of alcohol (prize of 20,000 francs). (1) The smell and taste of the proposed methylating addition must be such as to preclude the use of methylated alcohol as a drink; (2) the smell of the methylating addition must, however, not be so objectionable and strong as to prove harmful to those engaged in the manufacture of or in industries using methylated spirits, that is to say, the use of such bodies as acetylene, asafœtida, garlic, &c., is not permitted; (3) the method of methylating adopted may not leave any deposit on the wick or on any part of the lamp, if likely to interfere with the process of burning, as, for example, sea salt, sodium sulphate, alum, tincture of aloes, &c.; (4) the methylating additive may not be separable by fractional distillation; (5) it may not contain any substance which will attack the metallic parts of lamps or motors, *e.g.* ammonia, nitrobenzene, sulphuric acid, carbon bisulphide, &c.; (6) nor may it be poisonous; (7) further, its cost must not be so high as to prejudice the use of methylated spirits for industrial purposes or household use; (8) its presence in methylated alcohol must be easily detectable; (9) it must possess advantages over that now in use in France, and not permit of any swindling of the Excise. It might be remarked that the discovery of a methylating additive which shall fulfil all the foregoing conditions is a matter of great difficulty; indeed, four years ago the Russian Government offered a prize of about 50,000 marks for a similar purpose, without, however, as yet having had a satisfactory entry. (ii.) The use of alcohol for illuminating purposes (prize of 50,000 francs). In this the competitors are allowed full scope as to the proposed system to be followed in order that alcohol may be used for illuminating purposes under the same conditions as petroleum. Suggestions, together with the necessary apparatus and methods of using, are to be sent to the Chef du Service des Laboratoirs du Ministère des Finances, 11 rue de la Douane, Paris.

IT was pointed out recently by a correspondent of the *Times* that though in the manufacture of pig-iron before 1880 England was preeminent, and the product was 50 per cent. more than that of the United States and Germany combined, yet ten years later the former country produced more than England, and the United States and Germany together twice as much. In 1903 Germany produced more than England, while the United States alone produced twice as much as England. In 1880 England produced 45 per cent. of the world's make, Germany 15 per cent., the United States 14 per cent. In 1903 the United States produced 39 per cent., Germany 20 per cent., and England only 19 per cent. With steel the case is even worse. Since 1880 steel has replaced wrought iron in nearly all manufactures, and in 1830 the United States and Germany manufactured about 30 per cent. less than England. In 1888 the United States equalled England. In 1893 Germany nearly equalled, and the United States largely exceeded England. About 1898 Germany's manufacture was much greater than that of England, and America's manufacture three times as great. These figures show that during the last twenty-five years England has receded from a position of great preeminence to the lowest place among the three great steel-producing countries. On the other hand, between 1900 and 1905, the importation of iron and steel into England increased very largely, the importation in 1905 being 1,435,000 tons, as against 741,402 tons in 1900.

MESSRS. E. DENT AND CO. have lately introduced a new astronomical clock which should find its way into many observatories where an accurate instrument is required at a moderate cost. For the sum of 21*l*. they supply a clock with a 10-inch dial, dead-beat escapement, and wooden rod seconds pendulum in a solid mahogany case; and after examining the instrument we have no hesitation in pronouncing it a marvel of cheapness.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN MAY:—

May 1–6. Epoch of Aquarid meteoric shower (Radiant 338° – 2°).
2. 17h. Mercury at greatest elongation, 26° 46′ W.
4. 10h. 4m. Minimum of Algol (β Persei).
5. 13h. 33m. to 14h. 3m. Moon occults γ Virginis (mag. 3·0).
6. 2h. Venus in conjunction with Mars. (Venus 0° 5′ S).
May 11. 15h. Venus in conjunction with Jupiter. (Venus 1° 11′ N.).
15. Venus. Illuminated portion of disc = 0·921. Of Mars = 0·990.
18. 0h. Mars in conjunction with Jupiter. (Mars 1° 6′ N).
20. 23h. Ceres in conjunction with Moon. (Ceres 1° 6′ S.).
24. 5h. Mars in conjunction with Moon. (Mars 4° 57′ N.).
,, 11h. 46m. Minimum of Algol (β Persei).
25. 3h. Venus in conjunction with Moon. (Venus 4° 51′ N.).
27. 8h. 35m. Minimum of Algol (β Persei).

COMETS 1906*a* AND 1906*c*.—The results of a number of observations of comets 1906*a* and 1906*c*, made at the Royal Observatory at Arcetri during February and March, are recorded in No. 4083 of the *Astronomische Nachrichten* by Prof. Abetti.

The same journal also contains the following set of elements, and an ephemeris extending to May 8, for comet 1906*c*, computed by Herr E. Strömgren from places determined on March 19 (Nizza), 22 (Glasgow, Mo.), and 29 (Arcetri).

Elements.

$$T = 1906 \text{ Feb. } 20{\cdot}7555 \text{ M.T. Berlin.}$$
$$\left.\begin{array}{l}\omega = 274^\circ\ 46'{\cdot}4 \\ \Omega = 71^\circ\ 47'{\cdot}7 \\ i = 84^\circ\ 36'{\cdot}8\end{array}\right\} 1906{\cdot}0$$
$$\log q = 9{\cdot}84916$$

THE TOTAL SOLAR ECLIPSE OF JANUARY, 1908.—For the information of those astronomers who intend to observe next January's eclipse, Dr. Downing has prepared a number of astronomical details for the observations at two islands in the Pacific which are favourably placed.

These two stations are Hull Island (long. = 172° 13′ W., lat. = 4° 30′ S.) and Flint Island (long. = 151° 48′ W., lat. = 11° 26′ S.), now the properties of Lever's Pacific Plantations Company, Port Sunlight, Cheshire, with whom intending observers should communicate.

As the errors of the moon's tabular places now amount to sensible and apparently increasing quantities, Dr. Downing warns observers that the calculated times of the several phases may differ sensibly from the observed times. To obviate the possible inconvenience arising from this source, he gives the number of seconds before the commencement of totality that the cusps will subtend specified angles (Monthly Notices R.A.S., vol. lxvi., No. 5).

RADIANT POINT OF A BRIGHT METEOR.—In No. 4083 of the *Astronomische Nachrichten* Dr. Jiří Kaván publishes an account of a bright meteor observed at Prague at 6h. 21m. (M.E.T.) on October 1, 1905.

From observations of the altitude and azimuth, Dr. Kaván has deduced the following positions for the beginning and end points of the meteor's path:—

Beginning	$\alpha = 293°{\cdot}1$ ...	$\delta = -\ 2°{\cdot}6$
End	$\alpha = 273°{\cdot}4$ ...	$\delta = -11°{\cdot}1$

The duration of the meteor's flight was 2 to 2·5 seconds, and the colour of the object was green.

LUMINOUS PARTICLES IN THE CHROMOSPHERE.—The details of the equipment employed by Dr. Deslandres, in his experiments to determine whether the chromosphere contains luminous liquid or solid particles, are described in No. 14 (April 2) of the *Comptes rendus*. The results of the experiments were briefly described in these columns on April 19 (vol. lxxiii., p. 592).

NEW CATALOGUE OF DOUBLE STARS.—In No. 93 of the Lick Observatory Bulletins, Prof. R. G. Aitken publishes the detailed measures of 350 new double stars, A 901 to A 1250 inclusive. The stars contained in the present catalogue are similar in character to those published in Prof. Aitken's previous lists; 267 of them, or 76 per cent. of the entire number, have apparent distances less than 2″, 31 of them less than 0″·25, while only 9 approach the limit of 5″. Some of the pairs consist of closer components to Struve and Herschel stars, and most of them were observed with the 36-inch refractor.

EXPLORATIONS IN THE HIMALAYAS.

THE paper read by Mrs. Bullock Workman before the Royal Geographical Society in November last is published in the February number of the *Geographical Journal*. An account is given of the exploring work carried out by Dr. and Mrs. Bullock Workman during 1903 in the region of the Karakoram mountains lying south-west of the Hispar glacier, or between that glacier and the Indus. This region is cut off from the Hispar glacier by a practically continuous ridge, and is crossed by glaciers moving from north and north-west, the chief being the Chogo Lungma, Alchori, Hoh Lumba, and Sosbon glaciers. The work of the expedition consisted chiefly in the examination of the Hoh Lumba and Sosbon glaciers, and in ascents of Mounts Chogo (21,500 feet) and Lungma (22,568 feet), near the head of the Chogo Lungma glacier.

The narrow Hoh ravine runs northward from the junction with the Braldo River, and is ascended along the precipitous cliffs of nude mountains. It is filled by old glacial débris several hundreds of feet deep, the river cutting its way often at a great depth. Some four miles up is Pirnar Tapsa, a small grazing ground, and two miles beyond is Nangma Tapsa, a similar spot at an elevation of 11,595 feet. Immediately above this is a huge terminal moraine, of which we are able to reproduce a photograph. The snout of the glacier is about a mile further up, and the total length from the snout to the source on the "col des Aiguilles" is twelve miles. The expedition found much evidence that the glacier has retreated somewhat rapidly of late years.

FIG. 1.—Nangma Tapsa and the huge terminal moraine of the Hoh Lumba, forming a large hill about 500 feet high; its age is indicated by the tree growth covering its surface.

OSMOSIS AND OSMOTIC PRESSURE.

NO problem is of greater importance in modern physical chemistry than the determination of the true nature of osmosis and of osmotic pressure. Although for some considerable period this problem has to most chemists appeared solved, several recent investigations have thrown doubt upon the validity of van 't Hoff's hypothesis that the osmotic pressure developed in solutions is purely a kinetic phenomenon. The experiments of Battelli and Stephanini in this connection have already been referred to in NATURE (vol. lxxii., p. 541). Some remarkable results which have been obtained by Prof. Louis Kahlenberg are now described in the Transactions of the Wisconsin Academy (March) and the *Journal of Physical Chemistry* (vol. x., pp. 141–209); these, if subsequently verified, will invalidate van 't Hoff's theory, and, what is of even greater importance, destroy the basis of the theory of electrolytic dissociation, developed by Arrhenius, upon which modern physical chemistry so largely depends.

Prof. Kahlenberg's experiments would indicate that the osmotic pressure developed in the case of any solution depends essentially on the nature of the membrane used, even when this is practically semi-permeable, as well as on the nature and concentration of the solution. Strictly speaking, there is no definite osmotic pressure characterising a solution of given concentration at a definite temperature; the pressure depends on the septum employed. It is recalled to mind that van 't Hoff's conception really rests on the measurements of osmotic pressure made by Pfeffer, that these measurements were few in number and were obtained with one membrane only, and that several recent direct measurements of osmotic pressures have given values not in accord with the gas laws. It is stated that in order to obtain a definite value for the osmotic pressure it is absolutely necessary that the solution within the osmometer should be well stirred, a precaution that has hitherto been omitted in all measurements. The measurements obtained by the author, observing this precaution, did not agree in any case with the gas laws.

The magnitude as well as the direction of the osmotic pressure are, according to Prof. Kahlenberg, determined by the power of the membrane to "imbibe" the solvent and solute, and by the mutual solubilities of the substances dealt with. Cases of abnormal dialysis are adduced in support of this theory. Thus a colloid, copper oleate, dissolved in pyridine, will diffuse through a rubber membrane, whilst a crystalloid, cane sugar, remains behind. Again, when a solution of camphor and cane sugar in pyridine is subjected to dialysis through the same membrane, the camphor diffuses through it, and the cane sugar is again left behind. In this case two crystalloids are separated completely by dialysis. Such facts are not reconcilable with the ordinary views of diffusion. Some suggestive remarks by the late Prof. Raoult, contained in a letter to Prof. Bancroft, in criticism of van 't Hoff's theory are now published for the first time.

MARINE BIOLOGY ON THE WEST COAST.[1]

THE report for 1905 on the Lancashire Sea Fisheries Laboratory at the University of Liverpool and the Sea Fish Hatchery at Piel is a somewhat thicker volume than was the report for 1904, and contains some interesting papers.

Besides the introduction and general account of the work by Prof. Herdman, and a report upon the classes, visitors, &c., at Piel by Mr. Andrew Scott, it contains eleven scientific papers, two of which are from Prof. Herdman's pen, while Mr. James Johnstone is responsible for five and Mr. Andrew Scott for four, one of which he contributes jointly with Mr. Thomas Baxter. The papers are upon the same lines of work as have been carried on in previous years, but the one upon mussel transplantation, by Messrs. Scott and Baxter, describes for the first time an experi-

[1] No. xiv. Report for 1905 on the Lancashire Sea Fisheries Laboratory at the University of Liverpool and the Sea Fish Hatchery at Piel. Drawn up by Prof. W. A. Herdman, F.R.S., Hon. Director of the Scientific Work, assisted by Mr. Andrew Scott and Mr. James Johnstone. Illustrated. (Liverpool, 1906.)

ment commenced some years ago, which has given interesting results. The removal of mussels from overcrowded beds and the laying down of new grounds and the restocking of old ones has proved eminently successful, and the increased rate of growth of transplanted individuals is very marked.

From the report on the sea-fish hatching at Piel we learn that more than a million plaice larvæ and nearly twelve million flounder larvæ were liberated during the breeding season, and a similar report upon the sea-fish hatching at Port Erin shows that five million plaice larvæ were liberated off the Isle of Man, but we look in vain for any word which will show us that the liberation of these fry during several years has produced any effect upon the fisheries of the district.

An interesting paper upon trawling observations, by Mr. James Johnstone, contains a section upon the food of plaice, dabs, and other fishes, and we gather that the results so far obtained tend to show that the plaice and the dab are not competitors for food, although living upon the same ground; that whereas the former feed chiefly upon molluscs, the latter prefer Ophiurids and Crustacea, although they are less particular as to the nature of their food than are the plaice. Mr. Todd's observations as to the food of these species in the North Sea seem to bear out the omnivorous tendency of the dab, but they also seem to show that the chief food of both species in that region consists of molluscs.

Mr. Johnstone also contributes a paper on the marked fish experiments, in which he sets out the migrations of the plaice in the district, as shown by the re-capture of marked specimens. He finds that the fish tend to move along the shore lines during the winter months, and to migrate off-shore during the summer months, which facts appear to agree with the results so far determined as to the migrations of this species in the North Sea.

Mr. Andrew Scott's report on the tow-nettings for the year contains a large amount of material, but the author has not drawn conclusions therefrom, so that the paper is somewhat heavy reading.

Prof. Herdman's paper upon the oligodynamic action of copper, dealing with the possibilities of purifying infected shell-fish by immersion in distilled water which has been in contact with copper-foil, is extremely interesting, but is in the nature of a preliminary statement, as he is about to investigate the whole question in conjunction with Prof. B. Moore.

The volume is illustrated, including a useful series of plates of copepods, trematodes, &c., in connection with Mr. Andrew Scott's "Faunistic Notes."

FRANK BALFOUR BROWNE.

PHYSIOLOGICAL EFFECTS OF MENTAL ACTIONS.

THE most recent number of the *Beiträge zur Psychologie und Philosophie* (Band i., Heft 4) contains two articles, one by the editor, Prof. Martius, on the theory of the influence exerted on pulse and respiration by mental stimuli, while the other, by Mr. C. Minnemann, discusses pulse and respiration as studied in the subjects of genuine, first-hand emotion. Prof. Martius starts with pointing out the contradictory opinions held by other investigators regarding the effect of attention, of joyful or painful emotions on pulse and respiration. This diversity he regards as partly due to the neglect of several precautions, and he proceeds to study, amongst other points, those fluctuations of the pulse which are in direct correspondence with respiration periods. He then examines the plethysmographic method, and comes to the conclusion that variations of volume registered by it are partly due to movements of the limb under investigation, and that the method cannot be used at present to secure any definite results regarding the circulation of the blood.

Elaborate details and analyses are next given of his experiments on five human subjects; they are classed thus:—(1) effects on the pulse of artificial alterations in respiration (*e.g.* deepening, acceleration, retardation of breathing); (2) effects of bodily activity on pulse and respiration; (3) effects of mental activity; (4) effects of bodily pain; (5) effects of taste and smell (whether pleasant or unpleasant; (6) effects of moods (of joy and depression) artificially induced, *e.g.* by hearing witty stories, recalling the contents of certain poems, or the like.

With regard to many points Prof. Martius thinks that definite conclusions are at present impossible; all that he regards as established is the presence of a series of types of general emotional or "affective" states, and especially the distinction of the two types of activity and rest. But the methods described are insufficient to characterise definitely for us special emotions like those of fear or sympathy. It seems established, too, that joy and sorrow do not possess definite complexes of symptoms by which they can be separated from one another, and further, bodily and mental activity produce the same appearances. Hence while the will and the intellect are not to be regarded as one, they cannot be separated, and we can never analyse the products of intellect merely into sensations and feelings. The other article follows the same lines and reaches a similarly safe conclusion, that we can read out of the experiment curves nothing but the most general characteristics of emotional states, viz. excitement or repression.

DISCOVERY OF SEVEN THOUSAND ROMAN COINS.

A COARSE earthenware jar containing upwards of seven thousand "third brass" Roman coins was recently unearthed by the ploughshare on the farm of Mrs. Wheatley, Stanley, near Wakefield. In very early times the bed of the river Calder, which has a remarkable sweep at this point, was deepened by the ancient Britons or Romans, and an embankment made with the sand; in this the jar, with its contents, was deposited 1500 years ago.

The coins all belong to the Constantinian group; to Constantine the Great, to his mother Helena, his stepmother Theodora, his four sons, Crispus, Constantine, Constantius, and Constans, Licinius his brother-in-law, with his wife Constantina and their son Licinius, and to Delmatius. The reverses are chiefly of the "Gloria Exercitus" type.

One-half, of nearly five thousand coins, which I have carefully examined is, in about equal quantities, of the "Urbs Roma" type, with wolf and twins on the reverse, and "Constantinopolis," with a Victory on the reverse with spear and shield, standing on the prow of a vessel; these latter were struck to commemorate the founding of Constantinople A.D. 330. There are twelve represented of the twenty-four mints of issue known to us, among which are Carthage, Alexandria, Antioch, Rome; but most are from Treves in Germany, the residence of the governor of the west, Lyons, and Constantina, now Arles in France.

Very few of them, if any, have ever been in circulation. They are most likely a portion of a military chest concealed during a threatened raid or invasion. It is remarkable that ten or twelve years ago a find of seventeen thousand was made in the Forest of Dean, covering the same period, of exactly the same types, with a similar redundancy of certain coins and a scarcity of others. A series of the Stanley coins has been presented to the museum of the Leeds Philosophical and Literary Society, and are now on exhibition.

AQUILA DODGSON.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The date of the fellowship examination in chemistry at Merton College has been altered from September 25 to September 18. Candidates are asked to send their names to the Warden on or before September 1, and to call on him on September 17, by which date they should submit to him any dissertations or papers, or evidence of research they have done.

During the vacancy of the Linacre chair of comparative anatomy, Mr. Edwin S. Goodrich, fellow of Merton College, has been appointed to act as deputy-professor.

New College has resolved to raise the college contribution to the stipend of the Wykeham professor of physics to 650*l.* a year, thereby increasing the total income of the professorship to 800*l.* a year.

H. W. Normanton, of Batley Grammar School, has been elected to a natural science postmastership at Merton College. A. H. Simpson, of Rugby School, has been elected to a natural science scholarship at Corpus Christi College.

CAMBRIDGE.—The striking success of the Appointments Board in procuring appointments for young graduates at Cambridge is shown by the following figures:—in 1902 the number of appointments obtained was 67; in 1903, 93; in 1904, 102; in 1905, 134. These appointments fall mainly into the following classes:—appointments under various public authorities at home and abroad, industrial and technical appointments, administrative appointments on railways, appointments for scientific work of various kinds, and lectureships in university colleges.

Major E. H. Hills, C.M.G., R.E., late head of the Topographical Department of the War Office, will deliver a public lecture on the geography of international frontiers, at the Sedgwick Museum, on Saturday, May 5.

The governing body of Gonville and Caius College, Cambridge, proposes in the summer, if suitable candidates apply, to make an election to the Wollaston research studentship in physics. The value of the studentship will be 120*l*. a year. It will be tenable in the first instance for one year, but may be prolonged for a second year. Candidates for the studentship must be more than twenty-one and under twenty-five years of age on the first day of October, 1906. The studentship is open to students of all British, colonial, and American universities. Applications should be made before July 21 to the Master (the Rev. E. S. Roberts).

The Gilbey lecturer on the history and economics of agriculture gives notice that he will lecture on "The Relations of Rent, Profits and Wages in Agriculture, and the bearing on Rural Depopulation," on Tuesday, May 15, and the three following days.

By the bequest of Dr. E. H. Perowne, the late Master of Corpus, a fine collection of specimens of amber has been acquired by the Sedgwick Museum.

ON Commemoration Day, Wednesday, May 9, after the presentation of graduates at the University of London, there will be a reception at Bedford College for Women from four to seven o'clock.

PROF. T. W. RICHARDS, professor of chemistry at Harvard University, has been designated by the German Government as Harvard visiting professor at the University of Berlin for the academic year 1906–7.

THE fiftieth anniversary of the foundation of the University of Melbourne was celebrated last week. Congratulatory addresses were presented by representatives of British and other universities.

IT is proposed to form an association of past students of the Technical College, Finsbury. With this end in view a meeting of old students will be held at the college on May 8. Sir Owen Roberts will preside. Any old student who has not received a notice of this meeting is requested to communicate with Mr. J. W. G. Brooker, Durlstone, Brockley Park, Forest Hill, S.E.

PROF. WALTER NERNST, director of the chemical physics institute, Berlin, is to deliver a course of lectures on experimental and theoretical applications of thermodynamics in Yale University, Connecticut. He will also give the Silliman lectures, founded in memory of Benjamin Silliman, father and son, the former of whom was connected with Yale so far back as 1805, and is best known to European people as the founder of *Silliman's American Journal of Science and Arts*.

UNDER the doubtfully appropriate title of "Technical Overtraining in Germany," attention is directed in the Journal of the Society of Arts for March 30 to what is undoubtedly a real danger. It is not a question of overtraining in the sense that the courses of the technical colleges are of too high a scientific standard, but the danger lies in the great increase in the number of technically trained students, an increase which makes the supply greatly in excess of the demand. A survey of the figures given, which are largely based on the report of the American Consul at Mannheim, shows that in such branches of technical instruction as building, for example, there has been an increase of, say, 200 per cent. in ten years in the output of the technical colleges, whereas in such subjects as medicine and theology there has been a considerable falling off in the number of students. As the writer of the note points out, "The consequence of this over-production in technical resources is a constantly diminishing rate of wages."

THE Government of India has decided, says the *Pioneer Mail*, to make to the Punjab University for the next four years an annual grant of 20,000 rupees. The main purpose of the grant is to assist in the improvement and efficiency of the constituent colleges in those respects in which an inspection by the University showed them to be defective. The Government of India has decided that no part of the grant shall be devoted to the improvement of the Government colleges. In addition to this grant, another of 10,000 rupees a year for four years has been assigned to the Punjab University by the Government of India. This sum is to be regarded as a consolidated grant to be applied primarily to the inspection of colleges and to strengthening the administration of the University. The Government of India has made a further grant of 30,000 rupees a year for four years for building purposes and for the equipment of the new Senate hall and the University library.

SPEAKING on Saturday last at the opening of a new grammar school at Farnham, the Archbishop of Canterbury remarked that secondary education in England has not made progress during the last fifty years commensurate with that made by those forms of education that are both above and below it. He believes that the explanation lies in a certain unwillingness to bring this kind of education under central government and organisation. He does not believe that either the German or French people are more anxious as a whole for higher education than we are in England, but they will consent to what English people will not consent to, viz. a kind of drilling on the subject which will bring about a uniformity that can better promote progress than the more lax, scattered, and independent efforts which the people of this country in their national nature prefer to the more hide-bound and red-tape systems. The Education Bill recently introduced in Parliament, if it passes into law, will give English people an opportunity which they have never had before of taxing themselves ten times as much for secondary education. No one will be forced to do it, but everyone will be able to do it, and those who have been pining to be able to give more largely to the cause of secondary education will, if the Bill becomes law, have an opportunity of doing so.

THE paramount importance of secondary education in any national system designed to educate the children of all social grades becomes more recognised every year by those in authority. The presence of the President of the Board of Education at the opening of the new county school at Acton on April 28, and of Sir William Anson, late Parliamentary Secretary to the Board of Education, at Sutton Coldfield on April 27, on a similar occasion, are indications of this recognition. Speaking at Acton, Mr. Birrell said the only difference of a philosophical character between elementary and secondary education turns upon the lengths of time available for each. There is naturally a distinction between children who remain at school only to the age of fourteen and those who stay until sixteen or seventeen years of age. The great thing for the nation to accomplish is the wise selection of those children who are fitted to benefit from a prolonged educational course, and to see that they get it, irrespective of their rank or position in life. Sir William Anson, dealing with the question of the curriculum in secondary schools, said he does not think it is possible ever to revert to the old type of classical school. He went on to say that the claims of science are nowadays never likely to be disregarded, but the study of languages should not be neglected. He remarked, in conclusion, that the overloading of the curriculum of secondary schools with subjects which might be postponed to a later stage is a mistake.

IT appears from an article by the special correspondent of the *Times* at Palo Alto, published in Tuesday's issue, that the Leland Stanford Junior University at Palo Alto suffered great damage by the earthquake on April 18. A massive gateway of stone at the main entrance to the University grounds is now a ruin, and the great dragons which surmounted it lie broken to pieces on the ground. An immense memorial arch has been wrecked, and a fine marble memorial to Henry Lathrop, Mrs. Stanford's brother, has been demolished. The museum has been seriously damaged, the whole roof of the art gallery having fallen in, and part of the roof of the other wing. The entire centre of the building devoted to the department of chemistry is a wreck. The gymnasium, just completed and never used, is an absolute ruin, and another large new building, the library, also just completed and about to be dedicated, is in the same condition. The building devoted to zoology and physiology is not much damaged. The president of the University, Dr. D. S. Jordan, who was at home at the time of the earthquake, believes that the shock of April 18 was not only one of the severest, but also one of the longest duration on record. The *Times* correspondent learns also that the narrow-gauge railway to Santa Cruz has been so badly damaged that it will be months before trains can again be run. There are many tunnels on this line, and in various instances these tunnels, which formerly were straight lines, are now corkscrew-shaped. At San Jose a flower garden was turned into a lake of mud from which a dozen geysers burst into activity after the earthquake.

THE current number of the *University Review* contains an inspiring article on "Science and the Public" by Major Ronald Ross, F.R.S., professor of tropical medicine in the University of Liverpool. Insistence is laid on the fact that science is almost exclusively the work of individuals, and that, though willing enough to benefit by the discoveries and inventions of men of science, the public is in no sense imbued with the scientific spirit. Instead of cultivating the absolutely impartial judgment demanded by science, the public encourages the habit of mind eulogised by Tennyson, "believing where we cannot prove," and forgets there is nothing meritorious in such conduct, but much that is the reverse. The essay proceeds to show that to this willingness to ignore science and scientific methods may be traced the credulity of the public which leads it to subsidise quack medicine, to ignore beneficent discoveries like that of Jenner, to hamper scientific research by unintelligent anti-vivisection societies, and generally to proclaim its adherence to the policy of "muddling through." An instance is given by Major Ross from his own experience which shows how slightly as yet the mass of mankind has been influenced by scientific methods. More than seven years ago it was demonstrated that malaria is conveyed from man to man by a group of gnats, and several obvious and practicable modes of prevention were suggested in consequence of the discovery. But when these measures were urged upon the public and governments of our tropical colonies, the so-called educated white people scoffed at the whole discovery, without troubling to ascertain the facts, and the governments, with the exception of a few, took no action which could for a moment be called adequate. The magnitude of the offence may be gathered when it is remembered that half the people in the tropics suffer from the disease every year; but in view of recent events it is easy to see that the world will be dominated eventually more and more by the disciplined and scientific peoples, and those nations which reject science will be set aside.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 25.—"An Electrical Measuring Machine." By Dr. P. E. **Shaw.** Communicated by Prof. J. H. Poynting, F.R.S.

The principle of the measuring machines in general use is that one face of the gauge rests against one jaw, fixed, of the machine, whilst the other jaw is moved forward by a screw until it touches the other face. These machines may be called mechanical-touch machines in contradistinction to the new machine called the electric-touch machine. This depends on the same general principle as the electric micrometer used by the author in several researches.

Objections to the mechanical-touch methods are:—(1) they involve strain in the machine of a much larger order than in the electric method; (2) they are less sensitive; (3) it is impossible to measure between point and point. To measure between points or rounded points is essential in accurate metrology, especially for gauges with flat ends; for when each jaw has a flat face and each end of the gauge has also a flat face, each of these four faces having errors in planeness and parallelism, the resulting measurements must be erroneous. If, however, measurement be taken between small spheres on the screw ends, no assumptions as to planeness and parallelism are made, and such errors vanish from the results.

The electric measuring machine consists of (*a*) two head-stocks containing micrometer screws; (*b*) a table to carry the gauge; (*c*) a massive slide bed, on which run the head-stocks and table. The gauge to be measured is clamped on the table, and is set true with respect to the micrometer screws by two rotations and two translations provided in the table. This adjustment is made by special electric-touch methods devised for the purpose. To make a measurement of the gauge the left screw is brought into electric contact (indicated by a telephone) with the gauge; then the right screw is brought into electric touch with it, and when current passes through from one measuring point to the other the two divided heads on the micrometer screws are read. To turn the graduated head the screw system is not actually touched by the hand, but is worked by an outside hand-pulley and string.

Special care is taken in the design of the machine to avoid periodical screw error and backlash.

A careful calibration by wave-lengths of several millimetres of the screws shows where they are specially uniform, and therefore fit for use.

Results are obtained for all kinds of gauges. For bar gauges with flat ends, measurements taken at many places reveal considerable variation in thickness, so that irregular contour curves, roughly centred in the centre of the gauge faces, can be drawn showing that the ends are far from being plane or parallel. These errors in bar gauges have not been previously pointed out or measured. The author contends that all bar gauges should be measured by this method and the errors registered, so that, even if the errors are not corrected, by re-scraping or otherwise, they will be known and allowed for.

Cylindrical and spherical gauges are also tested; these are shown to be much more nearly perfect than bar gauges.

A further use of the machine is in the measurement of non-conducting bodies, such as glass plates, the thickness of which can be measured with great accuracy.

Readings are taken with ease and certainty to 1/250,000th of an inch, and one-quarter of this can be obtained if specially desired.

March 1.—"An Experimental Inquiry into the Factors which determine the Growth and Activity of the Mammary Glands." By Miss J. E. **Lane-Claypon**, D.Sc., and Prof. E. H. **Starling**, F.R.S.

So far as the authors' experiments go, they show that the growth of the mammary glands during pregnancy is due to the action of a specific chemical stimulus produced in the fertilised ovum. The amount of this substance increases with the growth of the fœtus, and is therefore largest during the latter half of pregnancy. Lactation is due to the removal of this substance, which must therefore be regarded as exerting an inhibitory influence on the gland cells, hindering their secretory activity and furthering their growth. It is probable that the specific substance is diffusible, and will withstand the boiling temperature.

The authors do not, however, claim that these conclusions are firmly established. A final decision can only be given by a research carried on under more favourable conditions. In fact, a farm is required where the authors could have at their disposal 500 rabbits, and could arrange for a plentiful supply each day of rabbits about the middle of pregnancy.

Zoological Society, April 10.—Mr. H. Druce, vice-president, in the chair.—The fresh-water fishes of the island of Trinidad: C. Tate **Regan**. The author's remarks were chiefly based on a collection made by Mr. Lechmere Guppy, jun., and presented by him to the British Museum.

The collection was accompanied by natural history notes and by a series of beautifully executed water-colour drawings. Forty species of fresh-water fishes were now known from the island; these were enumerated in the paper, and four of them described as new to science.—The collection of Alcyonarians made by Mr. Cyril Crossland at Zanzibar in 1901–2: Prof. J. A. **Thomson** and W. D. **Henderson.** Specimens of sixty-five species or varieties were contained in the collection, of which twenty-seven were described as new.—Cyclopia in osseous fishes, as observed in several advanced trout embryos: Dr. J. F. **Gemmill.** A detailed account of the anatomy of the specimens was given, and a comparison made with Cyclopia in mammals. The author's views were also put forward regarding the mode of origin of this condition in fishes.—Cases of supernumerary eyes, and local deficiency and re-duplication of the notochord, in trout embryos: Dr. **Gemmill.**—Descriptions of three new varieties of butterflies of the genus Heliconius: P. J. **Lathy.**

Faraday Society, April 10.—Prof. A. K. Huntington in the chair.—Electrothermics of iron and steel: C. A. **Keller.** The author deals with the present position of his processes; he describes the electrical steel plant which Messrs. J. Holtzer and Co. have just installed in their works at Unieux (Loire). This is a 1500 h.p. plant, and will utilise in a single furnace the current from a 20,000-ampere Westinghouse alternator. The furnace, which rests on a steel cradle and can be tilted, weighs about 50,000 kilos.; the various mechanical and electrical controls are obtained by hydraulic motors. The steel obtained from a Siemens-Martin furnace will be run into the electric furnace immediately after the oxidising melt, and for the remaining operations of deoxidising and refining the current exclusively will be used.—Note on the rotating electric steel furnace in the Artillery Construction Works, Turin: Ernesto **Stassano.** The furnace described and illustrated in the paper is being installed by the "Forni Termoelettrici Stassano" Company for the Italian War Office. It is of the author's well-known arc type, and absorbs 140 kilowatts, yielding 2400 kilos. of steel in twenty-four hours. The current is a rotary one with 80 volts between each phase. The consumption of electrodes is less than 5 kilos. per ton of steel, and the cost of renewing the refractory covering of the furnace 10 francs per ton of metal made. The furnace is principally used for refining pig-iron and smelting scrap. The product ordinarily made is used for artillery projectiles.—Note on recent developments in the Gin electric steel furnace: Gustave **Gin.** The author's canal-type of furnace is now installed at the Plettenberg Works, Westphalia, of which illustrations are given in the paper, but it is not stated which particular type of furnace has there been experimented with. The following types are described:—(1) furnace with canals and chambers; (2) combination furnace; (3) induction furnace.—Notes on the cleaning of work by means of the electric current: H. S. **Coleman.** The work to be cleaned (usually preparatory to electro-plating) is suspended in a hot solution of equal quantities of brown Montreal potash and sodium hydrate contained in a wrought-iron tank. The work and the tank are connected to a dynamo, and the tank used as the anode for five to ten minutes, the voltage being about 2·5. The current is then reversed for a short time, until the surface of the work is clear and bright. The operation is repeated as many times as may be necessary.

Royal Meteorological Society, April 18.—Mr. R. Bentley, president, in the chair.—Some so-called vagaries of lightning reproduced experimentally: A. **Hands.** The author, in the course of an extended investigation into the effects of lightning, has come across many cases that have been called vagaries, but which on a close inspection have proved to be extraordinary only in the erroneous way in which they were described, and, had they been correctly reported, would have appeared perfectly consistent with preconceived ideas—in fact, could have been foretold in every case if the conditions that led to those effects had been known before the events occurred. The author reproduced experimentally several so-called vagaries of lightning, showing by means of rough models the conditions under which they occurred.—The value of a projected image of the sun for meteorological study: Miss C. O. **Stevens.** By this method it has been ascertained that where the direction of movement of the atmosphere is tangential to the limb of the sun, the phenomenon of "boiling" displays a coursing or rippling character, and that where it is perpendicular to the limb of the sun, the character of the movements of distortion is that of springing in and out of the area of the sun's image. Both these elements of movement are continuous even in the absence of all visible cloud, and it is possible, not only to detect, but also to distinguish between overlying invisible atmospheric strata.

Mathematical Society, April 26.—Prof. A. R. Forsyth, president, and subsequently Prof. W. Burnside, vice-president, in the chair.—Perpetuants and contra-perpetuants: Prof. E. B. **Elliott.** It is proposed to apply a method, based on the use of symmetric functions and of certain differential operators, to the discovery of complete systems of perpetuants of given partial degrees in assigned sets of coefficients, which shall be equivalent in their aggregate to those which have been arrived at by the systematic examination of symbolic products. Contra-perpetuants are introduced in connection with Hermite's doctrine of reciprocity between degree and extent in systems of seminvariants when this doctrine is correlated with the theory of perpetuants.—A set of intervals about the rational numbers: A. R. **Richardson.** A definite construction is given for associating a set of intervals with the rational numbers, in such a way that all the rational numbers are included in the intervals, and certain definite sets of irrational numbers are excluded from all the intervals.—Some theorems connected with Abel's theorem on the continuity of power series: G. H. **Hardy.** The paper deals with the generalisation, for series of which the terms are continuous functions of a variable, of certain well-known theorems relating to power series. The convergence of Σa_n is sufficient to secure the uniform convergence of $\Sigma a_n f_n(x)$ in an interval in which all the functions $f_n(x)$ are continuous, and these functions diminish in value as n increases; a similar theorem holds also if Σa_n diverges, but is of the type which can be summed by averages.—The canonical forms of the ternary sextic and quaternary quartic: Prof. A. C. **Dixon.** The forms are the sums of ten sixth, or fourth, powers, as the case may be. Processes are given for carrying out the reductions to these forms, and it is shown that in each case there are two solutions.—The accuracy of interpolation by finite differences: W. F. **Sheppard.** The paper deals with the relative accuracy of the ordinary advancing-difference formula and the central-difference formulæ in regard to the two sources of error which arise (1) from omitting the remainder in the series by which the values of a function are calculated, (2) from the fact that tabulated values of a function are only approximate.—The geometrical interpretation of apolar binary forms: C. F. **Russell.** The paper is concerned with geometrical constructions which may be regarded as generalisations of the construction of the fourth harmonic point of three given points in a definite order. For two apolar forms of the same order, analogous to two quadratic forms harmonically related, the construction is linear.—Two cubic curves in triangular relation: Prof. F. **Morley.**—The question of the existence of transfinite numbers: P. E. B. **Jourdain.**—A question in the theory of aggregates: Prof. A. C. **Dixon.**

Paris.

Academy of Sciences, April 17.—M. H. Poincaré in the chair.—The president announced the death of Prof. Langley, correspondant of the academy.—The evaluation of the foco-facial distances of microscopic objectives: L. **Malassez.** A comparison of two experimental methods with the results of a formula developed by the author in previous papers.—Pure ferro-molybdenums: contribution to the study of their constituents: Em. **Vigouroux.** Alloys of iron and molybdenum containing varying proportions of the two constituents were submitted to treatment either with dilute hydrochloric acid or an acid solution of cuprous chloride. The insoluble residues from fourteen separate alloys were analysed, and the following four compounds of iron and molybdenum isolated in a pure state:—Fe_2Mo, Fe_3Mo_2, FeMo, $FeMo_2$. The physical and chemical properties of each of these are given.—A characteristic reaction of ethyl glyoxylate: the action of ammonia on this ether and its derivatives: L. J. **Simon** and G. **Chavanne.** By the action of ammonia on ethyl glyoxylate a substance $C_4H_9N_3O_4$ is formed. This is blue-black in colour, and possesses very powerful tinctorial properties, and hence may form a useful test for this ester. The composition of this substance has not yet been established.—The acid properties of starch: E. **Demoussy.** Starch possesses all the characters of a feeble acid, comparable with carbonic acid, and resembling in this respect the other carbohydrates. It forms compounds with metallic hydroxides which are dissociable by water, and can absorb small quantities of neutral salts. These properties probably play a part in the absorption of mineral matters by plants.—The state of colouring matters in crystals coloured artificially: P. **Gaubert.** It has been shown in previous papers that there are two cases in the artificial colouring of crystals; in the first case the crystal is only coloured when the solution from which the crystal is depositing is nearly saturated with the colouring material; in the other case the crystal is coloured, whatever the dilution of the colouring material. The present paper gives details of measurements made on crystals of the latter class, phthalic acid, with methylene blue in solution. It was found that the ratio of the concentrations of the methylene blue in the liquid and crystals was practically constant, although the absolute concentration of the methylene blue was made to vary within wide limits. Similar results were found with methylene blue and crystals of urea nitrate.—The Vesuvian origin of the dry storm observed at Paris on the morning of April 11: Stanislas **Meunier.** A microscopical examination of the dust deposited during this storm showed it to be identical in nature with the dust from Vesuvius in 1822.

DIARY OF SOCIETIES.

THURSDAY, MAY 3.

ROYAL SOCIETY, at 4.—Election of Fellows.—At 4.30.—On a Static Method of Comparing the Densities of Gases: R. Threlfall, F.R.S.—The Stability of Submarines: Sir William H. White, K.C.B., F.R.S.—The Action on Bacteria of Electrical Discharges of High Potential and Rapid Frequency: A. G. R. Foulerton and A. M. Kellas.—The Action of Pituitary Extracts upon the Kidney: Prof. E. A. Schäfer, F.R.S., and P. T. Herring.

ROYAL INSTITUTION, at 5.—The Digestive Tract in Birds and Mammals: Dr. P. Chalmers Mitchell.

CHEMICAL SOCIETY, at 8.30.—The Relation between Absorption-Spectra and Chemical Constitution, part v.: The *iso*Nitroso-compounds: E. C. C. Baly, E. G. Marsden, and A. W. Stewart.—The Action of Tribromopropane on the Sodium Derivative of Ethyl Malonate, part ii.: W. H. Perkin, jun., and J. L. Simonsen.—Brazilin and Hæmatoxylin, part vii., Some Derivatives of Brazilein: P. Engels, and W. H. Perkin, jun.—Pipitzahoic Acid: J. M. Sanders.—The Constitution of the Hydroxides and Cyanides obtained from Acridine, Methyl-acridine and Phenanthridine Methiodides: C. K. Tinkler.—The Constitution of Ammonium Amalgam: E. M. Rich and M. W. Travers.—Action of Light on Potassium Ferrocyanide: G. W. A. Foster.

LINNEAN SOCIETY, at 8.—Origin of Gymnosperms (*Continuation of Discussion*): Dr. D. H. Scott, F.R.S.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY, at 8.—Some Observations on Bacterial Tank Operations: Dr. W. O. Travis.

FRIDAY, MAY 4.

ROYAL INSTITUTION, at 9.—The Steam Turbine on Land and at Sea: Hon. Charles A. Parsons, C.B., F.R.S.

GEOLOGISTS' ASSOCIATION, at 8.—The Erosion of the Batoka Gorge of the Zambesi: G. W. Lamplugh, F.R.S.

MONDAY, MAY 7.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—From the Victoria Nyanza to Kilimanjaro: Col. G. E. Smith, R.E.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Some Notes on the Gutzeit Test for Arsenic: J. Goode and Dr. F. Mollwo Perkin.—The Separation of Brucine and Strychnine. Influence of Nitrous Acid in Oxidation by Nitric Acid: W. C. Reynolds and R. Sutcliffe.—Absorption of Gallic Acid by Organic Colloids: W. P. Dreaper and A. Wilson.

VICTORIA INSTITUTE, at 4.30.—The Zodiac: its History and Biblical References: Rev. A. B. Grimaldi.

TUESDAY, MAY 8.

SOCIETY OF ARTS, at 8.—Damascening, and the Inlaying and Ornamenting of Metallic Surfaces: Sherard Cowper-Coles.

UNIVERSITY OF LONDON, at 5.—The Atmospheric Circulation and its Relation to Weather: Dr. W. N. Shaw, F.R.S.

ROYAL INSTITUTION, at 5.—Glands and their Products: Prof. W. Stirling.

WEDNESDAY, MAY 9.

SOCIETY OF ARTS, at 8.—Bridge Building by Means of Caissons, including Remarks upon Compressed Air Illness: Prof. Thomas Oliver.

GEOLOGICAL SOCIETY, at 8.—The Eruption of Vesuvius in April, 1906: Prof. Giuseppe de Lorenzo.—The Ordovician Rocks of Western Caermarthenshire: D. C. Evans.

THURSDAY, MAY 10.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: "Adsorption" and "Occlusion": the Law of Distribution in the Case in which one of the Phases possesses Rigidity: Prof. M. W. Travers, F.R.S.—Cyanogenesis in Plants, part iv., Phaseolunatin in Common Flax (*Linum usitatissimum*); part v., The Occurrence of Phaseolunatin in Cassava (*Manihot Aipi* and *Manihot Utilissima*): Prof. W. R. Dunstan, F.R.S., Drs. T. A. Henry, and S. J. M. Auld.—A Variety of Thorianite from Galle, Ceylon: Prof. W. R. Dunstan, F.R.S., and B. Mouat Jones.—The Mechanism of Carbon Assimilation in Green Plants: the Photolytic Decomposition of Carbon Dioxide *in vitro*: F. L. Usher and J. H. Priestley.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Long Flame Arc Lamps: L. Andrews (Adjourned Discussion).

FRIDAY, MAY 11.

ROYAL INSTITUTION, at 9.—Some Astronomical Consequences of the Pressure of Light: Prof. J. H. Poynting, F.R.S.

PHYSICAL SOCIETY, at 8.—The Effect of a Rapid Discharge on the Throw of a Galvanometer: A. Russell.—Exhibition of Lippmann Capillary Dynamo and Electromotor: Prof. H. A. Wilson.—Exhibition of an Apparatus for demonstrating the Movements of the Diaphragms of Telephonic Transmitters and Receivers and the Current flowing into and out of the Cable during Speech: W. Duddell.

ROYAL ASTRONOMICAL SOCIETY, at 5.

MALACOLOGICAL SOCIETY, at 8.—Notes on the Subgenus Malluvium: E. A. Smith, I.S.O.—Notes on some Species of the Genus Mitra, with the Description of *M. Brettinghami*, n.sp: E. A. Smith, I.S.O.—On some Land- and Fresh-water Mollusca from Sumatra, part ii.: Rev. R. Ashington Bullen.—Notes on a Collection of Nudibranchs from the Cape Verde Islands: C. Crossland and Sir Charles Eliot, K.C.M.G.—Notes on Indian and Ceylonese Species of Glessula: Col. R. H. Beddome.

CONTENTS.

THURSDAY, MAY 10, 1906.

THE CELL IN MODERN BIOLOGY.

Algemeine Biologie. Die Zelle und die Gewebe. Second edition. By Oscar Hertwig. Pp. xvi+648; 371 illustrations. (Jena: Gustav Fischer, 1906.) Price 15 marks.

THE volume before us appears as the second edition of the author's well known treatise on the cell, the first part of which was published so long ago as 1892.

Cytology has advanced a good deal since that time, and one finds a significant recognition of its wider scope in the new title—"General Biology" given by Prof. Hertwig to his book. Experience is showing that the larger problems connected with living things, such as organisation, heredity, function, as well as those abnormal reactions constituting what we call pathology, are all reducible to cell problems.

For the most complex living creature is resolvable into groups of more or less modified cells, and the latter are not merely bound together like faggots in a bundle, but each group, each cell it may be, in so far as it is the seat of chemical or physical change, is able in greater or less degree to exert an influence on other individuals of the cell community. In this way there arise those adjusted relationships that exist between different organs, tissues, and cells which we designate as correlations, and it is just because of the existence of these inter-dependent cellular reactivities that complex organisation has come to be a possibility.

One of the chief aims of Prof. Hertwig's book is to trace the cell in its manifold variety of form and its diverse conditions of activity, especially with reference to the part it plays as a corporate unit of the organism. It is perhaps inevitable that such a task should prove too great for any single writer to accomplish satisfactorily throughout, and, indeed, the present work is by no means free from the faults of its ambition. Some aspects of the subject are exceedingly well treated, others are left comparatively untouched, while in the case of yet others the standpoint taken up perhaps hardly represents that of contemporary thought. The last criticism especially applies to the discussion of some of the physiological attributes of cell life. Again, the more recently studied phenomena of apospory, apogamy, and parthenogenesis, with their general bearings on the processes of maiosis and fertilisation, are very scantily dealt with. The work is decidedly strongest on the morphological side, although even here the treatment seems to suffer from want of the physiological relationships involved.

A considerable portion of the book is occupied with discussions as to the connection that may subsist between the facts of cell structure and the phenomena of ontogeny and heredity. Brief accounts are given of the standpoints adopted and the theories advocated by other writers, and Hertwig adds another of his own, which he terms biogenesis.

It is not very easy to extract the author's exact position with regard to biogenesis, and nowhere in the volume does the theory appear to be summarised and presented in a succinct and complete form. But the doctrine it seems to embody is that development and specialisation of function, with the corresponding segregation of structure, are due to the correlative action of the parts on one another coupled with the influence of agencies operating from without—*i.e.* of the environmental conditions. It is this speculative part of the treatise, suggestive and interesting as it is, that will probably provoke the greatest antagonism. Hertwig is a thorough believer in the inheritance of acquired characters, though it seems not improbable that many will dissent from the interpretations he puts on cases that he apparently regards as critical ones.

The example of the supposed inheritance of immunity against the poisonous action of ricin, shown by Ehrlich to occur in the case of the offspring of mice under certain conditions, can hardly be accepted as satisfactory evidence of the "inheritance of acquired characters" as the phrase is critically understood. Indeed, it seems to break down altogether when the conditions under which it may be observed are examined and analysed. Mice are excessively sensitive to the effects of ricin, very minute doses being sufficient to bring about the death of the animal. But by repeated inoculation of sublethal doses of the poison a mouse may reach a state of immunity against the action of a quantity far greater than that which normally proves fatal. The offspring of *female* immunised mice are themselves also immune, at least during early life, whereas the young resulting from a cross between an immune male and an ordinary female do not exhibit the transmission of the "acquired character." In other words, the transmission is confined to the female side. It is evident, however, that such a case is really of no value whatever as evidence of transmission of acquired characters in the proper acceptation of the term. For it is manifest that the young animal during the whole of its existence *in utero* has been directly exposed to influences that ought to confer immunity upon it, apart altogether from any question of "transmission." Furthermore, it might well be that the bulky protoplasm of the egg, irrespective of the maternal influence after conception, may have been affected without any disturbance of the hereditary mechanism, and, indeed, Hertwig himself admits as much.

The case of certain Lepidoptera is more difficult of satisfactory explanation, although the evidence would probably be insufficient to convince an opponent. Some of these insects respond to different climatal conditions by the production of different colour-patterns on their wings. Now if the pupæ of some species (*e.g. Arctia caja*) be subjected to cold, the "cold" form of imago will appear, and if the fertile eggs of such "cold" forms be raised under warmer conditions, a small percentage of the perfect insects thus produced will retain the characters of the "cold" form. Hertwig dissents from the explanation, suggested by Weismann, that the eggs themselves may have been affected whilst still in the body of the parent insect in the pupal condition, but his argument does not amount to much; and it may well be borne in mind that an example of somewhat analogous character is afforded by the alternative characters exhibited by the leaves and other structures of many amphibious plants. Many of these can assume one of two different forms, the production of either depending on the stimulus given by the environment to the embryonic tissues at the growing points. Thus the form of, say, a leaf of such a plant is determined at a very early stage in its development, and long before it is sufficiently advanced for any functionally direct adaptation to a terrestrial or to an aquatic environment. But when once the stimulus has operated, subsequent removal to opposite conditions does not result in a corresponding alteration in the future development of such a leaf—it belongs definitely to the aquatic or to the terrestrial type, whichever line of ontogeny it embarked on from the first. It would seem, at any rate for the present, and in the absence of sufficient experimental evidence to the contrary, more natural to regard these di- or polymorphic species as "balanced" forms; the actual course of their ontogeny, whilst restricted to certain directions, and confined within definite limits, depending on the alternative character of some metabolic activity. This is, however, very different from an admission of the "inheritance of acquired characters." For if anything at all is meant by the expression, it can only imply that the hereditary mechanism has itself undergone a definite and corresponding change; and at present a direct influence of the environment in this sense is negatived by the results of the most critically conducted experiments on breeding.

Hertwig takes up a definite position as to the relation of the "somatic" to the "germ" cells. He regards all the cells of the body as fundamentally equivalent, though differentiation may mask and finally render impossible the return of a particular cell to the embryonic state. The definite tissue cell has become specialised rather as the result of an impulse from without than by a segregative process of analysis; and herein he is diametrically opposed to Weismann and his followers, in regarding cellular differentiation as a secondary rather than as a primary matter. In this he will find many who are at one with him, for the "erbungleich" division postulated by Weismann, which would result in development consisting of a sorting out or analysis of the characters of the germ, conflicts with many facts of experience, and it is only by numerous "Hilfshypothese" that it can be sustained for the plant and vegetable kingdoms.

In a notice of a book like this one of Hertwig's, it is natural that the points on which diversity of opinion prevails should occupy a relatively prominent place. But such treatment is in no way intended to detract from or to minimise the great value of the work, coming as it does from one who has himself done so much to advance the subject of which he writes, and whose lucid and suggestive treatment of his theme will always command attention. It is a book that should be read by all who are interested in the questions of modern biology. J. B. Farmer.

APPRECIATIONS OF HAECKEL.

(1) *Ernst Haeckel: Der Mann und sein Werk.* By Carl W. Neumann. Pp. 80. (Berlin: Gose and Tetzlaff, n.d.) Price 1.50 marks.

(2) *Haeckel: His Life and Work.* By Wilhelm Bölsche, with introduction and supplementary chapter by the translator, Joseph McCabe. Pp. 336; illustrated. (London: T. Fisher Unwin, 1906.) Price 15*s*. net.

(3) *Last Words on Evolution: a Popular Retrospect and Summary.* By Ernst Haeckel. Translated from the second edition by Joseph McCabe. Pp. 127; with portrait and three plates. (London: A. Owen and Co., 1906.) Price 6*s*.

(1) MANY who know Prof. Haeckel only as the author of zoological memoirs, evolutionist essays, and monistic propaganda, will be glad of the opportunity which this brightly written booklet affords of becoming more closely acquainted with the man himself and with the story of his life. We read with interest of the eager boy-naturalist wandering on the Siebengebirge, of the apprenticeship under Johannes Müller, of the year of medical practice (if a man can practise on three patients!), of the eventful year in Italy during which Haeckel nearly became a landscape painter, of the growing fascination which the plankton exerted, satisfying at once his artistic and scientific interests, of the influence that the "Origin of Species" had on him, and of his early settlement in Jena—that "feste Burg freien Denkens"—which nothing could ever induce him to leave. At the Stettin Versammlung in 1863 Haeckel entered the lists as a champion of the evolutionist "Weltanschauung," contending almost single-handed against contempt and prejudice. His cause, which eventually prevailed, as the truth must, had to be fought for, and those who are offended by the impetuous expressions of Haeckel's "Stürmernatur" are profitably reminded by this little book of the courage and indefatigability of perhaps the most virile protagonist of a thesis which has been one of the greatest contributions made by science to human progress. The author has told the story of Haeckel's life and work with vividness and enthusiasm. He concludes his effective sketch by indicating, somewhat too tersely and vaguely, how it has been possible for him to use the truth that is in Haeckel in developing a monistic philosophy more satisfying to the human spirit.

(2) Prof. W. Bölsche's study of Ernst Haeckel is, like the frontispiece to the book, a picture in warm colours. The author is nothing if not enthusiastic, and indeed no one can think over the achievements of Haeckel's life without sharing the author's admiration for his hero. If it be true, as the translator says, that "a hundred Haeckels, grotesque in their unlikeness to each other, circulate in our midst to-day," this "plain study of his personality and the growth of his ideas" should go far to replace them by giving us an appreciation approximately true. We should not ourselves have called Bölsche's book, as Mr. McCabe does, a "plain study," for its characteristic features are exuberant enthusiasm and a brilliantly

picturesque style which sometimes startles the reader with its daring.

We cannot do more than refer to a few of the interesting facts regarding Haeckel to which the author gives prominence. "Haeckel's genealogical tree spreads into the legal profession in a curiously complex way." This inheritance was expressed in Haeckel's imperious craving for clear lines and systematic arrangement, and in his fondness for formulating "laws." Apart from the influence of his teachers, such as Johannes Müller and Virchow, and of his friends, such as Gegenbaur, it was the sea—at Helgoland, at Nice, at Messina—that really won Haeckel for zoology. Regarding his pupillary period, the curious fact is mentioned that one of the theses he defended when taking his doctorate at Berlin was the impossibility of spontaneous generation. In 1860 Haeckel was "profoundly moved" by a first reading of "The Origin of Species," and conversations with Gegenbaur finally confirmed his conviction of the truth of Darwinism—a conviction which found its first, though not prominent, expression in his monograph on Radiolaria (1862). In 1863, at the Stettin congress, when Haeckel made his first open confession of the faith that was now in him, he won a laurel crown at the Leipzig athletic festival for the long jump (20 feet), and the translator justly remarks that we have here "the note of much in his character." What many zoologists, who neither misunderstand Haeckel nor fail to do him homage, feel, is that the impetuous, daring, pioneering evolutionist of Jena has taken many long jumps which scientific caution makes them refuse.

A fine chapter of the book is devoted to what is perhaps Haeckel's best and most lasting work, the "Generelle Morphologie" (1866). It was written, partly as a relief from sorrow, in less than a year, during which the author lived the life of a hermit, sleeping barely three or four hours a day, with habits so ascetic that he wondered at his survival. But the great work was too difficult for the general reader, too philosophical for the biologists, too biological for the philosophers, and thus with a clearly defined mission Haeckel set himself to the task, which he has so successfully accomplished, of making monistic evolutionism "understanded of the people."

One of the many interesting incidents related in Bölsche's appreciation may be quoted.

"A stern theologian presented himself in person at the chateau of Karl Alexander, Grand Duke of Weimar, and begged him to put an end to this scandal of the professorship of Haeckel, the arch-heretic. The Grand Duke, educated in the Weimar tradition of Goethe, asked, 'Do you think he really believes these things that he publishes?' 'Most certainly he does,' was the prompt reply. 'Very good,' said the Grand Duke, 'then the man simply does the same as you do.'"

As Prof. Bölsche closed his charming biographical sketch in 1900, the translator, who has done his work admirably, has added a chapter on the crowning years, dealing with the controversies over the "Riddle of the Universe," and other events. The whole work, helped by the excellent portraits, leaves one with a grateful impression of a remarkable personality who has all his life been a good fighter yet most lovable withal, who has done much for pure science and yet has never ceased to say "Das Leben ist schön."

(3) In these three lectures, delivered last year in Berlin, Prof. Haeckel reiterated with wonted frankness and fearlessness his evolutionist and monistic convictions. He trounced the theologians and metaphysicians for ignoring or combating or misrepresenting the secure results of science, and he did not refrain from reproving some of his own craft—even his revered master, Virchow—for trying to sit on both sides of the fence. He is himself so well satisfied with the naturalistic formulation of what goes on, and has gone on, in the wide world, that he has no patience with those who seek for explanations that science *ex hypothesi* can never give.

The law of evolution and the law of substance (the conservation of matter and energy) "are irreconcilable with the three central dogmas of metaphysics, which so many educated people still regard as the most precious treasures of their spiritual life—the belief in a personal God, the personal immortality of the soul and the liberty of the human will." Not that these are to be driven out of the world. "They merely cease to pose as truths in the realm of pure science. As imaginative creations, they retain a certain value in the world of poetry."

To many this will seem a false antithesis, an opposition of incommensurables. It can hardly be pathologically that the human spirit has so persistently attempted to get beyond common sense and empirical science to a formulation of the efficient causes, the significance, the purpose of all becoming. As a matter of fact, Haeckel himself is a worshipper of "a Monistic god, the all-embracing essence of the world, the Nature-god of Spinoza and Goethe, identical with the eternal, all-inspiring energy, one, in eternal and infinite substance, with space-filling matter," whose "will is at work in every falling drop of rain and every growing crystal, in the scent of the rose and in the spirit of man."

The lectures have been very successfully translated by Mr. McCabe. We may note that the date given for Weismann's theory of germ-plasm is 1844, which seems rather early, while that of Lamarck's "Philosophie Zoologique" (1899) is rather late.

PRACTICAL GEOGRAPHY.

An Introduction to Practical Geography. By A. T. Simmons and Hugh Richardson. Pp. xi+380. (London: Macmillan and Co., Ltd., 1905.) Price 3*s*. 6*d*.

THIS book is based on an excellent idea, which has in many ways been excellently carried out. Its design is to show how to cultivate in the teaching of geography the methods of scientific training, the methods by which boys and girls are guided to reach sound conclusions from their own observations and experiments.

Unfortunately, the execution of this design is marred by the apparent absence from the minds of the authors of a clear idea of what geography is. Geography, it must be admitted, is a subject which is sadly in want of a generally accepted definition fitted to give a clear idea of its scope. But though this definition is lacking, the handling of the subject is coming to be more and more in accordance with the idea that the governing function of geography is to indicate the nature and relative importance of the influences exercised on the life of the globe, especially human life, by local conditions and place relations. It is evident that this idea has been implicitly in the minds of the authors in the preparation of some parts of the book, but it is equally evident that the idea has never been expressly recognised by them, and accordingly it has not been consistently acted on. One result is that a good deal is admitted into the book which has no place in geography, but a still more serious result is that again and again the practical guidance stops short of the goal to which the learners should have been led.

Some examples may be given. Inevitably the work lays stress on map-making and the observations on which maps are based. Maps being necessary in the study of geography, boys and girls must be got to understand as clearly as possible how far those records of the facts which have to be studied serve in place of the actual facts, and in what points they are apt to mislead. Now, while there is much that is admirable in what is said, shown, and hinted on pp. 51–72 on hachures and contours, there is no hint of what hachures and contours respectively fail to represent. The subject of projections is rightly dealt with, for within due limits it is not beyond the reach of school children. But here the failure is more striking. The only reason for taking up this subject is to get the learners to understand how inevitably any projection must fail to represent the truth in some points, to perceive in each case the chief failures, and to discern the reasons for using certain projections in spite of their defects. But on these points no hint is given. The principle of the construction of what is called Mercator's projection is described, but, strangely enough, no question is put with the view of getting those who use the book to recognise its obvious faults, and no indication is furnished of its compensating utilities. This, indeed, would have been impossible, at least in the case of its utility for marine charts, inasmuch as the projection described is not Mercator's, but the useless central cylindrical. So, too, the projection described as the conical is not the conical, and is, in fact, no used projection whatever.

To take another subject, under the heading of isotherms and parallels of latitude we have on pp. 227 and 228 a large number of average mean temperatures for the months of January and July, but for different places, thus failing to afford an opportunity for comparing ranges of temperature. Then again, under the heading of aspect and temperature, pp. 241–3, the important subject of the difference of temperature between the east and west of the northern oceans and land-masses is dealt with, but is illustrated only by certain figures from Hann presenting this difference in the least instructive light, in the manner which fails to bring out the difference which is of most practical importance to the inhabitants of the earth. The figures show only the difference in the mean annual range of temperature, and do not indicate that this difference is brought about in every case in a greatly preponderant degree by the varying range of the winter temperatures.

Such defects are worth pointing out, chiefly because the book is on the whole so good that one cannot help earnestly wishing that it were better, and because it may be hoped that they will be removed in a future edition. Even as it is, it must be recognised that the immense pains taken by the authors have resulted in the preparation of a work which is full of suggestiveness, and ought to supply a countless number of useful hints to capable teachers of geography.

Geo. G. Chisholm.

FOLKLORE AND MEDICINE OF THE ZULU-KAFIR.

Bantu Folklore (Medical and General). By Dr. Matthew L. Hewat. Pp. 112. (Cape Town: T. M. Miller; London: J. and A. Churchill, n.d.)

THIS is an interesting little work. It will be of value to students of primitive races. It deals chiefly with the ideas of the South African Kafir tribes on the subject of magic, medicine, diseases, and initiation ceremonies. Incidentally it gives a great insight into the extraordinary mixture of superstition, quackery, and practical research in native medicine. The Kafirs are nearly always at fault in their guesses as to the origin of diseases. Some maladies are thought to be caused by the supernatural influence of snakes or of water monsters, half man and half animal, or by the strange bird called impundulu, which by some is thought to be the origin of lightning. Other diseases are attributed to direct poisoning—the word for poison, *ubuti*, being a very old Bantu root that means the "essence of the tree." This is a word that in many Bantu languages means medicine quite as much as poison, all the medicines of primitive man having been derived from the bark, sap, fruit, or leaves of trees. Some of the "snakes" alluded to by the author as the cause of intestinal diseases (in the native mind) are evidently distorted accounts of guinea-worm or tape-worm.

The king or chief of the tribe is theoretically regarded as the first amongst the local medicine men. Professional doctors, however, may be of either sex. They are often divided into the following classes: (1) Witch doctors—diviners, mesmerists, prophets, or secret service agents, "faith-healers," and masseurs. The last-named type of witch doctor is the only one that performs any good service. Like most negro races, the Kafirs believe greatly in the efficacy of massage. (2) The surgeon or bone-setter, who also practises cupping. (3) The physician or herb doctor. In addition there are two special classes of medicine men, who attend to the bringing of rain or the prediction and direction of warlike operations. Very great misery and loss of life were caused until quite recently by the witch-hunting practices of the medicine men. These priests often became petty tyrants, introducing a tyranny as hateful as that of the Holy Inquisition by their witch-smelling practices.

As regards the use of herbs, it is pointed out that the natives are in the possession of many valuable drugs. Amongst these they have been for generations in the habit of using a decoction of the leaves of the Cape willow for the cure of rheumatic pains, thus preceding Europe in an appreciation of the curative properties of salicin. A list of all the diseases to which Kafir man, woman, and child are liable is given, together with their native names, and the remedies which the natives so successfully apply. There is a chapter on midwifery and the rearing of infants, which leaves one surprised that the Kafir race has not long since come to an end by indirect infanticide. The extraordinary treatment of newly-born children may act as a kind of spur to the survival of the fittest; it most certainly kills out weakly children. The newly-born baby is "bled at the point of the fingers for luck; then held in the smoke of a slow fire till it sneezes or coughs, to show that it is not bewitched. It is then thoroughly rubbed all over with a solution of cow-dung," and so forth. Instead of being allowed to suck at the breast, it is fed at first on sour cow's milk, which is "forced down the throat of the poor little mortal by blowing into its mouth and compelling it to swallow."

Notes are given as to the operations performed on girls in the initiation schools (the elongation of the *labia minora*), and also in regard to the circumcision of the males.

The introduction to the book contains a useful summary of Kafir history, but is marked, like nearly all the writing that comes from South Africa, by a curious ignorance of Bantu history north of the Zambezi.

H. H. JOHNSTON.

OUR BOOK SHELF.

Sociological Papers. Vol. ii., 1905. Pp. xiii+312. Published for the Sociological Society. (London: Macmillan and Co., Ltd., 1906.) Price 10s. 6d.

THOUGH hardly equal in interest to its precursor, the present volume contains some valuable contributions to sociology. First, and foremost in interest and importance, comes a paper on eugenics by Mr. Francis Galton. He argues that man, whether civilised or barbarian, has submitted to restrictions in marriage, and, therefore, that a new restriction in accordance with eugenics may be imposed. Mankind has borne the yoke of monogamy, endogamy, exogamy. He has recognised prohibited degrees of kinship. Why cannot a new taboo be started? Dr. Haddon adduces an argument that is much to the point: the world is becoming self-conscious and modern civilisation has at command great resources for bringing about a revolution in men's views and practice. Dr. Max Nordau thinks the proposals unpractical. Modern restrictions would have no religious sanction, and would therefore fail. He would trust more to an improvement of the environment than to eugenics. There are many medical men who, like Dr Max Nordau, think that environment is everything. Prof. Tönnies fears that *mariages de convenance* and *mariages de passion* will continue in spite of eugenics. Lady Welby sees the difficulty of considering the interests of the race and at the same time making the most of the individual. Mr. Galton, whose enthusiasm compels admiration, answers the main objections forcibly.

Among the other papers are the following:—Civics, by Prof. Geddes (he argues for evolutionary sociology and for a civics exhibition); The school in some of its relations to social organisation and to national life, by Prof. M. E. Sadler (he urges that scope be left for "group effort and private enterprise in education"); The influence of magic on social relationships, by Dr. E. Westermarck; On the relation between sociology and ethics, by Prof. Höffding; Some guiding principles in the philosophy of history, by Dr. J. H. Bridges; Sociological studies, by Mr. J. S. Stuart-Glennie.

F. W. H.

The Heart of a Garden. By Rosamund Marriott Watson. Pp. 162. (London: Alexander Moring, Ltd., The De La More Press, 1906.) Price 7s. 6d. net.

THE title of this book is significant. The reader is not led to expect cultural details or botanical technicalities. To use a vulgarism, "science is not in it." What we have is a record of musings, such as would suggest themselves at each successive season, to one more concerned with the poetry and beauty of nature than with its philosophy. Notwithstanding this, the author shows herself a careful observer and a skilful delineator. Take, for instance, this account of the winter aconite (Eranthis). The writer is descanting on the promise of early spring, and goes on to say:—

"And even flowers are not wanting; multitudes of small, gold heads have shyly thrust themselves up through the dark earth, wrapped closely about in their green hoods which, as the sun grows warmer, they will fling back to do service as jaunty fringed capes."

This is not a botanical description; nevertheless, there is no mistaking what flower the writer had in view. The lady, with most other people, has her likes and her dislikes, and her ideals are not those of her gardener. Still, that functionary is paid to do certain work, and it is difficult to see how he can fulfil his duties properly if "milk-white pigeons with the roseate feet" are allowed to gratify their proclivities among the sweet peas and the gooseberries, and other culprits are permitted to make havoc with the strawberries.

Be this as it may, the author contrives to get a continuous feast of pleasure from the garden of which she writes, and by her cheery optimism and the elegance of her narrative affords the reader a share of the gratification she herself experiences. Dainty lyrics enliven the text. Even the pug-dog "Momotaro" is immortalised, though the invocation to him, "Hued like the full moon of the apricot," strikes us as peculiar. What sort of apricots can they be that possess full moons? In a work of this kind, however, allowance must be made for poetic imaginings. The illustrations are numerous and well executed. The book throughout is pleasantly written, and attractive to the eye.

Methods in Microscopical Research—Vegetable Histology. By Abraham Flatters. Pp. x+116. (Manchester and London: Sherratt and Hughes.) Price 21s. net.

THIS work is designed to give a course of instruction in the practical working out of the internal structure of a number of higher types belonging to the vegetable kingdom, and should admirably fulfil this purpose. The earlier portion deals with the general preparation of specimens, collection, fixation, and preservation; instruments and section cutting; staining and mounting, and is fully illustrated. Formulæ for reagents, stains, &c., then follow, after which certain types are selected and full directions given for demonstrating root, stem, floral, cell, and other structures. This section is illustrated with twenty-three coloured plates of the specimens, beautifully executed and with ample descriptions. The author is to be congratulated on the success which he has attained in the production of this work. R. T. Hewlett.

LETTERS TO THE EDITOR.

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

The San Francisco Earthquake of April 18.

This disastrous earthquake was remarkable for its long duration and the rotatory character of the movement. As observed at Mare Island the first sign was a very faint, gentle rustling, the waves being the merest tremors; but after about a minute's duration they had grown to such proportions as to be felt by everyone. The violent phase lasted about forty seconds, and then the shocks died out, the last feeble tremors vanishing about three and a half minutes from the time of the first perception. The writer was favourably situated for noting the slightest disturbance, and had been awake some time before the first tremors were felt, and he could see the clock face at the beginning and end of the disturbance, which read about 5h. 11m. and 5h. 14m. 30s. Two of the four astronomical clocks at the Mare Island Observatory were stopped by having their pendulums thrown upon the ledge which carries the scale for measuring the amplitude of the swing. The time of the violent oscillation thus automatically recorded was 5h. 12m. 37s., Pacific Standard Time, eight hours slow of Greenwich. The waves were mainly from the south and south-south-west, and they seemed to turn to the west, giving the movement an elliptical, clockwise rotation. The pendulums of the two clocks which kept moving had their points rubbed against the swing index of the ledge so violently that the metal of the index was brightened by the friction of the pendulum points, and the time thereby deranged more than twenty seconds. Except for the disturbance of objects on the ground, the earthquake seemed to be essentially noiseless. Other slight shocks have continued at irregular intervals for the past five days. T. J. J. See.

U.S. Naval Observatory, Mare Island, California, April 23.

Interpretation of Meteorological Records.

I regret that, owing to absence from home, I have only now seen Mr. Lander's letter in Nature of April 19; I have to apologise for my inexcusable carelessness in writing of the storm as being accompanied by rain in place of snow and hail. However, accepting Mr. Lander's correction, it does not appear that the change will produce any alteration in the interpretation of the records, as it does not matter whether the water fell in the liquid or the solid state; its presence in either form would check any rise of temperature due to compression in the downward moving air. Any difference in the effect of snow compared with rain in producing a downward movement of the air would be to make the current stronger, because the air offers greater resistance to the fall of snow than to rain.

It is very interesting to know that at the place where Mr. Lander made his observations the barometer began to rise before the first hail arrived. But if the interpretation offered of the records be correct, this would only seem to indicate that his place of observation was not directly under the area where the storm began, and that the compression produced by the falling hail and snow travelled outwards and caused a rise in his barometer before the storm cloud brought the hail to him.

Baveno, Italy, May 7. John Aitken.

RECENT PUBLICATIONS OF THE BUREAU OF AMERICAN ETHNOLOGY.[1]

We welcome the long-looked-for monograph on the Hako ceremony of the Pawnee by Miss Alice C. Fletcher, the Thaw Fellow of Harvard University, as upon her, so to speak, has fallen the mantle of Cushing. Not only has she a long and intimate acquaintance with certain tribes of the Plains Indians, but her affection for and sympathy with the Indians is so marked that the old and prominent natives have confided to her their sacred lore; and she was even able to induce Tahirussawichi to come to Washington, he being the keeper of the old and sacred objects, whose life has been devoted to the acquisition and maintenance of certain sacred rites. In 1898 he was taken to the Capitol and the Library of Congress. While the vastness and beauty of these structures gave him pleasure, they did not appeal to him, for such buildings, he said, were unfitted to contain sacred symbols of the religion of his ancestors, in the service of which he had spent his long life. He admired at a distance the Washington Monument, and when he visited it he measured the base by pacing, but he would not go up, saying, "I will not go up. The white man likes to pile up stones, and he may go to the top of them; I will not. I have ascended the mountains made by Tira'wa."

The purpose of the ceremony was twofold: (1) to benefit particular individuals by bringing to them the promise of children, long life, and plenty; (2) to establish a bond of friendship and peace between two distinct groups of people. It is intertribal, and not only serves as a means for the interchange of ideas through contact and through gifts, but represents one of the many powerful agencies which, by spreading tolerance and friendly feeling, tend to weld scattered warlike bands of men into great, peaceful nations. A desire for offspring was probably the original idea. The ceremony is very old, and has been modified in the process of time to adapt it to changed conditions of environment. For example, the substitution of the buffalo for the deer, and the transference of songs; thus one formerly sung while on a journey to the mesa is now sung within the lodge.

"Each ritual contains one general thought, which is elaborated by songs and attendant acts. These songs and acts are so closely related to the central thought that one helps to keep the other in mind, and they all form a sequence that, in the mind of the Pawnee, can not logically be broken. The compact structure of the Hako ceremony bears testimony to the mental grasp of the people who formulated it. As we note the balancing of the various parts, and the steady progression from the opening song of the first ritual to the closing prayer in the twentieth, and recall the fact that the ceremony was constructed without the steadying force of the written record, we

[1] "Hopi Katcinas." Drawn by Native Artists. By Jesse Walter Fewkes.
"Iroquoian Cosmology." First Part. By J. N. B. Hewitt. Twenty-first Annual Report of the Bureau of American Ethnology. 1899–1900. (Washington, 1903.)
"Two Summers' Work in Pueblo Ruins." By Jesse Walter Fewkes.
"Mayan Calendar Systems, II." By Cyrus Thomas. Twenty-second Annual Report. Part i., 1900–1901 (1904).
"The Hako: a Pawnee Ceremony." By Alice C. Fletcher, assisted by James R. Murie. Music transcribed by E. S. Tracy. *Ibid.* Part ii. (1904).
"The Zuñi Indians; their Mythology, Esoteric Fraternities, and Ceremonies." By Matilda Coxe Stevenson. Twenty-third Annual Report, 1901–1902 (1904).
"Mexican and Central American Antiquities, Calendar Systems, and History." Twenty-four Papers. By E. Seler, E. Förstmann, P. Schellhas, C. Sapper, and E. P. Dieseldorff. Translated from the German under the supervision of C. P. Bowditch. Smithsonian Institution, Bureau of American Ethnology. Bulletin 28 (pp. 682). (Washington: Government Printing Office, 1904.)
"Haida Texts and Myths; Skidegate Dialect." Recorded by John R. Swanton. *Ibid.* Bulletin 29, 1905.

are impressed, on the one hand, by the intellectual power displayed in the construction, and, on the other, by the sharply defined belief fundamental to the ceremony."

Miss Fletcher gives the music and exact translation of the songs, with a native explanation of their meaning. The ritual objects are illustrated by several coloured plates. This sympathetic interpretation of an ancient ritual deserves the careful study of those interested in comparative religion or in the beginnings of literary expression.

Mr. J. N. B. Hewitt gives the first part of a careful study of Iroquoian cosmology; three texts, with literal and free translations, are given of Onondaga, Mohawk, and Seneca variants. A fact of great importance in these texts is that man-beings were in Iroquoian thought the primal beings; they belonged to a rather vague class of which man was the characteristic type. Beast gods appear later. In the development of

FIG. 1.—The Kurahus in ceremonial dress. A Kurahus is the director of the Hako Ceremony; the name means an old man who is venerated for his knowledge and experience.

Iroquoian thought animals, plants, rocks, and streams, having human or other effective attributes or properties in a paramount measure, were regarded as the controllers of those attributes or properties, which could be made available by *orenda* or magic power. Thus began the reign of beast gods, tree gods, and their kind, but the native term usually translated into English as "god" really signifies "disposer" or "controller," and each received worship and prayers.

In a profusely and beautifully illustrated memoir of over six hundred pages Mrs. Matilda Coxe Stevenson has given us an elaborate account of the mythology, esoteric fraternities, and the ceremonies of the Zuñis, as well as brief sketches describing the everyday life, arts, and customs of the people. It is obvious that it would be very difficult to give anything like an adequate account of this storehouse of data. The ceremonies are described with that commendable wealth of detail which characterises the work done by the best American students, and the book is a worthy extension of earlier studies of the Zuñi by the lamented Cushing and by Dr. J. W. Fewkes. The Pueblo Indians are the most interesting of North American aborigines, owing to the effects the wonderful desert-land has upon the social condition of the people, and to the intricate and symbolic ritual they have evolved, which also may in a real sense be said to be a direct result of their environment. It is therefore with great satisfaction that we welcome additions to the already voluminous literature concerning these charming people. Mrs. Stevenson says:—

"The philosophy of the Indian, as of man wher-

FIG. 2.—Hopi Katcinas drawn by native artists. Pañwû is represented by the two top figures. The figure Tiwenu carries a tablet on the head and a pine branch in each hand. The Kwewû picture has a well-drawn wolf's head with projecting mouth. The kilt is made of horse-hair stained red.

ever found, is the result of his desire and his efforts to understand the mysteries of nature. These children of the human family are highly imaginative. The soul of the Zuñi expands with adoration toward the supreme mysterious power that controls all things, and toward the gods, whose forms are visible in the heavens above, in the earth beneath, and in the waters under the earth, who are only less mighty than the supreme power, and who bless the good and punish the wicked."

She admits it is yet to be determined what part clanship played in the dawn of the ritualistic life of the Zuñi.

"It is certain that for a long time past membership at large in the fundamental religious bodies of the Zuñi has not been dependent on the ties of clanship, though in certain cases succession to office in fraternities does depend on clanship. Before any exposition of the origin of the fundamental religious organisations and of the ritual can be offered, a comparative study of the Pueblos must be made. In this work the passing hours are golden, for not only are the villages losing their old-time landmarks, but the people themselves are changing, are adapting themselves to a suddenly and profoundly altered environment, and the Zuñi at least, whose religion teaches them to speak with one tongue, to be gentle to all, and to subdue the passions, thereby winning the favour of their gods, are, under the influence of modern conditions, losing the restraining power of this religion, and, as a result, are changing for the worse."

It is to be hoped that competent students will make a thorough study of the sociology of these people without delay, and at the same time make a serious effort to trace the transition of the old clan system into the later religious fraternities.

FIG. 3.—Sword Swallowers of Ma'ke Hlan nakwe (Great Fire Fraternity of the Zuñis).

The memoir by Dr. J. W. Fewkes on Hopi Katcinas drawn by native artists cannot fail to be of considerable interest to students of various departments of ethnology. The practice of illustrating ethnological researches by native drawings is much to be recommended, as the drawings throw considerable sidelight upon the ideas and skill of the artists, and help us in the study of their psychology; in the present instance they have additional value in the suggestive similarities they present to pictographs in the codices of more southerly regions. The term katcina was originally limited to the spirits of the ancients of the Hopi or personified medicine power, and personifications of a similar power in other objects have likewise come to be called katcinas. Thus the magic power or medicine of the sun or earth may be called katcina. The term is also applied to personations of these spirits or medicine potencies by men, or their representation by pictures or images. In the Hopi ritual there are dramatic celebrations of the arrival and departure of the katcinas, and during the whole year there are ceremonies in which katcinas take part. The annual ceremonies vary considerably each year, so the katcinas are correspondingly numerous, and not only have clans introduced new katcinas from time to time, but individuals have done the same even by men still alive. Some of these ceremonies have developed into a regular dramatic performance; the motive of one of these dramas is the growth of corn, with representations of the maleficent and beneficent agencies that affect the crop. The performance is designed primarily to invoke the favour of the mysteries by appropriate symbols combined with the edification of the community at large. Thus a portion of the chamber is set apart as a stage, while the greater portion is reserved as an auditorium. A screen on the stage is painted with appropriate symbols, and is perforated to permit the passage of the masked effigies representing the mystical potencies, which are operated by shamans hidden behind the screen, something after the fashion of marionettes. The front of the stage is occupied by a symbolic field of corn, and the figures which represent the storm and drought emerge from their respective apertures in the screen and destroy the cornfield; but they are opposed partly by musical and other incantations of a group of shamans occupying one side of the stage, and partly by human actors who wrestle with and finally overcome the evil marionettes. The entire dramatisation stands on a higher plane than any prevalent among other tribes of the territory of the United States, though lower than that reached among the Nahuatlan and Mayan peoples of Mexico.

Under the title of "Two Summers' Work in Pueblo Ruins," Dr. Fewkes describes his survey of certain ruins mainly in the Province of Tusayan. Dr. Fewkes's excavations confirmed some statements made by the Hopis concerning their former history, and his intimate knowledge of the ritual and ceremonies of the existing Pueblo Indians has enabled him to explain the use or significance of objects dug up by him. The report is illustrated by photographs of ruins, plans of buildings, and a large number of beautifully executed coloured plates of decorated pottery, besides numerous figures in the text. The author inclines to the belief that the Zuñis never advanced to the same perfection in the ceramic art as did the Hopis. The author says, "In the evolution of Pueblo decoration the development of ornamentation advances from geometrical patterns to rude picture writing, and, as a rule, the pottery on which the former predominate is inferior to that on which the latter is most prominent"; but this hardly seems consistent with the subsequent remark that "the more ancient the ruin is, the better is the pottery."

Dr. Cyrus Thomas gives the second portion of his study of Mayan calendar systems, in which he deals with Maudslay's investigation of the ruins at Quirigua and discusses Goodman's results. The paper includes an account of the Maya method of calculation.

Serious English-speaking students of Central American archaeology must know the writings of the distinguished German scholars whose names appear in Bulletin 28 under review; but even they will be glad to have these scattered papers translated for more convenient reference and collected in one volume. Other students who like to know what is being discovered in this region will be very thankful to Mr. Bowditch for his enterprise and labour in translating these papers, and to the Smithsonian Institution for placing all this material at their disposal in so convenient a form. On the whole, these papers will be of most value to those who concern themselves with the chronology and history of the Central American peoples; but there is a great deal to interest the general ethnologist, though he will have to search for his material, as most of it is scattered all over the volume in diverse papers. Particularly interesting in this respect are the papers on "Zapotec Priesthood and Ceremonials," "Deities and Religious Conceptions of the Zapotecs," and "Comparative Studies in the Field of Maya Antiquities"; the last paper deals with the clothing, personal decoration, and utensils of the Mayas as illustrated in the manuscripts, or on the monuments or other remains. According to a widespread tradition, the Toltecs were the originators of all arts and sciences; and the invention of the calendar is ascribed to them, and we are informed they carried their book with them on their migrations. The calendar is the fount of the Central American sacerdotal wisdom, and the great mass of Mexican and Maya manuscripts is nothing more than an elaboration of this calendric system in respect to its numerical theory, its chronology, and its system of divination. The book is copiously illustrated, and altogether it will form a most welcome addition to the working library of various kinds of students of archaeology and ethnology.

Mr. Swanton gives literal translations of a number of Haida folk-tales obtained on the Queen Charlotte Islands, British Columbia; this careful piece of work will be much appreciated by folklorists.

When one looks at the bulk of ethnological matter published by the United States Government, and realises the enormous value to students of these full, accurate, and well-illustrated memoirs, one cannot but feel ashamed of our Government, which, possessing every opportunity and inducement to study and report upon our own native races, does absolutely nothing.

A. C. HADDON.

THE EDUCATION AND TRAINING OF THE ENGINEER.

ENGINEERING in its various branches takes so large and important a part in the industrial activities of modern nations that no pains are too great which will secure for our engineers a suitable and adequate school and college training, supplemented by a judiciously organised scheme of practical work in the shops and drawing office. More especially is this the case in this country, where, owing to the satisfaction which has followed previous success, manufacturers have been insufficiently alive to the fact that for many years other nations have been steadily building up efficient schemes of technical and professional education at the cost of much enterprise and greater self-sacrifice, with the natural result that our supremacy, long undisputed in these spheres of industry, has been undermined, and in some degree wrested from us.

It is for reasons such as these that the investigations inaugurated and carried out under the auspices of the Institution of Civil Engineers, the results of which are embodied in a recent report on the education and training of engineers, are to be welcomed. In November, 1903, the council of the Institution appointed a committee to consider and report as to the best methods of training for all classes of engineers, including both scholastic and subsequent technical education, it being an instruction of the council that the principle was to be maintained that the education of an engineer must include both practical experience and scientific training. The constitution of the committee was completed in February, 1904, and owing to the wisdom and breadth of outlook of the council of the Institution of Civil Engineers, accredited representatives of the various institutions of mechanical, electrical, gas, and mining engineers, naval architects, shipbuilders, and others were added to the committee, which under the able chairmanship of Sir William White, K.C.B., F.R.S., was soon actively at work.

The inquiry, which has extended over more than two years, proceeded under the following sections: (1) Preparatory education in secondary schools; (2) training in offices, workshops, factories, or on works; (3) training in universities and higher technical institutions; (4) post-graduate work. The investigations under the first heading were entrusted to a subcommitee, while the committee as a whole undertook the consideration of the questions arising under the remaining three sections. The inquiries of the committee have been prosecuted by obtaining, sometimes orally though generally by correspondence, the opinions of teachers and professors with experience in engineering education, and of eminent engineers practising in various branches of the profession. The ultimate result is that, though diversities of opinion have been disclosed in regard to some details, yet, in all the main features of its recommendations, the committee has support from the great majority of professional engineers as well as of the professors of engineering subjects in our universities and higher technical institutions.

PREPARATORY EDUCATION.

The subcommittee, entrusted with the work of ascertaining the views of authorities competent to speak concerning the most suitable form of secondary education for boys destined to become engineers, issued a schedule of questions to 120 representative teachers in engineering colleges, headmasters of secondary schools devoting special attention to scientific training, and engineers not engaged in teaching. The queries raised in the schedule dealt with such points as the proper age for leaving school, the desirability of a leaving examination for secondary schools, the extent and methods of the teaching—suitable for future engineers—in English subjects, languages, mathematics, science, drawing, and surveying. The schedule of questions raised, in addition, the important subject as to how far schoolboys should have, as a school exercise, practice in ordinary handicraft work, such as carpentry or turning; and to what extent it has been found better to make all "practical" work into laboratory exercises in science. Replies were received from 80 per cent. of the gentlemen whose opinions were invited, and from these definite conclusions were deduced as to the prevailing opinion on the points raised in the schedule of questions. These conclusions were embodied in a report of the subcommittee, which was eventually approved and adopted by the main committee. The following recommendations are the outcome of the exhaustive inquiry.

A boy intended for the engineering profession should, before leaving school and commencing to specialise, have attained a standard of education equivalent to that recognised by universities for matriculation purposes. His special training should not commence until he is about seventeen years of age. To ensure such a standard of efficiency a leaving examination for secondary schools is desirable throughout the United Kingdom, so that there may be no room for doubt as to whether a boy has received a satisfactory preliminary education.

Advanced teaching of history and geography, with instruction and practice in essay-writing and in précis-writing, should be included in the ordinary school curriculum; and the instruction in English subjects should include at least an introduction to English literature.

Greek should not be required, but an elementary knowledge of Latin is desirable. The study of Latin should, however, be discontinued during the last two years of attendance at school, or after the standard required for the leaving certificate has been attained. Modern languages, especially French and German, should be studied, and should be taught colloquially or in such a way as to give the pupils a practical knowledge of each language, sufficient to enable them to study its literature and to converse in it with some degree of facility.

Instruction in mathematics should be given by methods differing considerably from those usually adopted in the teaching of this subject merely as an intellectual exercise. The geometrical side of mathematics should be fostered, and before they leave school boys should be conversant with the use of logarithms, and with at least the elements of trigonometry. Instruction in practical arithmetic should be carried further than has been generally the case hitherto, with the object especially of encouraging the use of contracted methods and of encouraging also the expression of results with only such a degree of accuracy as is consistent with the known degree of certainty of the data on which the calculations are based.

It is preferable that boys should attain at school a general knowledge of physics and chemistry rather than that they should pursue in detail some particular branch of science. Special attention should be given to drawing. Work in the nature of handicraft, such as carpentry or turning, may be encouraged as a recreation, but should not be required as a school exercise.

The committee very properly recommends that the scheme of education outlined in its report should be communicated officially to the Board of Education and be circulated widely amongst those responsible for the work in secondary schools and engineering colleges. The importance of the committee's recommendations, indeed, cannot be overestimated. Educational experts have long foreseen the impossibility of securing a rational system of secondary education in the absence of a carefully planned investigation to determine precisely what secondary education has to accomplish and how the desired end may best be reached. The Institution of Civil Engineers has by its public-spirited action shown schoolmasters the way so far as the education of future engineers is concerned. Here is the opportunity for which earnest educators have been looking. The ground to be covered has been carefully mapped out by experts, and we at last know precisely what is required of the secondary school so far as training engineers is concerned. It is earnestly to be hoped that the opportunity will not be lost. If for the next ten years these judicious recommendations could be made the basis of the secondary education provided for all boys intended for engineering, and if the results of following the scheme could be accurately recorded during this period, we should in 1916 be in possession of data which would bring us within easy distance of formulating with confidence a course of school study which would provide engineers with boys trained in such a way as to make their future rational development easy and straightforward.

ENGINEERING TRAINING.

It was eventually decided by the committee to deal together with the sections of its inquiry concerned with training in offices, workshops, factories, or on works; training in universities and higher technical institutions; and post-graduate work. As in the case of the investigation dealing with the school career of the future engineer, so in this case a schedule of questions was framed and circulated widely. But a modification was introduced; the committee embodied in the schedule certain conclusions on important subjects on which it was unanimous. At the same time a free expression of divergent opinions was invited.

In the schedule of opinions and questions the committee expressed its opinion that the age for leaving school of the future engineer should be seventeen years, and seventy per cent. of the 267 engineers and others who sent replies expressed agreement with this proposal. The opinion of the committee that it is desirable that the course of training for all branches of engineering should include at least one year's training in mechanical engineering workshops, where, ordinarily, information would be gained of the practical applications of electricity, was endorsed by 72 per cent. of those who responded to the invitation of the committee to express their views, and 21 per cent. considered this period too short. There was, however, far less unanimity as to when this introductory workshop course should be taken. The committee laid it down that the course should be taken at an early period—either previously to the commencement of college training, or after that portion of the college training which is common to all branches of engineering has been completed. Thirty-three per cent. of the responding referees merely expressed agreement with the committee, while 47 per cent. were definite that it should be before the college training began.

Four-fifths of the replies received agreed with the committee that during the introductory workshop course, and indeed in subsequent similar courses, boys should keep the regular working hours, be treated like ordinary apprentices, and be paid wages. Rather more than half the referees replying thought boys should be expected to attend evening classes during this workshop course, and 35 per cent. thought educational work should be suspended during this time. A large majority of the replies showed that it is generally considered desirable that this workshop course should be followed by a period of study in a technical college or university before specialisation in particular branches of engineering is undertaken, and that the period of college study should be arranged so as to alternate with the practical training.

There was great diversity of opinion as to what constitutes a reasonable total period of practical training on works, in factories, workshops, mines, and so on—apart from the introductory workshop course. Thirty per cent. of the replies mention three years, twenty per cent. give two years, and the remaining opinions vary from one to five years. The committee recommends a total period of four years inclusive of the introductory workshop course. On the other hand, it seemed to be generally agreed that the scale on which appliances and equipment for instructing engineering students should be provided in technical colleges should be limited only by the funds at the disposal of the college authorities.

The three concluding opinions formulated by the committee on the schedule distributed met with general approval. It is considered desirable, in connection with the grant of degrees, diplomas, and certificates to engineering students, that great importance should be attached to laboratory and experimental work performed by individual students, as well as to their progress in mathematical and scientific studies, rather than that degrees and so on should be granted on the results of terminal or final examinations. It is urged that facilities for post-graduate work by engineering students in higher technical institutions should be much increased; and it is admitted by almost all authorities that the improvements of engineering education depend greatly on the attitude of employers towards the recommendations made by the committee, and employers are urged to extend the facilities to engineering students for post-graduate study and research.

The recommendations of the committee in respect of engineering training embody the conclusions arrived at by an examination of the replies just summarised, and it is unnecessary to do more than point out the respects in which the recommendations amplify the opinions set forth in the schedule prepared for distribution. The recommendation respecting the introductory workshop course explained above recognises that at present there are practical difficulties in arranging for this workshop year being interposed between the school and college work, and that employers may consider the arrangement detrimental to their interests. The committee suggests, however, that these difficulties should not be insurmountable, and the general agreement as to its advantageous effect on training leads it to hope that practical trial may be given to the plan.

Concerning attendance at evening classes during the introductory workshop course, the committee thinks it is most important that all boys should at least maintain their scholastic acquirements, and it is considered that this result might be secured, by private tuition or otherwise, without undue physical strain. So, too, the general recommendation that the introductory workshop course should be followed immediately by attendance at college is modified. It is stated that in some cases—as, for example, when boys are intended to become mechanical engineers—it may be advantageous to complete the practical training before entering college; but, if this is done, private tuition or evening classes must be the rule during the years of practical work.

The longest of the recommendations urges the need for a sound and extensive knowledge of mathematics in all branches of engineering. The committee endorses the practically universal opinion that a sufficient time should be allotted to the study of pure mathematics during the common college course, and that the extent to which individual students can be carried in mathematics must be decided by the teachers.

Such are, in brief, the more important of the committee's recommendations, and it is interesting to compare these with some aspects of American practice. The rule in the engineering courses of the colleges of the United States, which it must be remembered always follow a prolonged secondary education, is that in the first two years of the course—which generally lasts four years—a fair amount of time is given to mathematics, English, modern languages, and experimental science, and it is chiefly in the workshop and drawing office that the specialisation towards engineering is apparent during these years. Specialisation begins to show itself prominently during the third year, and mechanical technology and electrotechnics are more or less taken up in the mechanical and electrical engineering courses. In the fourth year a crowd of engineering subjects is frequently introduced. But as Prof. Ripper remarks in his Mosely Commission report, "From the English standpoint too much importance may be attached to prolonged literary training, and not enough importance to the practical training of students during the earlier years of their career, nor to the cultural value of a scientific and professional education." But in no respect are American conditions more different from those at home than in the attitude of the employers of labour toward higher education. As Dr. Walmsley has testified in a recent report (see NATURE, vol. lxx., p. 231), "Without exception the officials interviewed asserted that, far from having any difficulty in placing the graduates turned out year by year from the engineering courses, for the last few years the graduate class has had every one of its individual members engaged for remunerative work before the completion of the course at college."

Such are the importance of the report of the Institution of Civil Engineers and the care which has been expended upon its preparation, that it is to be hoped it will be read alike by all responsible for the education of our future engineers, and by those who are in a position to employ the young men when their training is complete. In face of the severe competition between nations for industrial supremacy, it becomes a national duty for each and all, who can assist and forward the means of preparing the men in whose care our manufactures and general mercantile welfare will rest, to do their best; and a debt of gratitude is due to the Institution of Civil Engineers for the work it has accomplished. A. T. S.

BALLOONS AND KITES IN THE SERVICE OF METEOROLOGY.

DURING recent years a considerable amount of information has been accumulated about the conditions which prevail in the higher strata of the atmosphere. Although observations of temperature and humidity were made by Glaisher from a free balloon more than fifty years ago, and later Mr. Archibald used kites to determine the change of wind velocity with elevation, it is only in the last ten years that a systematic attempt has been inaugurated to obtain information. There is now a fair amount of observational material awaiting someone with the necessary skill and leisure to work it up, and it is much to be hoped that the task may be taken in hand shortly, so that the results obtained in various countries and by various organisations or individuals may be arranged and coordinated, in order that further inquiry may be pushed along the most promising lines.

The means of observation available are practically kites and small unmanned balloons carrying self-recording instruments, aided to some extent by direct observations made from manned balloons; and the only obstacle to continuous daily or even hourly readings at moderate heights is that of expense.

The free balloons possess the advantages of reaching heights unattainable by any other means, and of being independent of weather conditions. Either paper or rubber balloons are used of about six to ten feet diameter. These balloons are filled with hydrogen, and carry up with them a self-recording meteorograph made as light as possible; they frequently reach heights exceeding ten miles, and it is seldom, at least on the more thickly inhabited parts of the Continent, such as France and Germany, that they are lost. Each balloon carries an attached label offering a small reward to the finder, and the address to which information is to be sent, and in general the meteorograph is recovered with its record in a decipherable condition within a few weeks or a month. It is desirable that the balloon should fall as near as possible to its starting point, and with a rubber balloon this is effected in the following manner. The balloon is only partially filled with gas, and is then securely tied up. As it rises the external pressure is lessened and the gas inside expands, until finally the rubber is no longer able to stand the strain and the balloon bursts. A small parachute is used to prevent a too rapid fall of the meteorograph, and sometimes a second smaller balloon, filled to a less extent, so that it does not burst, is also attached; the second balloon takes the place of the parachute, but is employed that it may float over the position of the fallen meteorograph, and direct attention to it. With paper balloons an automatic arrangement is used by which the balloon is freed when it reaches a certain height. The general result is that the meteorograph returns to the earth within a time of about an hour, and within a distance of a hundred miles from the starting point.

Observations obtained by the help of kites have the advantage of being less costly, but they are dependent on the weather conditions, and it is not often that heights exceeding two miles are reached. At Lindenberg in Germany, the best equipped station for the purpose in existence, last year a height of just on four miles was reached by a train of kites. Given sufficient wind it is a perfectly simple process to send a kite up to the height of a few thousand feet, although if the wind be very strong it is not so simple to draw it back again. The chief obstacle to attaining great altitudes is the wind resistance upon the cord or wire which holds the kite, and it is on this account that the strongest and thinnest obtainable steel wire is used. The wire introduces many technical difficulties; it is difficult and to some extent dangerous to handle, and although capable of withstanding a great strain if fairly used, if a kink is once formed the piece of wire in which it is, is utterly useless. Usually steel music wire, the kind of wire used in a piano in fact, of about 1-32in. in diameter is used; this will bear a weight of 250lbs., and weighs 16lbs. to the mile. With a good kite presenting 77 square feet of surface to the wind and 8000 feet of this wire, a vertical height of one mile is easily reached under favourable conditions of wind, and one kite of this size has carried a meteorograph to 8000 feet of height. The conditions are not always favourable; instead of a steady wind of twenty-five to thirty miles per hour, increasing somewhat with altitude, which affords the best conditions, it not infrequently happens that quite different velocities are found in different strata. It is impossible to get through a stratum in which the velocity is under fifteen miles per hour, and if a velocity of much over forty miles per hour is encountered in the lower strata, the kite is very likely to be damaged or the wire broken. At greater heights a higher velocity is not so likely to cause damage, since the air is less dense, and (a point of perhaps far greater importance) the wind is far steadier.

Hence it is easily seen that to reach very great heights with a train of kites, in addition to having apparatus of the best design and quality, exceptional weather conditions must hold, and the observer must succeed in straining his wire just short, but only just short, of its breaking point. The attempt very often ends in the breaking of the wire near the winch, and the departure of five or six miles of wire and six or eight kites.

Very interesting results have been given by the unmanned balloons. It has been found that when they have reached a great height they fall in some locality lying to the east of their starting point, not necessarily due east, but on a more easterly meridian. Since they pass far beyond the upper limit of the cirrus cloud, this fact confirms the statement that in the temperate latitudes the upper currents are always from some westerly point. M. Teisserenc de Bort also finds that balloons sent up in a cyclone tend to move away from the centre at great heights, thus showing that the cyclonic circulation is not a mere surface phenomenon. He also states that at ten miles height the air is warmer over the cyclone, and colder over the anticyclone.

When observations by means of kites were first started by Mr. Rotch, at Blue Hill, Boston, U.S., it was hoped that the long disputed point as to the origin of cyclones would be elucidated; so far this has not been the case.

Ferrel, the well-known American meteorologist, held that cyclones were convectional effects, and that they were maintained chiefly by the latent heat of condensation of the vapour in the central and rainy part. Dr. Hann on the other hand considers that cyclones are what may be described as driven eddies in the general circulation of the atmosphere. Opinion on the Continent, based on the results of observations obtained by balloons and kites, seems to be in favour of Dr. Hann's hypothesis, but Mr. Clayton, of Blue Hill, U.S., considers that the ascents there made favour the convectional theory. The results of some two hundred kite ascents which I have obtained in England and Scotland, with an average height of about one mile, seem to me to give no evidence one way or the other. I think, however, that a fundamental error has generally been assumed in the discussion. We know that in a gas in equilibrium under a conservative system of forces the isothermal and isobaric surfaces must be identical; this point at least is not open to question. It is not, therefore, the proper test to consider whether the temperature in a cyclone is greater or less than in an anticyclone at the same height, but the test is whether it be greater or less at points on the same isobaric surfaces; and the isobaric surfaces in temperate latitudes may well differ from surfaces of equal height above mean sea level by a thousand feet or more.

W. H. Dines.

THE BICENTENARY CELEBRATION OF THE BIRTH OF BENJAMIN FRANKLIN.

The oldest scientific society in the new world is, I believe, the American Philosophical Society of Philadelphia. The Society was founded by Benjamin Franklin, son of an English father and born at Boston, Massachusetts, in January, 1706. It was natural that the bicentenary of the birth of a man of such extraordinary and diverse genius as Franklin should be commemorated in his native land, and accordingly during the past winter the Society issued invitations to leading universities and societies throughout the world to be present, through their delegates, at a festival to be held at Philadelphia from April 17 to 20. The date of the meeting was no doubt chosen because Philadelphia is liable to be intolerably hot in the summer, and would certainly be deserted at that season by many of the leading members of the Society, yet the chosen time was not a good one for European delegates, since academic duties would certainly preclude any large attendance from across the seas. Although, then, there were actually present only some half-dozen delegates from Europe, yet many European societies were represented by honorary members of American nationality, and sent addresses of congratulation to the Philosophical Society. The United States and Canada were naturally in great force, and the hundred and fifty or two hundred delegates who attended formed an imposing body of men of scientific repute.

The proceedings began on the evening of April 17, when the President of the Society, Prof. Edgar Smith, presided over a meeting of delegates for the reception of addresses. The President began by a speech in which he set forth the share taken by Franklin in the foundation of the Philosophical Society, and the bearers of addresses then handed to him successively, in the chronological order of the several foundations, the documents with which they had been entrusted. I myself had the honour of presenting addresses from Cambridge, the Royal Society, the Royal Institution, the British Association, and the Royal Meteorological Society. I do not know the whole number of addresses, but 126 bodies were represented in one way or another. The evening ended with an interesting ceremony, when Mr. Carnegie, in his robes as Lord Rector of the University of St. Andrews, conferred the degree of doctor on Miss Irwin, a great-granddaughter of Franklin; she is principal of Radcliffe Hall, which bears nearly the same relation to Harvard University that Newnham and Girton do to Cambridge.

Wednesday, April 18, was devoted to the reading of scientific papers, as in a sectional meeting of the British Association. The session was continued on the afternoon of Friday, and twenty-three papers in all were read. Amongst the papers which appeared to excite the greatest interest were those by Chamberlin, de Vries, Pickering, Hall, and Lorentz. I myself gave an account of a paper recently presented to the Royal Society, but as yet unpublished; but before doing so I had the pleasure of presenting to the Philosophical Society two Wedgwood medallions of Benjamin Franklin and of Erasmus Darwin. The archives of the Society show (what I was not aware of) that both Erasmus Darwin and my father had been honorary fellows—an honour which I share myself.

On Thursday morning, April 19, the University of Pennsylvania (of which Franklin was the initiator) conferred, at the hands of its Provost, Mr. Harrison, a number of honorary degrees in the fine theatre called the Academy of Music. The whole pit was occupied by students, and a national flavour was conferred on the ceremonies by their staccato college yell, and by their singing college songs.

An altogether exceptional feature of the ceremony was that a degree was conferred on the King, who was represented by Sir Mortimer Durand, H.M. Ambassador at Washington. In announcing this degree the Provost read with great effect the celebrated speech on England from Henry V. It is pleasant to record the enthusiastic cheers which the whole audience gave, standing, as the Ambassador was hooded. Some fifteen or twenty degrees were afterwards conferred, and the recipients—amongst whom I may name de Vries, Lorentz, Marconi, and Rutherford—were greeted with hearty cheers by the students. Afterwards the Attorney-General of Pennsylvania, Mr. Carson, gave an address on the shares borne by Franklin and by subsequent benefactors in the foundation of the University. In the afternoon there was a public procession to the grave of Franklin, but as I was not present I am unable to give any account of the proceedings.

On Friday morning, April 19, we heard some interesting speeches in the theatre by Mr. Furness, President Elliot, and Mr. Choate, formerly ambassador in London, on the various sides of Franklin's character and activity. On the stage in full view of the audience was the portrait of Franklin which had been removed from America by General Grey at the time of the revolutionary war. It has just been presented to the President of the United States by Lord Grey, Governor-General of Canada, and its ultimate destination will, I believe, be the White House at Washington. This graceful act of international courtesy is highly appreciated in America, and the fact that it coincides with the bicentenary of Franklin's birth can hardly be merely accidental.

After the addresses of which I have spoken came the presentation to the Republic of France, through the French Ambassador, M. Jusserand, of a gold medal commemorative of Franklin. All who have studied the history of the revolutionary war know the importance of Franklin's residence in Paris as a determining factor in the outcome of the war. It may easily be imagined how great was the enthusiasm created by this ceremony.

The festival closed with a banquet in the evening at which there were many striking speeches. An American dinner is managed somewhat differently from our own, for the toast-master is not, as with us, a servant with a stentorian voice, but is the most highly honoured of the hosts of the occasion. Dr. Weir Mitchell, the illustrious physician, performed this arduous task, and gave us a number of appropriate little speeches to the admiration of all.

To describe the other speeches would be simply tedious, but I may mention the excellent speech of M. Jusserand, who referred with the most exquisite tact to the appalling disaster of San Francisco, then at its full height. M. Jusserand is the most accomplished living student of England of the Plantagenet times, and his speech, although clothed in English, retained all the grace of its French origin.

It was natural that the ruin and misery at San Francisco should exercise a certain depressing influence on all, but those responsible for the proceedings determined, rightly, as I think, to carry them through as planned.

Those who have taken part in such festivals in America need not be told that the organisation was admirable and the hospitality unbounded.

G. H. DARWIN.

NOTES.

THE seventy-eighth annual meeting of the German Association of Naturalists and Physicians will be held at Stuttgart on September 16–22.

A REUTER message from Rome on May 5 reports that the volcano of Stromboli is in active eruption. Advices received from Tacna, Chile, state that a violent earthquake shock was felt in that city on May 6, the vibrations lasting thirty-five seconds. The shock was also felt at Arica.

THE death is announced of Prof. Eugène Renevier, professor of geology and palæontology at the University of Lausanne. Prof. Renevier was president of the Swiss Geological Society and president of the Simplon Geological Society.

ON Saturday week, May 19, Sir James Dewar will deliver the first of a course of two lectures at the Royal Institution on "The Old and the New Chemistry." The Friday evening discourse on May 18 will be delivered by Prof. Arthur Schuster, on "International Science."

THE second annual dinner of the London section of the Society of Dyers and Colourists will be held on Wednesday, May 23. Persons interested in dyeing and the allied industries who are not members of the society are specially invited. Particulars may be obtained from the hon. secretary, Mr. Wallace Burton, 219 Shooters Hill Road, Blackheath, S.E.

AT the final meeting of the sixth International Congress of Applied Chemistry on Saturday, it was resolved that the seventh congress shall be held in London, with Sir

William Ramsay, K.C.B., as the president, and Sir Henry Roscoe as honorary president. We hope to give in an early issue an account of matters of interest and importance brought before the recent congress at Rome.

THE astronomical observatory of La Plata has been affiliated with the new National University of La Plata, recently inaugurated by the Minister of Public Instruction of the Argentine Republic. The director of the observatory, Mr. Francisco Porro, invites observers in similar institutions to exchange publications with him, at the Observatorio Astronómico, Universidad Nacional, La Plata.

WE learn from *Science* of April 27 that the University of California and the Lick Observatory were not damaged by the disastrous earthquake of April 18. The buildings of Leland Stanford Junior University suffered severely, the loss being estimated at 800,000*l*. The building of the California Academy of Sciences and its valuable collections were destroyed.

THE engineering journals publish lengthy obituary memoirs of one of the most prominent figures in the industrial life of the north of England—Sir David Dale, Bart., of Darlington, who died suddenly on April 28. He was an eminent authority on economic questions, and probably did more than anyone to promote industrial peace. He was one of the founders of the Iron and Steel Institute, and served as treasurer until his election as president in 1898.

THE Harben lectures of the Royal Institute of Public Health will be delivered by Prof. Elie Metchnikoff, of the Pasteur Institute, Paris, on May 25, 28, and 30. A course of three lectures on "The Bacteriology of Water, Milk, and Tuberculosis," by Dr. Carl Prausnitz, commenced at the institute on Wednesday, May 9, and a course of three lectures on "The Manufacture and Sophistication of Potable Spirits," by Dr. C. E. Harris, will begin on June 12.

WE regret to see the announcement that Mrs. Brightwen, the popular writer on natural history, died on May 5 at seventy-five years of age. In 1890, at the age of sixty, Mrs. Brightwen published her first book, "Wild Nature won by Kindness." This book was very successful. In 1895 "Inmates of My House and Garden" appeared; then followed, in 1897, "Glimpses of Plant Life"; in 1899, "Rambles with Nature Students"; and in 1904, "Quiet Hours with Nature." Mrs. Brightwen was vice-president of the Selborne Society, a Fellow of the Zoological and Entomological Societies, and an active member of various local associations connected with the encouragement of natural history.

THE eighty-ninth annual meeting of the Société helvétique des Sciences naturelles will be held at St. Gall on July 21 to August 1. This will be the fifth time since the foundation of the society that the town of St. Gall has been the place of meeting. On Tuesday, July 31, there will be a discussion on variations among plants and animals and their phylogenetic and physiological importance, with reports upon the subject by Profs. Goebel and Ernst. During the meeting there will also be papers on the following subjects:—modern views on the tectonic synthesis and genesis of the Alps, Prof. Schardt; measurements of base lines in general, with particular reference to the geodetic work connected with the Simplon Tunnel, Prof. Rosenmund; results of the latest explorations made in the Wildkirchli grotto, and their importance to zoology and prehistoric science, Mr. E. Bächler; fossil remains at Kesslerloch and from palæolithic grottos in general, Prof. C. Hescheler; studies of the plankton of the Lake of Constance. The president of the society is Dr. G. Ambühl, and the two secretaries are Dr. H. Rehsteiner and Dr. A. Dreyer.

AFTER being closed for a very considerable time, the fish gallery of the British Museum (Natural History)—or, to be accurate, the southern half of it—has just been re-opened to the public in what may be termed a metamorphosed condition. In place of a dismal crowd of ill-mounted specimens, faded, for the most part, to one dull uniformity, the public has now a small but well-assorted selection of specimens, coloured artificially to imitate, so far as practicable, their appearance in life, and arranged in such a manner that they can be seen to the very best advantage. Descriptive labels—of which only a portion are yet printed—will render the exhibit about as perfect as is at present possible, and the gallery as a whole will enable the public to gain the greatest possible amount of information about fishes with the least possible trouble. As regards the advisability of colouring exhibited specimens of this nature there can scarcely be two opinions, for, although with our present methods and our present lack of knowledge of the appearance of many fishes in life it is impossible to imitate nature closely, yet such an approximation to natural colouring as it is practicable to make is infinitely better than no colour at all.

THE annual dinner of the Institution of Mining and Metallurgy was held on May 4, when a distinguished company of engineers and others assembled. Sir Julius Wernher, in proposing the toast of the institution, insisted that the mining industry has been conducted in the past as seriously and honourably as any other industry in the world. In replying to the toast, the chairman, Mr. William Frecheville, read a letter from Mr. Birrell, the President of the Board of Education, stating that the Government is keenly interested in the proposal to establish an institution at South Kensington for the advancement of the highest technical education, and that a scheme is in course of preparation designed to give effect to the recommendations of the recent departmental committee. The letter went on to express satisfaction that various bodies and persons associated with mining and metallurgy are showing sympathy with the proposed college by contributing to the Bessemer fund, which has for its object the furtherance of mining and metallurgical science by means of advanced education. Mr. Birrell's letter concluded by expressing the hope that this excellent example may be followed by other great industries, all of which must depend for success in no small degree upon the promotion of the study of the higher branches of science. The chairman announced that the subscriptions to the Bessemer memorial amounted to 11,000*l*.

DR. W. N. SHAW, F.R.S., delivered the second of his instructive lectures on "Atmospheric Circulation and its relation to Weather" at the University of London on May 8. The subjects specially dealt with related to persistent and periodical winds, tropical revolving storms and cyclonic depressions of middle latitudes. The lecturer referred more particularly to the rainfall in the various wind-systems, especially in the monsoons, and also quoted some remarkable instances of increase of rain with height above sea-level, for example, at Ascension and St. Helena. Among the many interesting diagrams thrown on the screen we may mention one showing a remarkable fall of the barometer from 755 mm. to 728 mm. during a typhoon at Manila in October, 1882, with an equally sudden rise in the course of a few hours. A wind velocity of 120 miles in the hour (old factor 3) was recorded in this storm. Diagrams of depressions moving across the British Isles were also shown, and an ingenious explanation was given of the usually heavy rainfall in the central portion of the storms.

The contents of the April number of the *American Naturalist*, which include three articles, are chiefly interesting to specialists. The first, by Mr. A. S. Pearse, is devoted to the fresh-water copepod crustaceans of Massachusetts, of which several new species are described. In the second Dr. J. B. Pollock discusses variations in the pollen-grain of *Picea excelsa*, while in the third Mr. A. M. Reese describes in considerable detail the anatomy of the American salamander, *Cryptobranchus allegheniensis*, comparing and contrasting it with that of its larger relative of Japan and China.

The *Journal of Anatomy and Physiology* for April is mainly devoted to anatomical subjects. Dr. Bertram Windle contributes a valuable report (the sixteenth) on recent teratological literature.

The new catalogue (thirty-third edition) of microscopes and appliances issued by Messrs. Carl Zeiss, of Jena, gives a complete list of apparatus manufactured by this eminent firm. Some new and improved microscope stands are included, and the majority of achromatic objectives are reduced in price.

In the *Révue Scientifique* (March 31) Dr. Remlinger discusses the *rôle* of the rat and mouse in the propagation of rabies. These animals are very susceptible to rabies, and Dr. Remlinger adduces evidence which suggests that certain cases of hydrophobia in man, apparently spontaneous, may be due to this source of infection.

According to the *Pioneer Mail* (Allahabad, March 23), the Plague Research Commission has established beyond question the validity of the theory of plague transmission by rat-fleas. A room was selected in which had been found the dead body of a rat suffering from plague. Animals were placed in this room, some protected by fine metallic wire screens against the attacks of rat-fleas, others unprotected. It was soon found that the unprotected animals were attacked by plague, while the protected animals enjoyed a complete immunity.

We learn from the *Pioneer Mail* that snakes and other wild animals accounted for the death of 2195 persons in the Madras Presidency last year, or twenty-six more than in 1904; and they caused the death of 14,899 cattle in 1905 as compared with 14,146 in the previous year. Of the fatalities among human beings, no fewer than 1896, or more than 80 per cent., were caused by snakes; while of those caused by other wild animals 155 were due to tigers, eighty to panthers, ten to wild pigs, nine to bears, eight to wolves, and five to wild dogs. The elephant only accounted for four deaths and the bison for only one, while the hyæna caused the death of two—presumably children. The total number of wild beasts destroyed, for which rewards were paid during the year, was 809, or four more than in the previous year. Included in this total are ninety-two tigers, 666 leopards and panthers, and fifty bears. The only method of reducing danger to life by snakes is apparently, according to our contemporary, the removal of prickly pear and noxious undergrowth.

Bryologists who have had experience of Jameson's "Guide to Mosses" will be glad to know of a similar work, wherein Mr. Symes M. Macvicar provides a revised key to the liverworts of the British Isles. It differs considerably from the key that was originally published in the *Journal of Botany* five years ago, although drawn up on the same lines. It contains merely the tables for determining the genera and keys to the species, without any further details. It is not apparent why the specific names are not given for the monotypic genera, as was done in the earlier issue.

In a contribution to the *Annales Mycologici*, vol. iii., No. 6, 1905, Mr. E. S. Salmon describes three well-marked varieties of the fungus *Phyllactinia corylea*, two of them distinguished by the characters of the conidiophore and the third by the special shape of the conidia. To a certain extent the characteristic features of the varieties appear to be associated with certain hosts, and Mr. Salmon hopes to discover further new varieties in the examination of the conidial stages of the fungus on other host plants; for this purpose he requests the cooperation of mycologists to supply him with material. Should such new varieties be found, it is probable that Phyllactinia, like other genera of the Erysiphaceæ, will prove to have developed special biologic forms on different hosts.

At the meeting of the scientific society of the Kaiserliche Akademie der Wissenschaften, in Vienna (February 1), Prof. F. Krasser and Mr. Kubart contributed a paper on the fossil flora of Moletein, in Moravia; the list of fossils includes *Gleichenia Kurriana, Sequoia Reichenbachi, Aralia formosa*, and *Eucalyptus Geinitzi*. Prof. O. Richter has confirmed the observation recorded by Molisch and others that seedlings, notably vetches and peas, respond more readily to the stimuli of light and gravity in the impure air of the laboratory than in the purer air of a greenhouse. An account of the nature of the mucilage in the fruit of the mistletoe and *Loranthus Europaeus* was presented by Prof. J. Wiesner at the subsequent meeting on February 8.

The occurrence in the United States of three fungi belonging to the Hypocreales or Perisporiales forms the subject of two papers by Prof. G. F. Atkinson. In the *Botanical Gazette*, December, 1905, he discusses the species *velutacea*, formerly referred to the genus Hypocrea, but now assigned to Podocrea or Podostroma. Tulasne and Winter stated that it was parasitic on Clavaria, but Prof. Atkinson agrees with Schröter that it is an autonomous plant, and adduces the evidence that he has obtained specimens in pure cultures from ascospores. In the *Journal of Mycology*, November, 1905, Prof. Atkinson describes a species of Balansia, a genus differing from Claviceps in the formation of a stroma without a sclerotium, found growing parasitically on *Danthonia spicata*, and another fungus, parasitic on Andropogon, for which he proposes a new genus, Dothichloë, allied to Hypocrea and Hypocrella.

Within the last five years much has been written on the subject of the disposal of towns' refuse by fire. The more technical points have, however, received slight attention, and in this direction a paper contributed to the Transactions of the Institution of Engineers and Shipbuilders in Scotland (vol. xlix., part vi.) by Mr. H. Norman Leask throws much light. The forms of furnace in use and their accessories are described, and the results obtained in various parts of the world are considered. The results of careful tests show that, with a destructor of modern type, a high efficiency, both as regards evaporation and burning, is not more costly to work than a destructor burning at a lower rate and giving lower evaporative efficiencies.

THE general report of the Geological Survey of India for the year 1905, published by Mr. T. H. Holland, F.R.S., in the Records of the Geological Survey of India (vol. xxxiii., part ii.), is a document of permanent value. An enormous amount of valuable information on palæontology, petrology, physical geology, seismology, and economic geology has been got together, and the programme of work arranged for the current season indicates that results of more than ordinary interest are likely to be obtained. The investigation of the manganese ore deposits has now been completed, the deposits of chief importance consisting of braunite, psilomelane, and pyrolusite associated with and derived from manganese-bearing silicates occurring as bands and lenticles in the Archæan schists and gneisses. In the same issue of the Records, Mr. T. D. La Touche and Mr. R. R. Simpson describe the Lashio coalfield in the northern Shan States, and Mr. R. R. Simpson describes the Namma, Man-sang, and Man-se-le coalfields, also in the northern Shan States. In the case of Lashio the results are not encouraging. The coal is lignitic with a large proportion of moisture and more than 9 per cent. of ash. The Namma coal, or rather lignite, is distinctly superior to that of any other field in the northern Shan States; but in its raw state it would be a distinctly poor fuel, unfit for locomotive use, and would be mined under the usual difficulties due to soft including rocks.

THE Meteorological Service of the Netherlands, the central office of which is at De Bilt, a suburb of Utrecht, was recently re-organised, and has commenced the issue of a neat octavo publication entitled *Mededeelingen en Verhandelingen*, containing memoirs on meteorological and allied subjects. The articles will be written in Dutch and French, or in French, English, or German according to the nature of the contributions or the wish of the authors. There are separate branches at Amsterdam and Rotterdam; these act as agencies for maritime purposes, and issue local weather forecasts, while the branch at Amsterdam deals exclusively with storm warnings. Among the various useful publications of the Netherlands Institute we may specially mention (1) the daily weather report; (2) the monthly weather review, containing the results of twelve representative stations; and (3) the annals, which have been issued in various forms for fifty-five years; they now contain (1) the results of the observations made in Holland, and at Paramaribo (Surinam), and (2) observations of terrestrial magnetism. The institute has from time to time published valuable works on marine meteorology, and is at present engaged on a meteorological atlas of the Indian seas and other useful investigations.

IN vol. i., part iv., of "Beiträge zur Physik der freien Atmosphäre," Prof. H. Hergesell gives an interesting account of the exploration of the upper air over the Atlantic Ocean north of the Tropic of Cancer, from the Prince of Monaco's yacht in the year 1905. The observations were made under Prof. Hergesell's superintendence by means of tandem sounding-balloons, between 26° and 38° N. lat., and 10° and 42° W. long., and therefore partly in the true region of the trade winds; the chief object was to determine whether the results obtained in the previous year by means of kite experiments between Gibraltar and the Canaries, along the African coast, would be found in the open ocean, beyond the influence of the continent and islands, and at much greater altitudes. The observations of temperature and humidity completely confirmed those obtained in 1904, and further showed that up to altitudes of 12,000 metres and more, winds with northerly components prevailed, and that the anti-trade wind supposed to exist in the adopted theory of atmospheric circulation was not found in those latitudes over the free ocean. Southerly winds were only observed on one day at altitudes of 2000 metres and upwards in lat. 25° 58′ N., the most southerly point reached, but the next day, in lat. 26° 41′ N., the northerly current had again set in. These results differ somewhat from those given by Clayton and Maurice, acting for Mr. Rotch and M. Teisserenc de Bort respectively, in the same latitudes, as they found southerly winds in the upper strata of air. It will be interesting to determine by further experiments whether this difference really exists, and whether in the observations near the Canaries especially it was possibly due to the proximity of the African coast.

A NEW apparatus for determining the mechanical equivalent of heat or thermal capacity of water is described by Prof. H. Rubens in the *Verhandlungen der deutschen physikalischen Gesellschaft*, viii., 5 (1906). In it the work is supplied by turning a cylinder 60 cm. long through 180° and allowing a weight to descend in oil, and the arrangements for the calorimetric determinations obviate the disadvantages of Grimsehl's apparatus.

REFORM of higher education in France forms the subject of a paper in the *Revue générale des Sciences* (xvii., 4) by Prof. A. Turpain. It would appear that the French statutes relating to the appointment of university professors are unsuited to the present times and operate to the detriment of the provincial universities, and, moreover, the new programme of the École Normale tends to draw students from the provinces to Paris.

A NOTE in the *Revue générale des Sciences* (xvii., 4) directs attention to a method of exploding mines by means of acoustic waves. The method is based on the property that when a disc, free to turn about its diameter, is placed in the interior of a cylindrical resonator and the fundamental note sounded, the disc will place itself in a plane perpendicular to the cylinder. By causing the turning disc to complete an electric circuit a mine can be exploded by means of a signal given by a syren on a warship, tuned to the same note as the resonator. The description is taken from the *Technische Rundschau*.

IN a note contributed to the *Atti dei Lincei*, xv., 6, Dr. G. A. Blanc communicates some further results regarding the radio-active substance discovered by him in the thermal springs of Echaillon and Salins Moutiers, in Savoy, and of which an account was given at the congress of radiology at Liége last year. The experiments show the presence of hydrates in which the radio-activity at first increases instead of continually decreasing, thus reproducing the phenomena associated with thorium hydrate rather than those attributed to the element thorium X; but the radio-activity of the present element is far greater than that of ordinary thorium hydrate. In the same journal Messrs. R. Nasini and M. G. Levi give a preliminary note on the radio-activity of the spring at Fiuggi, near Anticoli.

THE α rays emitted by Prof. Marckwald's radio-tellurium are shown by Mr. H. Greinacher in No. 7 of the *Physikalische Zeitschrift* to be capable of causing a marked fluorescence in glass, and a similar but smaller effect in mica and quartz. The observation is of interest inasmuch as the α rays of radio-tellurium have also been shown to possess the property of causing air to fluoresce.

PROF. NERNST and Mr. H. von Wartenberg describe in the *Verhandlungen* of the German Physical Society a new determination of the melting points of platinum and palladium. The method used was an optical one employing a Wanner pyrometer which was specially calibrated for the purpose; the melting point of gold (1064° C.) was taken as the standard of reference. Pure palladium was found to melt at 1541° C. and pure platinum at 1745° C. Dr. Harker's recent determination of the melting point of platinum gave a value of 1710° C.

In spite of its importance as a fundamental physical constant, the latent heat of fusion of ice is known only very approximately. The value obtained by Bunsen was 80·03 cal., whilst Regnault found it to be 79·25 cal. In the *Journal de Physique* (vol. v., p. 157) M. A. Leduc points out that Bunsen's result is subject to an error due to an incorrect determination of the density of ice at 0°. A re-determination of this constant gave a value of 0·9170, and a re-calculation of the latent heat of fusion from Bunsen's data, using this value, gave a result of 79·2 cal. This is in close agreement with Regnault's determination. The principal difficulty experienced in determining the density of ice is in eliminating gas bubbles completely. M. A. Leduc describes an arrangement by which he was enabled to minimise this source of error.

Some remarkable specimens of phosphorescent calcite from Joplin, Missouri, are described by Mr. W. P. Headden in the April number of the *American Journal of Science*. Some of the crystals, after being exposed to sunlight, were found to become highly phosphorescent, and to retain this property for a period of thirteen hours. The specimens of calcite which showed prolonged phosphorescence were always yellow in colour, and contained 0·007 per cent. of ceria, 0·012 per cent. of the didymium earths, and 0·013 per cent. of yttrium and erbium; the spectrum of the latter was very distinct. Purple-coloured specimens of calcite found in the same neighbourhood were shown to owe their colour to the presence of didymium, and to differ from the yellow calcite in being non-phosphorescent. So far as the analytical evidence goes, the phosphorescence of the yellow calcite seems to be associated with the presence of earths of the yttrium group.

A number of foliaceous and fruticose lichens collected by Mr. A. W. C. Herre on the Santa Cruz peninsula, in proximity to San Francisco, are described by him in vol. vii. of the Proceedings of the Washington Academy of Sciences. Parmelia is an important genus, as the species are both numerous and conspicuous; *Parmelia enteromorpha* is a characteristic lichen of the red-wood forest, and *Parmelia Herrei* provides a new species. The new species *Gyrophora diabolica* forms in its locality, the Devil's Cañon, the dominant feature of the lichen rock-flora; another interesting species is the lace lichen, *Ramalina reticulata*, that festoons the oaks. The writer has drawn up a useful key for the determination of genera, and keys to the species.

A publication just received from the Harvard College Observatory describes in detail, and with examples, a telegraphic cipher code devised by Mr. W. P. Gerrish, of that observatory. Numerous advantages are claimed for this system over other systems now in use, its chief characteristic being the ready transmission of groups of figures in a form at once simple to dispatch and readily translatable. A test of the system between the Harvard and Lick observatories gave great satisfaction.

Messrs. Archibald Constable and Co., Ltd., will publish shortly a new book by Prof. H. C. Jones, of the Johns Hopkins University, entitled "The Electrical Theory of Matter and Radio-activity."

Messrs. Dawbarn and Ward, Ltd., are preparing a new issue of their "Directory of Photographic Dark Rooms," and will be glad to receive from photographers information as to any public dark room not included in their directory.

Some of the natural attractions of Norway are described in an illustrated booklet just received from the Albion Steamship Co., Ltd., Newcastle-on-Tyne, containing the itinerary of fortnightly pleasure cruises to the Norwegian fiords by the steam yacht *Midnight Sun*. The cruises are arranged so that passengers may see the most interesting scenery on or near the fiords from the Ryfylke to the Romsdal, and ample time is allowed for excursions away from the ship.

Mr. C. L. Muller has published a pamphlet giving an illustrated description of Dr. Looser's double thermoscope and some of the experiments possible with it. The instrument is an ingenious form of differential thermometer in which great sensitiveness is secured, and so arranged that it is possible to use it in making quantitative determinations. The booklet contains instructions for the performance of fifty-seven experiments in which the thermoscope can be employed.

OUR ASTRONOMICAL COLUMN.

The Expected Return of Holmes's Comet.—From the observations of Holmes's comet in 1899–1900, Dr. H. J. Zwiers has computed a set of elements of the comet's path and an ephemeris for the probable reappearance of the object during the present year.

Having computed the elements for the epoch 1899, Dr. Zwiers applied the Jupiter perturbations for the period January, 1899, to April, 1906, and for January 16·0 (G.M.T.), 1906, found the following elements:—

$$\begin{array}{ll} M = 351^\circ\ 46'\ 52''.14 & \\ \pi = 346\ \ 2\ 31.63 & \\ \Omega = 331\ 45\ 40.75 & 1906\cdot0 \\ i = \ 20\ 48\ 53.30 & \end{array} \qquad \begin{array}{l} \phi = 24^\circ\ 20'\ 25''.55 \\ \mu = 517''.447665 \\ \log a = 0.5574268 \end{array}$$

The ephemeris computed from these elements extends from May 1 to December 31, 1906, and is given, for every alternate day, in No. 4085 of the *Astronomische Nachrichten*.

According to the above elements, the perihelion passage should have taken place at March 14·1804 (G.M.T.), 1906, but, in a supplementary table, Dr. Zwiers gives the ephemeris corrections which will become necessary should it occur either four days earlier or later.

The Luminosity of the Brighter Stars.—An interesting discussion of the luminosity of the brighter stars is published by Mr. George C. Comstock in No. 3, vol. xxiii., of the *Astrophysical Journal*.

Of twenty-five stars discussed, the brightest in the heavens, Mr. Comstock finds that twenty-two have luminosities less than 1000, whilst three, β Crucis, Rigel, and Canopus, have luminosities *greatly* exceeding this value, the luminosity of the sun being taken as unity.

In Mr. Comstock's opinion, this irregular distribution of values and the enormous excess of the three exceptions above the mean value render it unlikely that the parallaxes hitherto accepted for these three stars are entirely trustworthy, for it is on them that the values obtained for the luminosities are based.

Surveying the whole discussion, Mr. Comstock arrives at the conclusion that there is no adequate evidence that the maximum of stellar luminosity exceeds 1000, and, further, he opines that the mean luminosity of first-magnitude stars is not less than 100.

The Variable Radial Velocity of ϵ Aurigæ.—In No. 4084 of the *Astronomische Nachrichten* Dr. H. Ludendorff discusses the variable radial velocity of the star ϵ Aurigæ.

The variability of this object was discovered by Fritsch in 1821, and its variable velocity by Vogel and Eberhard in 1902.

The present discussion is based on the measurements of twenty-six plates obtained between November 9, 1901, and March 23, 1905, with the No. iv. spectrograph and the 32·5 cm. refractor of the Potsdam Observatory.

The values obtained for the velocity, referred to the sun, vary between +5·3 km. (on November 9, 1901) and −16·9 km. (on December 11, 1902).

Early Observations of Eros.—No. 10, vol. liii., of the Harvard College Observatory Annals contains the details of a number of observations of Eros made at Harvard from twenty-one photographs obtained during the period 1893 (October) to 1896 (June).

The measurements of these plates were published in Circular No. 51 of the observatory, but in the present publication the whole of the data relating to the plates, the original measurements of the photographs, the positions of the standard stars employed, reproductions of the photographs, and many other important matters are dealt with in great detail.

As this number forms the concluding part of vol. liii. of the Annals, several reproductions previously given in the text are now reproduced on plates in a much more satisfactory manner, and published as an appendix.

Observations of Satellites in 1904 and 1905.—In No. 94 of the Lick Observatory Bulletins Prof. R. G. Aitken publishes the results of the observations of satellites made at Lick during 1904 and 1905.

Forty-seven observations of the satellites of Uranus were made, the position angle and distance of each object being referred to those of another satellite.

The second part of the publication refers to the observations of Saturn's satellites during 1905, which were, in some measure, a continuation of Prof. Hussey's work in previous years. Only those combinations most likely to improve our knowledge of the orbits of the inner satellites, *i.e.* Rhea with Dione, Tethys with Enceladus, and, as a check, Tethys with Rhea, were, however, measured. Four eclipses of Saturn's satellites were also observed.

Observations of Jupiter's fifth satellite, made during 1904 and 1905, referring this object to the three inner satellites, form the subject of the concluding section of the Bulletin.

New Variable Stars in Orion.—From a study of the Heidelberg 6-inch plates, Prof. Max Wolf has discovered seven new variables in Orion.

Photomicrographic reproductions, through a microscope, of the regions containing the stars on the 6-inch plates are given, together with the positions and observed variations of the seven objects, in No. 4085 of the *Astronomische Nachrichten*.

RECENT ADVANCES IN SEISMOLOGY.[1]

THE most remarkable development in modern seismology is not the seismic survey of a city, or even of a country, but of the whole world. This branch of inquiry is now in active progress. Since the time of the great earthquake of Lisbon in 1755 it has been known that disturbances of the magnitude of that event, although not directly recognisable as earthquakes in regions distant from the origin, have nevertheless given evidence of commotion by causing the water in lakes and ponds to oscillate. By observing and timing the movements of the bubbles of sensitive levels, astronomers have recorded unfelt pulsatory movements of the ground which they showed to be the result of seismic disturbances in far distant countries. In Japan these unfelt movements have been automatically recorded since 1884 (Seis. Soc. Trans., vol. x., p. 6). They were recognised to have originated at a great distance, but the centres from which they sprang were not determined. Some years later, while seeking for a gravitational influence of the moon, the late Dr. E. von Rebeur-Paschwitz found on his records abnormal movements, several of which he traced to definite but very distant seismic centres. Before this, indeed, it had been predicted that a large earthquake occurring in any one part of the world would produce movements which, with proper instruments, would be recorded in any other part,[2] but it was not until after von Rebeur's announcement that serious attention was directed to what has proved to be a line of research open to workers in all countries. Many instruments have been designed to record these unfelt breathings of our earth, but there is still much uncertainty in the interpretation of all their records.

Observations also show that large earth-waves are from time to time propagated over the whole surface of the globe. These far-reaching commotions lead to the inference that their originating impulse must have been delivered over a large region. Harboe has shown that within a meizoseismic area blows of varying intensity have been struck in quick succession at points long distances apart. A district appears to have given way, not simply along the line of one large fault, but along many minor faults. Oldham estimated that the Assam earthquake of 1897 had been accompanied by the bodily displacement of 10,000 square miles of country along a thrust plane. If we interpret the time observations made in connection with this disturbance in the light of the suggestion made by Harboe, then this relief of seismic strain originated over an area of 500,000 square miles.

Although a large block of the earth's crust may thus be fractured, our knowledge of the depth to which the effects of fracturing descend is largely one of inference. From the observations hitherto published, which are now in progress at Przibram, it would seem that a seismogram obtained at a depth of 1150 metres differs but little from one obtained on the surface. This is contrary to observations on small earthquakes, which, although they may alarm the inhabitants of a town and shatter chimneys, may pass unnoticed in shallow mines.

The fact that the large earth-waves have what is practically a constant arcual velocity of approximately 3 km. per second, whether the path be across continents, over ocean floors, or over districts which vary greatly in their geological structure, suggests the idea that the crust of the earth is moved as a whole, and that under the influence of its own elasticity and gravity it behaves in a manner similar to a sheet of ice upon an ocean swell. An alternative view is to assume that the wave motion is due to energy retained within the crust itself, the heterogeneity of which is superficial. Whichever be the case, we may picture a crust yielding irregularly, and possibly through its total thickness, until it gives up its energy to a medium which transmits undulatory movements with uniform velocity.

Many hypotheses have been adduced which suggest thicknesses for the superficial covering of our globe. To these as an outcome of recent seismological research we may add one more. Preceding the large waves of a teleseismic disturbance we find preliminary tremors. These are apparently propagated through the body of the globe with an average speed along paths which are assumed to be chords at about 10 km. per second. This high and nearly constant rate of transmission, however, only obtains for paths which represent arcs greater than 30°. For chords which lie within a depth of thirty miles the recorded speeds do not exceed those which we should expect for waves of compression in rocky material. This, therefore, is a maximum depth at which we should look for materials having similar physical properties to those we see on the earth's surface. Beneath this limit the materials of the outer part of this planet appear rapidly to merge into a fairly homogeneous nucleus with a high rigidity. Following closely on the heels of the preliminary tremors, but in advance of the large undulations, a second phase of motion appears, the chordal velocity of which up to distances of 120° is approximately 6 km. per second. These are tentatively regarded as the outcrop of distortional waves. When these are better understood it may be expected that they also will play their part in shedding fresh light upon the physics of the earth.

I will now turn to a consideration of the regions in which these sudden accelerations of geological change are in operation. They may be grouped as follows:—

Regions which lie on the western suboceanic frontier of the American and the eastern frontier of the Asiatic continents, and regions which lie on a band passing from the West Indies through the Mediterranean to the Himalayas.

In addition to these there are two minor regions, one following the eastern suboceanic frontier of the African continent, which I have called the Malagasy region, and

[1] Abridged from the Bakerian Lecture delivered by Prof. John Milne, F.R.S., at the Royal Society on March 22.

[2] See "Earthquakes," p. 225, International Scientific Series, 1883.

an Antarctic region which lies to the south-west of New Zealand.

Generally it would appear that regions of instability are to be found along the margins of continents or tablelands which rise suddenly to considerable heights above oceanic or other plains.

At the present time we may, therefore, say that megaseismic disturbances do not occur anywhere, but only in districts with similar contours. Are we dealing with primitive troughs and ridges which are simply altering their dimensions under the continued influence of secular contraction, or do these reliefs of seismic strain represent isostatic adjustments which denudation and sedimentation demand?

These and other activities may be looked to as primal causes leading up to displays of pronounced seismic activity. Their frequency, however, may be dominated by influences which at certain seasons or times cause an increase or decrease in seismic strain.

In the wide variations in position and rapidity of flow of ocean currents and in measured oscillations of sea-level which appear to be seasonal in their recurrence, we see influences which may give rise to seismic frequency in districts that possess a high degree of seismic sensibility. Other causes affecting large areas, and also possibly the frequency of small or after-shocks in different seismic districts, have by Knott and others been sought for in the loads due to the accumulation of snow, and in the seasonal fluctuations in the direction of barometric gradients. It does not seem likely, however, that stresses due to such influences have any marked effect upon the frequency of those reliefs of seismic strain which shake the world.

The data which we possess bearing upon this question are as yet far too meagre to admit of satisfactory analysis. It is, nevertheless, interesting to note the direction in which they point. In the six years ending in 1904 we find that off the west coast of North America fifty-one large earthquakes originated during the winter months (October to May) and thirty-five during the summer months. Off the east coast of Asia, north of the equator, the numbers for these seasons were forty-nine and forty-three. These numbers added together show that for the North Pacific, as a whole, 100 disturbances took place in winter and seventy-eight in summer, while in the Central Asian or Himalayan region the corresponding numbers are twenty-five and twenty-seven. Beneath an ocean, therefore, some indication has been obtained of seasonal seismic frequency, while on a continental surface no such frequency has yet been indicated.

If we take a chart showing the varying position of our earth's North Pole in relation to its mean position, we see that the secular movement of the pole is by no means always uniform. Although it may at times follow a path about its mean position which is approximately circular, at other times there are comparatively sharp changes in direction of motion which may even become retrograde. If now on a chart of this description we mark the time-positions of very large earthquakes, we find that they cluster round the sharper bends of the pole path.

In a period of nearly thirteen years (1892 to 1904) I find records for at least 750 world-shaking earthquakes, which may be referred to three periods continuous with each other, and each two-tenths of a year or seventy-three days' duration. The first period occurs when the pole movement followed an approximately straight line or curve of large radius, the second equal period when it was undergoing deflection or following a path of short radius, and the third when the movement was similar to that of the first period. The numbers of earthquakes in each of these periods taken in the order named were 211, 307, and 232, that is to say, during the period when the change in direction of motion has been comparatively rapid, the relief of seismic strain has not only been marked, but it has been localised along the junctions of land blocks and land plains where we should expect to find that the stress due to change in direction of motion was at a maximum. Until the magnitude of these induced stresses has been estimated, it would be premature to assume that the frequency under consideration is directly due to change in direction of pole movement, it being quite as likely that both phenomena may result from a general cause.

A world-shaking earthquake, wherever its motion is pronounced, gives rise to movements which may extend over three or four hours. They come to a close as a series of pulsations, each lasting a few minutes, and separated from each other by approximately equal intervals of rest. The expiring efforts of an earthquake present something more akin to musical reverberation than to intermittent and irregular settlement of disjointed material.

If instead of studying the life-history of an earthquake as recorded at a given station, we compare the seismograms it has yielded at different distances from its origin, we learn something of the manner in which its energy has been radiated and dissipated. An earthquake which in the vicinity of its origin has a duration of sixty minutes may appear at its antipodes ninety or 100 minutes later as a feeble movement with a duration of only four or five minutes. From the time this movement has taken to travel the half circumference of the globe the inference may be drawn that the surviving phase of such an earthquake is that of the large waves. The compressional and distortional precursors, together with the rhythmical succession of followers, are no longer visible on seismograms. The importance of this knowledge to those who are engaged in the analysis of earthquake registers is apparent.

The paucity of available data renders it premature to

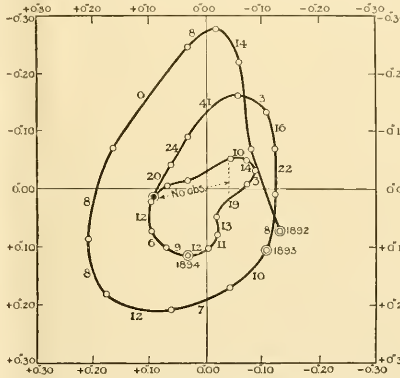


Fig. 1 shows, after Th. Albrecht, the path of the North Pole from 1892 to 1894 inclusive. Each year is divided into tenths or periods of 36·5 days. Numerals indicate the number of large earthquakes which occurred in each of these divisions, commencing with the third tenth of 1892.

make deductions respecting possible alternation in seismic frequency in various localities. But if, instead of confining our attention to a relationship between earthquakes, we consider the question of the relief of volcanic strain, many illustrations may be adduced which indicate a close connection between such activities. For example, all the known volcanic eruptions which have occurred in the Antilles, from the first which took place in 1692, have been heralded or closely accompanied by large earthquakes in that region, but more frequently by like disturbances in neighbouring rock-folds, particularly that of the Cordilleras. This was notably the case in 1902. On April 19 of that year an unusually large earthquake devastated cities in Guatemala. Small local shocks were felt in the West Indies, and on April 25 it was noticed that steam was escaping from the crater of the Mont Pelée, in Martinique. These activities continued to increase until May 8, when they terminated with terrific explosions, submarine disturbances, and the devastation of great portions of the islands of Martinique and St. Vincent.

The last illustration of hypogene relationship between these regions occurred on January 31 of the present year. On that date a heavy earthquake originated off the mouth of the Esmeralda River, in Colombia. Sea-waves inundated the coast, islands sank, and a volcano erupted. The newspapers of February 2 announced that cables between Jamaica and Puerto Rico had been interrupted, and on later dates it was reported that severe shocks had been felt among the West Indian islands, that six or seven submarine cables had been broken, and that Mont Pelée and La Soufrière, in St. Vincent, were again active.

In concluding this short discourse, I wish to direct attention to a class of phenomena from which the working seismologist cannot escape. At certain times horizontal pendulums may be fitfully moving continuously for hours or even days. Similar movements have often been noticed with balances and with other instruments. They are frequently referred to as microseismic disturbances. Inasmuch as they vary with varying meteorological conditions, and

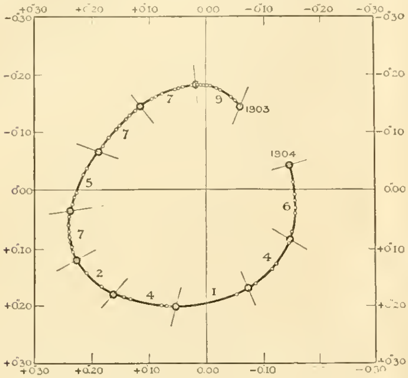


Fig. 2.—This is similar to Fig. 1, but refers to the year 1903, during which period the pole displacement was more uniform than that indicated in Fig. 1.

may be different in neighbouring rooms, I am inclined to think that it would be more accurate to describe these unwelcome visitors, with which not only seismologists, but also astronomers and others, have to contend, as air tremors. When, however, these irregular movements are replaced by movements which have definite periods very different from those of the recording instrument itself, and are at the same time regular in amplitude, it seems possible that they may be connected with actual pulsatory motion of the surface of the ground.

In addition to tremors and pulsations, the records on the films from seismographs show that nearly at all times

with barometric loading. The quantity of water in wells and that flowing in drains and from springs has been observed to vary with fluctuations in atmospheric pressure. Where this takes place, subsurface operations are revealed which may be sufficient to give rise to changes in surface level. Very marked changes of level take place at certain stations during wet weather. In the Isle of Wight, at Shide, which is situated on the side of a valley cut through an anticline of chalk, when heavy rain occurs, levels and horizontal pendulums indicate a tilting towards the bed of the valley. An instrument on the opposite side of the valley behaves in a corresponding manner. In other words, if these observed movements can be regarded as extending to the bed of the valley, it may be said that with rain the steepness of each of its sides is increased. During fine weather the direction of movement is reversed. A more regular movement is, however, found in a tilting known as the diurnal wave. With the same assumption as to the extent of corresponding motion we find, but only during fine weather, that the direction of movement of the sides of the same valley during the night corresponds to that observed during wet weather. During the day it is the same as that which takes place during fine weather. For convenience we may regard the valley as opening and closing. Similar observations have been made on the two sides of a valley which has been cut through alluvium in Tokio.

Probably an important part in the production of these diurnal movements is played by the differential loading and unloading of neighbouring areas by solar influences. During wet weather, in virtue of subsurface percolation and lateral drainage generally, the sides and bottom of a valley where water-level is raised carry a greater load than the bounding ridges. Under these conditions the bottom of a valley may sag and its sides close inwards. During fine weather, in virtue of evaporation and drainage, a movement in the opposite direction may be established. The fine-weather diurnal movement corresponding to the opening of a valley may find a partial explanation in the removal of load by evaporation, but more particularly by plant-transpiration. These activities are more pronounced during the day than at night, and they tend to reduce subsurface percolation and drainage towards the bed of a valley. The comparatively small retrograde nocturnal movement may be partly attributed to an increase of valley load at night, at which time transpiration and evaporation are replaced by surface and subsurface condensation. Transpiration and evaporation being at a minimum at night, it may be assumed that lateral percolation and surface drainage towards the bed of a valley are increased, and, possibly as a consequence of this action, the volume of water in certain wells and that flowing in certain streams and drains has been found to be greater at night than during the day.

Another activity which may result in a nocturnal increase

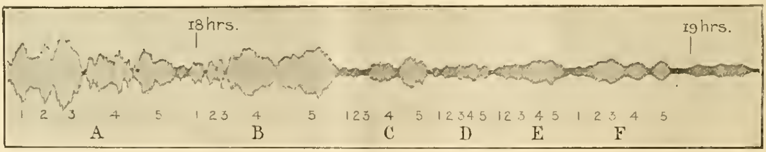


Fig. 3.—Recurrences of Wave Groups A to F in the terminal vibrations of the Colombian Earthquake of January 31, as recorded at Shide, Isle of Wight. Scale 108 mm. = 1 hour.

a slow change of level is taking place. For years a pier may be undergoing a tilt in one direction. Besides this general movement the instruments reveal the existence of waves that indicate a difference in the direction of movement in different seasons. Superimposed upon these again we find records of changes of level which may be associated with variations in the difference in loads on two sides of an observing station. When a horizontal pendulum swings towards the area of greatest atmospheric pressure it apparently indicates a change directly or indirectly connected

in the subsurface flow of water is the expansion of the air in soil by the slowly descending heat of the previous day, this expansion forcing soil-water into passages of easiest escape.

The explanation offered for the phenomena under consideration may be found wanting; but the facts remain that round the face of the globe diurnal superficial distortions can be observed which vary in magnitude and direction, and that rainfall is accompanied by measurable changes in the slopes of certain valleys.

GERMAN CONGRESS OF EXPERIMENTAL PSYCHOLOGY.

THE second congress of the German Society for Experimental Psychology took place on April 18–21 in the picturesque old town of Würzburg, partly at the old university and partly at the well-known psychological laboratory of Prof. Külpe. Two visits were paid to Prof. Rieger's nerve hospital. The attendance amounted to nearly 200, and thus was even more numerous than at the first congress two years previously in Giessen. Prof. G. E. Müller was in the chair. Fewer papers were read than before, but nevertheless they could with difficulty be got through in the three and a half days available, reading eight hours a day.

A new feature in this congress and one that indicates the rapid growth and advancing specialisation of experimental psychology—was that several members of the society had been commissioned to make general reports (Sammelreferate) on particular branches of research with which they were known to have an exhaustive acquaintance. Conspicuous among these reports was that of Külpe (Würzburg), on the general state of experimental æsthetics. The methods of experiment were grouped under three general heads, impression (Eindruck), formation (Herstellung), and expression (Ausdruck); each of these admitted of many further subdivisions. The interesting results communicated were mostly of American and very recent origin. In general, Külpe emphatically maintained that æsthetic values are not wholly of a subjective nature (Einfühlung, zuständlich, &c.), but are to some degree at least objective (gegenständlich). The time was near, he said, when these experimental investigations would claim serious attention from both art critics and artists.[1] Sommer (Giessen) gave a very interesting report on psychiatry and individual psychology, tracing back the modern close union and wonderful development of these two sciences to ideas which arose in the eighteenth century, as the natural sequel to the psychological researches of Descartes and, above all, Locke. The execution of these ideas has only been delayed until now for want of adequate methods. Sommer indicated the essentials of good methods of psycho-pathological investigation, particularly insisting upon the necessity of a uniform system of tests, thoroughly tried in normal, border, and distinctly pathological cases. Weygandt (Würzburg) presented a full report on the psychological examination of weak-minded children. Krueger (Leipzig) reported on the relation between phonetics and psychology. In the course of an exhaustive and lucid exposition of the previous methods and results, he showed that hitherto attention had been almost exclusively confined to the bare morphological elements of speech, as represented by the letters of the alphabet. He himself had chiefly investigated how one and the same syllable can be represented by very varying sounds, according to nationality, emotion, or shade of meaning; his graphic registrations of the modulations of voice as regards speed and pitch excited considerable interest among the audience. On a subsequent day Krueger gave a practical demonstration of his ingenious apparatus for registering the vibrations of the larynx (Kehltonschreiber), designed by himself together with Wirth. Schumann (Zürich) gave a report on the psychology of reading. He described the remarkable success with which reading had been taught by whole words, instead of by single letters. A large portion of the paper dealt with tachistoscopy, and especially with the best means of exposing letters to view for very short periods of time; the difficulty is to prevent a persistent after-image, and the remedy recommended is to let the exposed letters be replaced, not by a blank surface, but by another arrangement of letters.

Turning to the exclusively original papers, a remarkable one was read by Stumpf (Berlin) on the "sensations of feeling" (Gefühlsempfindungen). The feeling (*i.e.* the pleasantness or unpleasantness) that characterises a sensation must be sharply distinguished, he finds, from the feeling characterising intellectual states. The former may be conceived in three ways: first, as a "feeling-tone" or mere quality of the sensation; secondly, as a peculiar element of consciousness, closely associated indeed with the sensation, but just as self-existent as the latter; and thirdly, as only another kind of sensation in addition to, and independent of, those of touch, sight, sound, taste, and smell. He expounded the grounds which had now at last compelled him to adopt the *third* alternative. The paper found warm appreciation, but very little acquiescence. Dürr (Würzburg) had, by means of reaction experiments, investigated voluntary action and association. These two had proved themselves perfectly different from one another; the former was either a making distinct (Verdeutlichung) or else a production (Produktionserfolg); the latter was a *re*production (Reproduktionserfolg). Further, his results were in flat contradiction to the popular theory that the ultimately victorious motive must be the one accompanied by the idea of greatest pleasure or least pain. At the same time, he attributed little causal importance to the consciousness of self (Ichbewusstsein). In harmony with his results was a notable experimental investigation of the will by Ach (Marburg). Here too reaction experiments were used, but cleverly devised so that the force of the will and that of association acted in direct opposition to one another. By this means the manifestations of the two forces could be vividly contrasted, and even subjected to a certain degree of measurement. Ach, like Dürr, finds the pleasure-pain theory to be totally discordant with actual observation. Bühler (Würzburg) discussed the experimental analysis of complicated processes of thought. Each of his observers had had to reply to a series of questions, and at the same time to observe carefully the mental process thereby involved. The result had been to corroborate the statement of Ach and Binet, that the real elements of thought are not faint presentations (verblasste Vorstellungen), but ideas (Bewusstheiten). Messer (Giessen), in his experimental psychological investigation of thought (again by means of reaction experiments), had been able to detect and observe the process of "judgment" as a specific conscious experience. He admitted that this was only possible under certain very favourable conditions, and to this cause he attributed the fact that the experiments of Marbe had resulted in a denial of any such specific experience.

Wirth (Leipzig) dealt with the distribution of attention in different senses (sight, sound, and touch). The allotted three-quarters of an hour barely sufficed for enumerating swiftly the chief features of his wonderfully skilful and complicated mechanical arrangements. Of his rich harvest of psychological results he had only time left to exhibit some numerical tables, showing that all parts of each sensory field presented a regular gradation of sensibility, the maximum of which lay wherever the attention happened to be focused. Fortunately, this research will very soon find more adequate expression in print (*Psycholog. Studien*, ii., 2). Unexpected results had been obtained by Specht (Leipzig) concerning the divergence of the relative and absolute thresholds of sensibility under the influence of alcohol; though the power of discriminating between two sounds of different intensity is much weakened by alcohol, the power of hearing a sound at all is actually increased by it. Rupp (Göttingen) had analysed (by reaction experiments) the localisation of touch stimuli on the fingers into two distinct processes: the localisation of the sensation in space, and its attribution to a particular finger. The former process was the quicker one. By means of certain unusual postures the two processes could be brought to give contradictory indications; thereupon the reaction-time was always lengthened, and sometimes the sensation was even attributed to the wrong finger. Linke (Naumburg) showed by his new stroboscopical experiments that stroboscopical effect is not wholly due to after-images, but also in large measure to causes of a more intellectual nature. The investigation by Veraguth (Zürich) of the galvanic psychophysical reflex had revealed that mental excitement has a marked effect on an electric current passing through any part of the body; but Sommer explained that these electric phenomena were of a secondary character, arising from changes of pressure and sweat-excretion. Marbe (Frankfort) exhibited an ingenious, practical, and comparatively inexpensive experimental arrangement for brief optical stimuli; a ray of light of any desired briefness, intensity, or colour is projected beside another similar but continuant ray. Ebbing-

[1] Külpe's paper will be somewhat amplified in the official account of the proceedings of the Congress. (Published by Barth, Leipzig.)

haus demonstrated his new, but already widely adopted, fall apparatus for the control of chronoscopes and other time-measuring instruments (for full description, see *Zeitschr. f Psychologie*, xxx., 292). Several other apparatus were exhibited, but unfortunately not in such rich variety as at Giessen.

The other papers were those of Jerusalem (Vienna), on remembering and forgetting; Witasek (Gratz), on the methodics of measuring memory; Pfeiffer (Würzburg), on a method of determining qualitative types in school-work; Lipmann (Berlin), on the effect of suggestive questions; Asher (Bern), on the law of the specific energies of the senses; Detlessen (Wismar), on colour-values and colour-measurement; Hughes (Soden), on single affective states; Schultze (Würzburg), on accentual effects (Wirkungsakzente); Decroly (Brussels), on anthropometrical and psychological tests for children; v. Aster (Munich), on the third dimension of the spatial presentation (visual); and Kobylecki (Cracow), on psychological experiment without introspection.

On the whole, the congress showed itself strongly influenced by the universal and increasing reaction against the materialistic atomism of the early days of experimental psychology. The admission is ever gaining ground, that consciousness is something more than a mechanically changing conglomeration of sensations and feelings in varying quality, intensity and complication.

The earnest scientific tone and strict attention to business which had so favourably distinguished the Giessen congress from the international ones was on the present occasion even more marked. The members allowed themselves no relaxation until after the close of the proceedings, when a general picnic was made to the beautiful Veitshöchheim "Pleasure Palace" of the former Prince-Bishops. The next congress will be held at Frankfort (on the Main) on April 22–25, 1908. C. Spearman.

THE MILAN INTERNATIONAL EXHIBITION.

The Milan exhibition, which was opened in state by the King and Queen of Italy on April 28, is still far from complete. The reason for its unfinished condition is to be found in the increased scope of the exhibition. As originally planned, it was intended to commemorate the opening of the Simplon Tunnel by confining the exhibition to a display of progress in transport by land and water. Gradually other branches of industry were added, and support has been accorded by the leading European countries, France predominating with an area of 250,000 square feet. Austria follows with 180,000 square feet, Germany with 160,000 square feet, Belgium with 108,000 square feet, Great Britain with 75,000 square feet, and Hungary with 32,000 square feet. The exhibition covers an area of 400 acres, of which more than half is covered by buildings of a decorative character. Italian exhibitors occupy about one-half of the space, and the exhibits afford striking evidence of the remarkable industrial progress that has been made in Italy of late years. Altogether the exhibition is exceptionally attractive from a popular and a business point of view, whilst from a technical point of view its chief interest is due to the fact that it is the first international exhibition in which electricity has been used for driving the machinery shown in operation.

Of the exhibits of scientific interest, the most interesting are those of the Italian Admiralty. The methods employed in the preparation of charts and the manufacture of torpedoes are well shown. The retrospective exhibition associated with the transportation section is also of great interest. The early history of navigation and of steam transport is illustrated in an admirable manner. Exhibits of historical interest are contributed by the Board of Education, the Corporation of London, Lloyd's Register, the Institutions of Civil and Mechanical Engineers, and the Iron and Steel Institute.

In the various international sections valuable prizes are offered by the King of Italy. They include 400*l.* for the best exhibit of machinery, 400*l.* for the best type of workman's dwelling, 400*l.* for the best flying machine, 400*l.* for the best motor omnibus, 200*l.* for automatic railway couplings, 200*l.* for the best method of testing high-voltage electric currents, 200*l.* for motor-boats, and 200*l.* for the best motor-plough.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—The University Alembic Club celebrated its hundredth meeting on Saturday, April 28, by holding a dinner in the banqueting room of the Town Hall. The professor of chemistry, the Lee reader, and the Aldrichian demonstrator were present. All the past-presidents of the club and a number of old members attended.

The 283rd meeting of the Junior Scientific Club was held on Friday, May 4, when papers were read on "Bubbles and Emulsions," by Dr. W. Ramsden, and "Who were the Greeks?" by Mr. J. L. Myres.

Cambridge.—The council of the Senate has nominated Prof. Woodhead, Mr. A. Sedgwick, and Mr. A. E. Shipley, and the special board for biology and geology has nominated Prof. Langley, Mr. J. J. Lister, and Mr. F. F. Blackman, to be members of the board of managers of the Quick fund. The election to the Quick professorship of protozoology rests with the board of managers, who will also control the expenditure of the income derived from the bequest of the late Frederick James Quick.

Mr. F. G. Hopkins, of Emmanuel College, and Mr. W. M. Fletcher, of Trinity College, have been elected examiners to the Gedge prize in physiology.

It is arranged that the voting on the proposals of the Studies and Examination Syndicate with reference to the doing away with compulsory Greek for mathematical and natural science students will take place on the afternoons of Friday, May 25, and Saturday, May 26.

Prof. Macalister, Prof. Langley, and Dr. Hill have published a time-table of courses in human anatomy, physiology, and histology to be held during the long vacation, beginning on July 4.

In addition to the ordinary classes in general pathology and pharmacology to be given at the New Medical Schools during the long vacation, the series of shorter courses dealing with more advanced work will be repeated this year. These courses are open to medical men and senior students only.

A course of seven lectures on "The Morphology of the Bryophyta" was commenced by Prof. J. B. Farmer, F.R.S., at the Chelsea Physic Garden on Tuesday, May 8. Admission is free by ticket, obtainable on application to the Academic Registrar of the University of London.

A course of eight lectures on the "Structure and Functions of the Central Nervous System," with special reference to the brain stem, will be commenced in the physiology department of University College, London, by Dr. W. Page May, on Wednesday, May 16. The lectures are open to all students of the University of London, also to qualified medical men on presentation of their cards.

The following benefactions to higher education in the United States are announced in *Science*:—The University of California has received a gift of 20,000*l.* from the widow of the late Judge John H. Boalt. Mr. Andrew Carnegie has offered 8000*l.* to Denison University for a new library building on condition that a like sum is secured elsewhere for the endowment of the library. Through the generosity of Mr. Robert S. Brookings and Mr. Adolphus Busch, the medical department of Washington University (St. Louis) has received a gift of 10,000*l.*

An earnest and well-informed plea for the provision of more adequate funds for the University of Cambridge is made in the current number of the *Quarterly Review*. Though it is a mistake to suppose that the flow of benefactions to the old universities has ceased entirely, the fact remains that Cambridge has twice appealed, once in 1898 and again in 1904, for help to meet her responsibilities. It is alleged that the demands of science have emptied the University chest, and yet there is a popular belief that the university of Newton and Charles Darwin, of Maxwell and Rayleigh, is still shrouded in mediæval shadow. When it is remembered that the expenditure on buildings devoted to science alone since 1862 must have exceeded 300,000*l.*, and that other great expenses have been incurred in the same direction, it is not difficult to understand that it has been done only with external help, and that unless more funds are forthcoming due growth and development in the scientific departments are impossible. There certainly appears to be an absence of extravagance. The average annual income of the forty-four professors is not more than 550*l*., and the average income of university teachers, other than professors, is only 250*l*. a year. The needs of the University, as detailed in the article, are indeed numerous, and the means of satisfying them are at present ludicrously inadequate. As has been done with wearisome iteration in these columns, the article refers to American and German munificence on behalf of higher education, and points out the tempting chance of sensible generosity the needs of Cambridge offer to our men of wealth. The generous provision made for university education in Germany and the United States, the part played by such education in the progress of a modern State, and the need that exists to strengthen our intellectual defences if we are to take a leading position in the struggle toward efficiency, were described by Sir Norman Lockyer in his presidential address to the British Association at Southport in 1903. The warning uttered on that occasion, and the position taken as to the significance of higher education to national progress, have been the means of directing attention to our educational deficiencies, and a beginning has been made to remedy them by increased grants to university colleges. A capital sum of a million and a half sterling would solve all difficulties at Cambridge, but wealthy benefactors tarry, probably because the State has not in the past shown its belief in the value of university education; meanwhile the work of a great university languishes.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 15.—"Reciprocal Innervation of Antagonistic Muscles. Ninth Note. Successive Induction." By Prof. C. S. **Sherrington**, F.R.S.

In various reflex reactions inhibition is succeeded by marked exaltation of activity in the arcs inhibited. This after-effect may be figured as a rebound from inhibition.

An example is the following. When a dog in which the spinal cord has been transected in the thoracic region is, the period of shock having passed, supported so that its spine is vertical and its hind limbs hang freely, these latter begin to perform a rhythmic stepping movement.

Suppose this reflex is in regular progress and is being recorded from one knee, *e.g.* right, by a thread passing thence to a pulley and light lever, if then the other thigh (left) be gently supported from behind the knee the record shows that the stepping reflex at once ceases in the right limb. The reflex, on recommencing after this pause, continues as it ceases, that is, its tempo and amplitude are practically the same as before the interruption.

This result contrasts with the following. The reflex can be cut short by a strong squeeze of the tail.

The application of this stimulus to the tail does not in any way interfere mechanically with the stepping movement. Suppose the reflex to be in regular progress and recorded as before, if then the tail stimulus be applied the stepping reflex is almost immediately arrested, and in both limbs. The reflex remains in abeyance while the tail stimulus is continued. On the cessation of the latter the reflex returns, and on its return soon shows indubitable increase in activity as compared with its activity before the inhibitory arrest. The increase is chiefly seen in the amplitude of the movement, but there is also often marked quickening of the tempo of the rhythm. The author has seen the rhythm on some occasions quickened by 30 per cent. The after-increase of the reflex may persist in evidence for many seconds. Its decline is gradual.

The arrest of the stepping reflex by tail inhibition cannot be prolonged indefinitely. The reflex tends to return in spite of the inhibitory stimulation when the latter is long persisted in. It is different when the stepping reflex is arrested by lifting one knee; the reflex does not then tend to break through the arrest, however long the latter be continued. In this form the arrest seems referable simply to cessation of the stimulus which excites the reflex. In tail inhibition the arrest seems referable to a central inhibition, the peripheral stimulus excitatory of the reflex remaining in action all the time.

The after-increase consequent upon inhibition may be conveniently termed "*successive spinal induction*," the more so as that term directs attention to the likeness between the spinal process and certain visual phenomena commonly designated "induction."

Again, it is easy to evoke reflex extension of the hind limb by stimulation of the skin of the opposite hind limb. With the spinal dog laid on its side (*e.g.* left) and a thread attaching the knee of the slightly flexed right limb to a recording lever, the delivery of a stimulus at a skin-point of the left foot evokes reflex extension at right hip and knee. If this stimulus, at moderate and unchanged intensity, be given at regular intervals, a series of extension reflexes of regular height and duration is obtained. If in the course of such a series the right limb is, during one of the intervals, thrown into strong reflex flexion, the next extension-reflex following on the intercurrent flexion differs from those prior to it in being more ample and more prolonged. Its after-discharge is greatly increased and its latency is sometimes diminished. If the test stimulus for the extension-reflex be adjusted at just subliminal value, the intercurrent flexion-reflex will make it supraliminal. The exaltation of the extension-reflex may remain perceptible for five minutes.

Successive spinal induction seems to be a process qualified to play a part in linking together simpler reflexes so as to form from them reflex cycles of action. It appears especially fitted to combine the successive opposite phases of such cyclic reflexes as have been termed "alternating," and shown to be particularly characteristic of the locomotor activity of the mammalian spinal cord. If a reflex, A, not only temporarily inhibits the action of an antagonistic reflex, B, but also as an immediately subsequent result induces in arc of B a phase of superactivity, the central organ is in that way predisposed for a second reflex opposite to A to occur in immediate succession to A itself. Such an effect seems proved by the observations in this and a preceding communication.

"On the Existence of Cell Communications between Blastomeres." By C. **Shearer**. Communicated by Adam Sedgwick, F.R.S.

In cutting sections of a number of segmentation stages of Eupomatus and Polygordius eggs, delicate protoplasmic strands were frequently observed connecting the blastomeres. Experiments with different fixing reagents demonstrated that they were not of the nature of coagulation artifacts, or the result of disintegration of the protoplasm, for in many of the sections in which they were to be seen all the finer details of histological structure were well preserved. Under favourable conditions they could be observed during the living state, and were similar in all respects to the filose strands described by Andrews in a number of Metazoan eggs. They possibly afford a means of coordinating the various cell activities.

PARIS.

Academy of Sciences, April 23.—M. H. Poincaré in the chair.—The president announced the accidental death of M. Curie, and gave a short account of his work.—The eruption of Vesuvius, and in particular, remarks on the explosive phenomena: A. **Lacroix**. A general account of the recent eruption, with particulars of the lava outflows and the nature of the explosions.—A method allowing of the study of the solar corona at other times than during eclipses: G. **Millochau** and M. **Stefanik**. It is proposed to photograph the regions near the sun's edge by means of the spectroheliograph, isolating the line λ 4303 in the second slit, and eliminating the light from other radiations by means of an appropriate green screen. Preliminary attempts have been made at Meudon with encouraging results, and the authors hope to be able to complete the work at the summit of Mt. Blanc.—Algebraic curves of constant torsion: Eugène **Fabry**.—Reducible groups of linear and homogeneous transformations: Henry **Taber**.—The equation of Laplace with two variables: Georges **Lery**.—The use of an electrical tuning-fork as a generator of alternating currents: M. **Devaux-Charbonnel**. Some anomalous results obtained with the currents generated in the electromagnet of an electrical tuning-fork were examined with a Duddell oscillograph. The effects produced appear to be due to the electrostatic capacity, and cause difficulty when tuning-forks are used in multiplex telegraphy.—Diffusion of solutions and molecular weights: Michel **Yégounow.**—The atomic weight and spark spectrum of terbium: G. **Urbain.** The atomic weight was determined by estimating the amount of water in the carefully purified sulphate $Tb_2(SO_4)_3,8H_2O$, and was found to be 159·2. The spark spectrum of terbium is rich in lines, the wave-lengths of some thirty-seven of the most characteristic being given.—The estimation of cadmium in a volatile or organic salt: H. **Baubigny.** Cadmium sulphide precipitated in the presence of hydrochloric or hydrobromic acids obstinately retains some of the haloid salt, and this, on ignition, owing to the volatility of the chloride and bromide, gives rise to serious losses. The author proposes to convert the impure sulphide into sulphate, and weigh in this form with certain necessary precautions.—Distemper in dogs: H. **Carré.** Dogs which had been kept isolated from birth remained free from distemper, but were always sensitive to inoculation with the disease, whatever mode of inoculation was used. The blood of the animal, collected when the fever is at its height, is sterile, but communicates the disease.—The Tertiary strata at Turritelles and Congeries, Panama: E. **Joukowsky.**—The phenomena of slipping in Sicily: Maurice **Lugeon** and Émile **Argand.**

DIARY OF SOCIETIES.

THURSDAY, MAY 10.

ROYAL SOCIETY, at 4.30.—On Adsorption and Occlusion: the Law of Distribution in the Case in which one of the Phases possesses Rigidity: Prof. M. W. Travers, F.R.S.—Cyanogenesis in Plants, part iv., The Occurrence of Phaseolunatin in Common Flax (*Linum usitatissimum*), part v., The Occurrence of Phaseolunatin in Cassava (*Manihot Aipi* and *Manihot Utilissima*): Prof. W. R. Dunstan, F.R.S., Dr. T. A. Henry, and Dr. S. J. M. Auld.—A Variety of Thorianite from Galle, Ceylon: Prof. W. R. Dunstan, F.R.S., and B. Mouat Jones.—The Mechanism of Carbon Assimilation in Green Plants; the Photolytic Decomposition of Carbon Dioxide *in vitro*: F. L. Usher and J. H. Priestley.—The Action of Anæsthetics on Living Tissues, part ii., The Frog's Skin: Dr. N. H. Alcock.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Long Flame Arc Lamps: L. Andrews (Adjourned Discussion).

MATHEMATICAL SOCIETY, at 5.30.—On the Substitutional Theory of Classes and Relations: Hon. B. Russell.—On Linear Differential Equations of Rank Unity: E. Cunningham.—On the Motion of a Swarm of Particles whose Centre of Gravity describes an Elliptic Orbit of Small Eccentricity about the Sun: Dr. E. J. Routh.—The Theory of Integral Equations: H. Bateman.—Singularities of Power Series in Two Variables: G. H. Hardy.

FRIDAY, MAY 11.

ROYAL INSTITUTION, at 9.—Some Astronomical Consequences of the Pressure of Light: Prof. J. H. Poynting, F.R.S.

PHYSICAL SOCIETY, at 8.—The Dead Points of a Galvanometer Needle for Transient Currents: A. Russell.—Exhibition of Lippmann Capillary Dynamo and Electromotor: Prof. H. A. Wilson.—Exhibition of an Apparatus for demonstrating the Movements of the Diaphragms of Telephonic Transmitters and Receivers and the Current flowing into and out of the Cable during Speech: W. Duddell.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Observations of *Uranus* at Windsor, New South Wales: John Tebbutt.—Observations of Comet *c* 1905: Natal Observatory.—Note on the Parallax and Proper Motion of the Central Star in the Annular Nebula in Lyra: B. L. Newkirk.—On the Ratios of the Triangles in the Determination of the Elliptic Orbit from Three Observations: S. Hirayama.—Some Considerations regarding the Number of the Stars: Miss W. Gibson.—On the Ancient Eclipses of the Sun: E. Nevill.—Elements of Five Long-Period Variable Stars: A. Stanley Williams.—On the Orbit and Mass of 85 Pegasi: W. Bowyer and H. Furner.—Some Points arising out of a Discussion of the Double Stars in Struve's Mensuræ Micrometricæ: T. Lewis.—Exhibition of Stereoscopic Star Charts North of 20° N. Decl., and South, if near the Milky Way: T. E. Heath.

MALACOLOGICAL SOCIETY, at 8.—Notes on the Subgenus Malluvium: E. A. Smith, I.S.O.—Notes on some Species of the Genus Mitra, with the Description of *M. Brettinghami*, n.sp.: E. A. Smith, I.S.O.—On some Land- and Fresh-water Mollusca from Sumatra, part ii.: Rev. R. Ashington Bullen.—Notes on a Collection of Nudibranchs from the Cape Verde Islands: C. Crossland and Sir Charles Eliot, K.C.M.G.—Notes on Indian and Ceylonese Species of Glessula: Col. R. H. Beddome.

TUESDAY, MAY 15.

ROYAL INSTITUTION, at 5.—Glands and their Products: Prof. William Stirling.

UNIVERSITY OF LONDON, at 5.—The Atmospheric Circulation and its Relation to Weather: Dr. W. N. Shaw, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.

FARADAY SOCIETY, at 8.—The Electrolysis of Fused Zinc Chloride in Cells Heated Externally: Julius L. F. Vogel.—Sensitiveness of the Platinum Electrode: H. D. Law.

WEDNESDAY, MAY 16.

SOCIETY OF ARTS, at 8.—The Development of Watermarking in Hand-made and Machine-made Paper: Clayton Beadle.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Exhibition of Pond Life.

ROYAL METEOROLOGICAL SOCIETY, at 4.30.—An Instrument for Testing and Adjusting the Campbell-Stokes Sunshine Recorder: Dr. W. N. Shaw, F.R.S., and G. C. Simpson.—The Development and Progress of the Thunder Squall of February 8, 1906: R. G. K. Lempfert.

THURSDAY, MAY 17.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Determinations of Wave-Length from Spectra obtained at the Total Solar Eclipses of 1900, 1901 and 1905: Prof. F. W. Dyson, F.R.S.—Some Stars with Peculiar Spectra: Sir Norman Lockyer, K.C.B., F.R.S., and F. E. Baxandall.—An Apparent Periodicity in the Yield of Wheat for Eastern England, 1885–1905: Dr. W. N. Shaw, F.R.S.—Some Physical Constants of Ammonia, a Study of the Effect of Change of Temperature and Pressure on an Easily Condensible Gas: Dr. E. P. Perman and J. H. Davies.

CHEMICAL SOCIETY, at 8.30.—The Relation between Absorption Spectra and Chemical Constitution, part vi., The Phenyl Hydrazones of Simple Aldehydes and Ketones: E. C. C. Baly and W. B. Tuck.—Aromatic Compounds obtained from the Hydroaromatic Series, part ii., The Action of Phosphorus Pentachloride on Trimethyldihydroresorcin: A. W. Crossley and J. S. Hills.—Studies of Dynamic Isomerism, part v., Isomeric Sulphonic-derivatives of Camphor: T. M. Lowry and E. H. Magson.—Studies on Basic Carbonates, part i, Magnesium Carbonates: W. A. Davis.

ROYAL INSTITUTION, at 5.—The Influence of Ptolemaic Egypt on Græco-Roman Civilisation: Rev. J. P. Mahaffy.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Notes on Overhea Equipment of Tramways: R. N. Tweedy and H. Dudgeon.

FRIDAY, MAY 18.

ROYAL INSTITUTION, at 9.—International Science: Prof. A. Schuster F.R.S.

SATURDAY, MAY 19.

ROYAL INSTITUTION, at 3.—The Old and New Chemistry: Sir James Dewar, F.R.S.

CONTENTS. PAGE

THURSDAY, MAY 17, 1906.

THE MECHANISM OF THE UNIVERSE.

History of the Planetary Systems from Thales to Kepler. By Dr. J. L. E. Dreyer. Pp. xii+432. (Cambridge: University Press, 1906.) Price 10s. 6d. net.

BY the publication of this masterly account of the development of cosmogonic ideas and the history of planetary systems from the early dawn of Greek philosophy to the final establishment of the Copernican system, Dr. Dreyer has rendered a great service to those who take an interest in the fascinating history of astronomical science. Throughout the work we have reason to admire his lucid exposition, based on profound historical studies, of the manifold views formed by the thinking minds of antiquity and of the middle ages on the mechanism of the universe, his definite conclusions on many controversial points, and, above all, his endeavour to trace out, as much as possible, the influences of the philosophic and religious tendencies of the time on the cosmological conceptions under view.

The opening chapters describe the development of astronomical ideas among the Greeks. After a brief review of the cosmogony of the early atomistic school we are introduced to the more distinct teachings of the Pythagoreans. To their conception of the revolution of the earth round the central fire, notwithstanding its crudeness, distinct merit must be attributed, if judged by the favourable influence which the teaching of Philolaus exerted on the propagation of the Copernican system among those "who could only admire philosophers of classical antiquity." Complicated and erroneous as the Pythagorean idea was, it nevertheless paved the way for the true conception of the earth's rotation, but not, as was often believed, for the heliocentric system. The chapter on the primitive geocentric cosmology of Plato may, at first sight, appear somewhat too prominent. Considering, however, the various controversies to which Plato's astronomical system has given rise, a clear statement of his natural philosophy on the basis of an exhaustive analysis of the Dialogues is of importance, even apart from the author's apology that "there is a charm in the poetical conception of the 'soul of the world' which makes the study of the *Timaeus* peculiarly attractive."

With Eudoxus and Kalippus astronomy has started on its career as a science. Eudoxus is the first to go beyond mere speculative reasoning; he distinctly bases his system of the homocentric spheres on the demand of satisfying the observed motions. The possibilities of this mathematically elegant system, recently pointed out by Ideler and Schiaparelli, were, however, not much appreciated by the ancients, although Aristotle had accepted it in the improved version of Kalippus.

Dr. Dreyer's criticism of Aristotelian metaphysics is severe.

"His careful and critical examination of the opinions of previous philosophers makes us regret all the more that his search for the causes of phenomena was often a mere search among words. This tendency, which to us is his great defect, appealed strongly to the medieval mind and helped to retard the development of science in the days of Copernicus and Galileo."

The attempts of finding the physically true system of the world terminated with Herakleides, who taught the rotation of the earth, and Aristarchus, who proposed, as a way of "saving the phenomena," that the earth performed an annual motion round the sun. But the rapid rise of practical astronomy in the Alexandrian school had so enormously increased the knowledge of the complexities of the planetary motions, which none of the proposed systems could explain, that henceforth the idea of grasping the physical truth was altogether abandoned, and attention became concentrated upon a purely geometrical interpretation of the celestial phenomena.

The subsequent exposition of the theory of the epicycles and their utilisation in the Ptolemaic system naturally forms an important part of Dr. Dreyer's work. We cannot enter here upon his valuable account of the work of Apollonius, Hipparchus, Eratosthenes, and Ptolemy; nor can we dwell upon his fascinating picture of the advances in astronomical knowledge during the Alexandrian era, including, as they do, the discovery of the precession by Hipparchus, the mensuration of the earth by Eratosthenes, and general conclusions as to the dimensions of the universe. The chapter closes with a graphic account of the rapid decline of Hellenic culture after the destruction of the Alexandrian library, when "the curtain went down for ever on the great stage where Greek science had played its part so well and so long."

The return to archaic cosmology in Europe under patristic influence and the supreme sway of Aristotelian metaphysics in scholasticism, mark an epoch of scientific decadence in gloomy contrast to the flourishing period of Hellenic culture. But the same epoch is distinguished by the intense cultivation of Greek astronomy among the Arabs, whose labours, devoted to the further development of the Ptolemaic system, are expounded in chapter xi. Although no direct advance in cosmic ideas accrued from their work, they influenced the subsequent advancement of European astronomy in a most important manner by their invention of the trigonometric calculus.

The description of the revival of astronomy in Europe brings us face to face with some interesting philosophers of the pre-Copernican period. The vague and often mystic speculation of Cusa is contrasted with the practical merits of Peurbach and Regiomontanus, who successfully endeavoured to utilise the Ptolemaic system for the purposes of astronomical calculation, while we also find an interesting account of the hopelessly complicated attempts made by Fracastoro and Amici to revive the theory of solid spheres, and thereby to prove the physical truth of the Alexandrian system.

The three closing chapters dealing with Copernicus, Tycho, and Kepler are naturally those which command our special interest. They contain far more than mere statements of the works of these great heroes of astronomical science. They define clearly the specific *rôle* played by each of these actors in the revolution of scientific thought. In following the author through his analysis of "De revolutionibus," we realise not only the great mental power but also the heroism of the "quiet student at the shore of the Baltic," and we feel the importance of the moment when his work is ushered into the world with Osiander's apologetic introduction. We must agree with the author's endeavour to show how little Copernicus could have been influenced by Philolaus and the vague ideas of Aristarchus, whose anticipations detract nothing from the originality of his own thoughts. On the other hand, the exposition of the defects of the system is so lucid that it requires no intimate technical knowledge of astronomy to recognise the necessity of modification, which so immediately urged Tycho to the invention of his ingenious compromise between the geocentric and heliocentric conception.

How far Tycho's all-important work as an observer has paved the way for the final recognition of the true system by Kepler is admirably shown in the last chapter, where the author opens before us the successive paths along which, through a labyrinth of errors and failures, the never tiring genius of Kepler was finally led to the "golden portal of truth." The long and weary road he had to go before he finally broke away from the time-sacred idea of circular motion and the Ptolemaic *punctum aequans*, and proved conclusively the elliptic character of the Martian orbit, is brought before us by an exhaustive analysis of his works, the study of which is so highly instructive, not only from the scientific, but also from the psychological point of view. The reproach, often levelled against the author of the "Mysterium Cosmographicum," of having filled his books with all sorts of mystic fancies, is, in Dr. Dreyer's opinion, founded on a misconception of Kepler's object in making his investigations. "There is the most intimate connection between his speculations and his great achievements; without the former we should never have had the latter."

We cannot attempt to enter upon the author's review of the opinions of science and church on the Copernican system during the time between Kepler and Newton, with which, on the whole, the student of history is familiar, though it is particularly interesting to hear on this matter the verdict of an historian who has derived his knowledge so directly and completely from an exhaustive study of the original prints and manuscripts.

It is difficult to emphasise sufficiently the specific merits of a work of this kind in a brief review. Doubtless not the least of its many meritorious features is the lucidity and conciseness of exposition. In its endeavour to grasp the essence of the cosmogonic ideas the mind is nowhere impeded by an unnecessary accumulation of cumbersome detail. At the same time the non-mathematical reader is supplied with sufficient technical information to secure his acquaintance with the principal geometry of the cosmic systems under discussion. This latter advantage is important in the case of a work which is clearly not written for a limited circulation among the small section of astronomical experts, but may justly claim to appeal to all who are interested in the history of the general development of scientific culture.

PROF. EHLERS'S "FESTSCHRIFT."

Zeitschrift für wissenschaftliche Zoologie. Vols. lxxxii. and lxxxiii. *Festschrift zur Feier seines siebzigsten Geburtstages am* 11 *Nov.* 1905, *Herrn Geheimen Regierungsrat Prof. Ernst Ehlers.* Band i., pp. iv+692; Band ii., pp. 741; and plates. (Leipzig: Engelmann, 1905.) 2 vols., price 5*l.*

THE distinguished zoologist in whose honour these volumes are issued is widely known as an indefatigable worker and one of the most genial of men. Together with the late von Kölliker, Prof. Ehlers has for many years edited the journal which now celebrates his seventieth birthday. As a testimony of the inspiring character of his teaching and of the regard in which he is held this "Festschrift" gives abundant witness. With no less clearness it indicates the diverse activities of modern zoologists and the particular problems upon which they are engaged.

With such a varied content, the volumes are difficult to review. The systematic work, admirable as it is, and coordinating or expanding as it does our knowledge of annelids, starfish, and flat-worms, can only be mentioned; nor can we do more than indicate the purport of a few of the many anatomical and physiological papers.

The place of honour is appropriately given to von Kölliker's paper on the histogenesis of the vertebrate nervous system, the last contribution of the master of histology, whose amazing vitality at eighty-seven years enabled him to conduct research and to discuss difficulties of fact and interpretation with unabated zeal. The month in which this latest defence of the neuron-theory was published brought the tidings that von Kölliker had ceased from work.

A long and exquisitely illustrated memoir by Vejdowsky gives a minute account of the structure and mode of origin of the annelidan vascular system. The nature of this system in the lower animals has been of late the goal of much research. Under the influence of the trophocœl theory, as stated by Lang on the basis of Bergh's work upon annelids, the vascular system has come to be regarded generally as a mesodermic structure, its cavities as a schizocœl, and not, as had often been suggested, a blastocœlic structure. The results of Vejdowsky's work have led him to a very different conclusion. First he proves, what had often been denied, that annelids possess a vascular endothelium. He finds that this "vasothelium" arises in the following way. Blood-vessels are intimately associated with the gut. Their cavities are at first simply a space between the outer ends of the gut-cells and their basal membrane. Into this space cells are budded off from the endoderm. Some of these become differentiated into epithelio-muscle elements that constitute the vasothelium, and others into blood-cells. Thus the study of annelids leads Vejdowsky to conclude that their hæmocœl is a hypoblastic structure *sui generis*, not comparable to that of arthropods or of molluscs, but rather to the cardiac vasothelium in vertebrates. Such a result emphasises that relation of vascular system to the alimentary tract which topography has insisted upon.

In his article on the morphology of the cestode body, Prof. Spengel stoutly supports the monozoic theory. He regards the Bothriocephalidæ as the most primitive tapeworms, and considers that in the highly modified Tæniidæ we have simply a coincidence of somatic and gonidial segmentation areas. Incidentally he suggests the comparison of the scolex with the hinder end of segmented worm, and emphasises the singular nature of the cestodes by pointing out their entire lack of true regenerative power.

The remaining anatomical papers deal with the modifications of clasping organs in arboreal mammals, with the head of collembolous and culicid insects, the nervous system of leeches, and certain abnormal gasteropods.

Of the embryological memoirs, the accurate and laborious research of Wierzejski on the cell-lineage of Physa will be welcomed as a topographical paper of the first rank. Prof. McIntosh contributes a well illustrated account of the life-history of the shanny, and then follow memoirs on the early development of the blind-worm, on the breeding habits of Rhinoderma and of the salamanders.

The physiological papers are of more general interest. Prof. Häcker continues his illuminating work on the skeleton of the Radiolaria by treating the Tripylaria from the same ecological standpoint which he adopted in his paper of last year. Häcker is the most active of a band of workers who are putting new life and new significance into the merely geometric descriptions of earlier students of these skeletal products. Dr. Rhumbler gives a further instalment of his work on the mechanics of streaming movement in Amœbæ, and shows some interesting stream figures produced by dropping chloroform water upon shellac. He fully recognises the inward and autogenous control that dominates those displays in organisms that we cannot parallel in not-living matter, but he holds that in Amœba the phenomena of movement and feeding are capable of mechanical explanation in terms of the aggregation theory which he has formulated elsewhere.

Dr. Jordan contributes an essay on the origin of species in Lepidoptera. His main thesis is to the effect that geographical subspecies, and no other variations, are the material out of which new species have been evolved. Much of the paper is summarised from his earlier work, and represents a line of research to which several naturalists are applying themselves. The work of Petersen on the Fritillaries in particular pursues the method employed by Dr. Jordan, but in a more comprehensive manner, and it is to be hoped that these important results may be rendered more available to the student of evolution than they now are by a new mode of presentation, graphic, tabular, or other than textual description.

Lastly, the memoir of the Baroness von Linden on the influence of heat, cold, and gases upon the coloration of Vanessid butterflies constitutes a further instalment of the author's prolonged investigation. The general conclusion drawn from these experiments is that whatever lowers the rate of pupal metabolism increases amount of black imaginal pigment and diminishes the extent of red colour in the butterfly.

F. W. Gamble.

THE BIRDS OF TUNISIA.

The Birds of Tunisia. Being a history of the birds found in the Regency of Tunis. By J. I. S. Whitaker. 2 vols. Royal 8vo. Pp. xxxii+294 and xviii+410. Plates and maps. (London: R. H. Porter, 1905.) Price £3 3s. net.

THE two handsome and beautifully illustrated volumes containing the history of the birds of the Regency of Tunis form a fitting crown to the years of work in the field, the museum, and the library which their author has devoted to the ornithology of this until recently little known country. They form too a valuable contribution to the avifauna of the western Mediterranean region; for although the present work purports to be merely a history of the birds noticed in Tunisia, and of their lives as observed in that country, the author has thought it advisable, when possible, to allude to the occurrence of the various species also in Algeria and Morocco, as likewise, in some cases, in Tripoli, and in the Mediterranean basin generally.

The articles on various warblers (especially the interesting remarks on their life-history), and other birds which are met with most commonly in that region, will be most welcome, even to those whose interests are restricted to the birds which figure on the British list. Tunisia, a long and somewhat narrow country, stretching from the Mediterranean back in the vagueness of the great desert, presents a great variety of natural features and climate; and the contrast between the well-watered, wooded and mountainous region north of the Atlas Mountains and the rainless, sandy and rocky desert country is very great. To these circumstances, and to the fact, pointed out by the author, that few countries are geographically so favourably situated as the Regency for the observation of the migration of birds, the wealth of the Tunisian avifauna is due. No less than 365 species and subspecies of birds are included in this work; and only about thirty-five of these have to be relegated to the roll of occasional and accidental visitors. Two beautiful photogravures give an excellent and most truthful idea of the character of the scenery and the traveller's mode of life in the south of the country; while other plates introduce the reader to some of those wonderful Roman ruins, so marvellously preserved in that dry, clear air, which so startle the inexperienced wanderer in the central parts of Tunisia.

Each species is fully described, and a careful account of its distribution in Tunis, with some observations on its range in the neighbouring Mediterranean countries, is followed by an interesting and graphic account of its nesting habits, song, and life-history generally.

The four natural divisions into which the Regency may be divided appear to have each certain species peculiar to it, or more abundant in it than in the other regions. Besides this, in the case of some resident species, such as the crested larks, for instance, different forms of the same species are to be found in the different regions, the variation of these forms being in some cases considerable, and not always limited to the coloration of the plumage alone, but occasionally extending to the structural parts of the birds. The crested larks, says the author, afford a striking example of the extent to which local variation may be carried by natural causes, and no country probably affords a better opportunity of observing and studying this subject than Tunisia. The author is naturally in favour of recognising subspecies, and the use of trinomials for them; and his remarks hereon and upon what constitutes a species and a subspecies may be read with great advantage.

Many noteworthy and peculiar birds may be studied in Tunisia, but probably the families of larks and chats are better represented than any other; of the former twenty-one and of the latter eleven species and subspecies are treated, and the fifteen beautifully executed coloured plates which adorn these sumptuous volumes are largely devoted to illustrating these two families. Tunis is indeed especially rich in larks; and years of study, a long series of specimens collected by himself, and an examination of the various types in museums and the literature of the subject, added moreover to his having had the advantage of observing the birds in life, have enabled the author to clear up many puzzling points respecting the specific and subspecific value of the numerous forms of larks. We have here a very clear and lucid exposition of the larks of the western Mediterranean basin; and especially of the crested larks (the most puzzling of them all), of which the author considers that there are two distinct groups, viz., one including the common crested lark of Europe, the other the small-billed crested lark of Southern Spain, each with its allies.

The necessity for protective colouring is undoubtedly great in a country like Southern Tunisia, where the scanty vegetation affords but little shelter to its feathered denizens. Hence it is that the plumage of most of the species resident in the desert and semi-desert region harmonises with the sandy coloration of the soil. This is especially remarkable in the larks. But the author points out that although at first sight it may appear curious that the chats, except in a few instances, are more or less conspicuously coloured, it will, however, be found that the conspicuously attired chats frequent, as a rule, rocky and broken ground full of dark clefts and fissures, where the rocks are sometimes black and in other cases of a glittering white, and in such situations a strongly marked plumage is really far less conspicuous than a uniform light coloured one would be. The ravens also remain as black as ever, but they, too, frequent cliffs and rocks for the most part, and their case seems analogous to that of the rock-haunting chats. Two good maps enable the reader unacquainted with the country to follow the author's remarks on its topography.

O. V. Aplin.

AMŒBÆ AND THEIR ALLIES.

British Fresh-water Rhizopoda. Vol. i. By James Cash, assisted by John Hopkinson. Pp. x + 148 + xvi plates. (Ray Society, 1905.) Price 12*s.* 6*d.* net.

THE important discoveries that have recently been made on the morphology of Protozoa have revived the interest in British fresh-water amœbæ and their allies, and a monograph on the subject has been regarded for some time as a special need of the zoologist.

Mr. James Cash has been known for some years as an ardent microscopist with a special knowledge of the forms and habits of the species of fresh-water rhizopoda in the north of England, and he has given us in this volume the benefit of his experience in this line of work, illustrated by many beautiful original drawings of the living organisms. As a work of reference for the names of species, and in so far as it suggests to the young amateur naturalist exercises for his amusement and instruction, it will be useful; but as references to important details of structure and reproduction are in general meagre, often misleading, and in many instances omitted altogether, it will not supply the need that is felt. The description of the cell (p. 3) as "physiologically, a minute vesicle, or closed sac, the enveloping membrane or cell-wall enclosing the protoplasmic substance in which the functional phenomena reside," appears to us singularly unfortunate in an introduction to the study of the Protozoa.

The description of the nucleus is very short, but long enough to contain considerable extracts from the work of Calkins, whose views the author adopts, but there is no reference to the chromidial network which the recent papers of Hertwig, Schaudinn, and others have shown plays such an important part in reproductive phenomena of many rhizopoda. It is disappointing to find no reference, either in the introduction or in the systematic part, to the evidence of a developmental cycle in the life-history of Amœba, based on the researches of Scheel and Calkins.

In the very brief account of the reproduction of Arcella, again, although Hertwig's important paper published in Kupffer's *Festschrift* is included in the list of references, the statements made are incomplete and misleading. Many other criticisms similar to these could be made, but the critic is disarmed by the confession in the preface that the author has not "investigated very closely the physiological problems associated with the life-history of these organisms." With this confession before them, it seems difficult to account for the action of the council of the Ray Society in undertaking the publication of this monograph without previously enlisting the services of a trained morphologist, with special knowledge of the group, to correct and revise the introduction and the morphological details in the description of the genera.

A monograph written by Mr. Cash, with the co-operation of a good morphologist, might have been one of really first-rate importance. As it now appears, however, useful as it may be in some respects and valuable in others, it is not complete, and does not constitute a serious advance of knowledge.

OUR BOOK SHELF.

Physikalisch-chemisches Centralblatt. Band i. and ii. (in parts). (Berlin: Borntraeger, 1903–1905.)

WE have received the first two volumes of the above serial, the first number of which was issued on December 15, 1903, twenty-four parts and authors' and subject indexes appearing annually. Besides the German title, the cover bears the titles "Physico-Chemical Review" and "Revue physico-chimique," and the abstracts of French and English papers are given in the respective languages, all others being in German.

The periodical is edited by Dr. Max Rudolphi, of Darmstadt, with the collaboration of chemists and physicists in various parts of the world, London being represented by Sir W. Ramsay. Most, if not all, of the papers abstracted would doubtless be found to be noticed in other publications, and although the multiplication of such serials is not to be commended, this one may appeal to physical chemists who prefer to find abstracts on their own subjects separated from those of general physics and of inorganic and organic chemistry. In order that the serial should be useful to workers, it is necessary that the abstracts should be given as soon as possible after the publication of the original papers from which they are taken. It would not be just to criticise a serial in its infancy, but some of the abstracts mght have appeared earlier; possibly their publication has been unavoidably delayed, and as time progresses the cause of this reproach will be removed. The periodical is well printed and contains many tabulated results.

The Philosophy of Martineau in Relation to the Idealism of the Present Day. By Prof. Henry Jones. Pp. 37. (London: Macmillan and Co., Ltd., 1905.) Price 1s. net.

THIS thoughtful and eloquent address, originally delivered at the celebration of the Martineau centenary, contains much more about absolute idealism than about the philosophic system of the great Unitarian preacher. Prof. Jones, after pointing out the close agreement between Martineau and the Idealists in several respects, finds his text in the division made at the beginning of "Types of Ethical Theory" between systems that start with nature or God, and those that start with the spirit of man. Absolute idealism, of course, ranks under the former head, and the idiopsychological ethics of Martineau under the latter. So in the remainder of the paper the doctrines of absolute idealism are re-stated in a form such as might rob Martineau's chief objections of their force—the objections, in particular, that ethical interests are not conserved, and that a refusal to sever man from nature and God means that man is merged into them and lost within them. Whether the reader will think this re-statement absolutely convincing or not will probably depend on his previous sympathies. Prof. Jones takes occasion, in passing, to notice the similarity of Dr. James Ward's "activity" and Martineau's "free will" as philosophic explanations, and takes occasion, too, as in many other recent utterances, to have one or two clever flings at the Pragmatists.

The Romance of the South Seas. By Clement L. Wragge. Pp. xv+312, with 84 illustrations. (London: Chatto and Windus, 1906.) Price 7s. 6d. net.

IN connection with Mr. Wragge's work as Government Meteorologist of Queensland, he paid a visit to New Caledonia, with the view of establishing a weather-observing station there. In this book he gives an account of his visit to the island, and also to Rarotonga and Tahiti. We wish there were more information in the book about the meteorological results of his journey. The volume contains instead simply a chatty account of the islands; and the most interesting matter is the author's visit to the convict prisons in New Caledonia. At Tahiti he paid a pilgrimage to Point Venus, where Cook on June 3, 1769, observed the transit of Venus. The author is enthusiastic over the scenery in both islands, and the only thing that justifies the mention of "romance" in the title is the spell of their scenery. The author's style is very discursive, and the book is full of smoke-room gossip and snatches of sailors' songs. It is illustrated by some good photographs, and in an appendix is a list of some shells and corals which the author collected in the Society Islands.

The Wild Fauna and Flora of the Royal Botanic Gardens, Kew. Kew Bulletin of Miscellaneous Information, additional series v. Pp. vii+223. Edited by Sir William Thiselton-Dyer. (London: H.M. Stationery Office, 1906.) Price 2s.

THIS volume is the combined work of a number of well-known zoologists and botanists, each of whom has made a special section the subject of his own investigation; it ought, therefore, to be exhaustive and trustworthy, as indeed it appears to be. The chief interest attaching to a catalogue of this nature is in relation to the important evidence it will afford in the future as to how a country fauna and flora become gradually modified as their surroundings become altered with the incoming of suburban conditions. Many such changes have already taken place in the animal and vegetable products of Kew; and many more are likely to take place in the near future. One of the most remarkable instances of adaptation to new conditions in the London parks and gardens generally is afforded by the wood-pigeon, which in the country is one of the wildest and shiest of all birds. A conservative spirit—possibly in the case of the mammals a little too conservative—we are glad to see, obtains in the matter of nomenclature. R. L.

Physical Chemistry, and its Applications in Medical and Biological Science. By Dr. Alex. Findlay. Pp. 68. (London: Longmans, Green and Co., 1905.) 2s. net.

THIS little book makes its appearance at an opportune moment, for no one engaged in biological work can now neglect the teachings of physical chemistry, and the great influence which this branch is exercising on the development of the biological sciences. It is just the sort of work the physiologist, pathologist, bacteriologist, and scientific medical practitioner need—brief and at the same time dealing in a simple manner with fundamental facts. The author thus reviews diffusion, osmosis, cryoscopic methods, and the study of osmotic pressures in plants and animals, chemotaxis, the theory of ionisation and its application to the germicidal action of disinfectants, the permeability of membranes and the influence of this on secretion, the velocity of reactions, catalysis, colloidal solutions, and the bearing of physical chemistry on serum therapy, in which connection the work of Ehrlich, Arrhenius, and Madsen is briefly reviewed. Altogether this book supplies a decided want, and can be thoroughly recommended.

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.*]

Osmotic Pressure.

In the issue of Nature for May 3 (p. 19) appeared an abstract of a recent paper by Prof. Kahlenberg on "Osmosis and Osmotic Pressure." In Prof. Kahlenberg's paper, and also in the abstract, it is claimed that his experiments invalidate van 't Hoff's theory of osmotic pressure, by which the concordance between the pressure of gases and the osmotic pressure of dilute solutions was established. As the basis of that theory seems sometimes to be misunderstood, may I be allowed to recall the principles on which it is founded?

In a paper published in the *Zeitschrift für physikalische Chemie* for 1887, van 't Hoff showed that, from the well-known experimental relation between the solubility of a gas and the pressure, it followed by a simple application of the second law of thermodynamics that the osmotic pressure of a dilute solution must possess the same value as the ordinary pressure of a gas at the same concentration. The solution must be so dilute that the dissolved systems, each made up of a particle of solute as nucleus, and the portion of solvent which it influences, are beyond each others' spheres of action. The proof has been put in a modified form by Lord Rayleigh (Nature, 1897), and Prof. Larmor has obtained the same result by using the fundamental conceptions of the molecular theory as a basis, instead of the experimental solubility relations of a gas (Phil. Trans., A, 1897). In all these proofs no assumption is made as to the nature of osmotic pressure. It may be due to molecular impacts or to chemical affinity, or to some other undiscovered cause. The strength (and weakness) of a thermodynamic proof lies in this very independence of assumptions as to the mechanism by which the effects are produced. Prof. Kahlenberg and his followers seem to consider that the thermodynamic theory of solutions stands or falls with the hypothesis that the pressure is due to molecular bombardment.

If the conditions assumed in the proofs are realised, the whole authority of thermodynamics goes to support the result. The importance of experiments on osmotic pressure, such as those of Prof. Pfeffer, Lord Berkeley and Mr. Hartley, and Prof. Kahlenberg, lies in the question how far the assumptions made in the thermodynamic proofs can be realised experimentally. This is a much humbler *rôle* than that assigned to the experiments by Prof. Kahlenberg, who claims that the application of gas laws to solutions is based on the few observations of Pfeffer and others by which those laws have been verified directly. Nevertheless, the experiments are of great interest. The gas value for the osmotic pressures measured by Pfeffer shows that the conditions laid down in the thermodynamic theory are realised in practice: (1) that for sugar solutions in water an approximately perfect semi-permeable membrane has been obtained; (2) that no selective action such as could be produced by a Maxwellian dæmon is in operation; (3) that the molecules of cane sugar in solution are the simple molecules indicated by the chemical formula, though they may or may not be combined with solvent molecules; (4) that a solution which is dilute in the thermodynamic sense can be realised at possible concentrations; (5) that a theory deduced for volatile solutes may be extended to other cases. When other solutions and different membranes are employed, one or more of these conditions may fail, and the theoretical value be beyond the reach of experimental attainment. Prof. Kahlenberg remarks that because a semi-permeable membrane does not exist, a theory which postulates one cannot be maintained. We might construct a parallel statement by saying that because a frictionless piston is not practically obtainable, in Carnot's engine and the science of reversible thermodynamics physicists and engineers have imagined a vain thing.

But I may point out that at least two perfect semi-permeable surfaces are probably known: (1) when a solution freezes to give the solid of the pure solvent, the solute is compressed into a smaller volume of liquid solution; the surface of the growing crystals is semi-permeable. (2) When a volatile solvent evaporates from the solution of a non-volatile solute, the free surface of the liquid is again a semi-permeable membrane. From these two facts follows the validity of the thermodynamic relations between the osmotic pressure on the one side and the freezing point and vapour pressure on the other. This is important, for it enables us to use measurements of freezing points or vapour pressures when it is not possible to realise the experimental conditions necessary for a satisfactory determination of the true osmotic pressure.

Osmotic pressure is a thermodynamic conception. The pressures observed in practice may or may not represent the same thing. We may define osmotic pressure as the excess of hydrostatic pressure it is necessary to exert on a solution in order that it may be in equilibrium with the solvent through a perfect semi-permeable membrane. With this definition we may use the conception of osmotic pressure as a basis for a Carnot's cycle and a thermodynamic theory of solutions. Prof. Kahlenberg writes that opponents of van 't Hoff's idea have generally held that the so-called osmotic pressure is an ordinary hydrostatic pressure, brought about by the entrance of liquid into the osmotic cell. It is delightful to find one point at least in which the supporters of van 't Hoff, and van 't Hoff himself, are in complete agreement with his opponents.

In the abstract of Prof. Kahlenberg's paper which appeared in Nature we are warned that, among the general ruin of physical theories which is to follow his experiments, the hypothesis of ionic dissociation is involved. I confess that the warning leaves me unmoved. The idea that the ions of electrolytic solutions are dissociated from each other during their movement (though possibly or probably combined with the solvent) is required by the electrical phenomena. The abnormally great osmotic pressures of certain electrolytes dissolved in water indicate some kind of dissociation, but cannot tell us whether or not that dissociation takes place so as to give rise to electrified systems. In simple salts such as potassium chloride, which we know by their electrical properties to be electrically dissociated, it is difficult to see how a second kind of simultaneous dissociation could occur. But that non-electrical separation is sometimes found is indicated by some older experiments of Prof. Kahlenberg himself, who found that solutions of diphenylamine in methyl cyanide show abnormally low molecular weights, but are non-conductors of electricity. The theory of ionic dissociation rests upon electrical evidence, and by such evidence it must be tried. W. C. D. Whetham.

Trinity College, Cambridge, May 12.

Considerable importance seems to be attached to a recent paper by Prof. Kahlenberg on "Osmosis and Osmotic Pressures" (*Jour. Phys. Chem.*, vol. x.), as is evidenced by a separate summary published in Nature (May 3, p. 19). In these circumstances it may not be out of place to point out that the conclusions Prof. Kahlenberg deduces are not warranted.

On p. 142 he says "indirect measurements of osmotic pressures . . . from vapour tensions . . . involves the assumption that the gas laws hold for solutions." This is contrary to fact. We have shown experimentally (see vol. lxxvii. Proc. Roy. Soc.) that aqueous solutions of cane sugar give the same osmotic pressure whether observed directly or deduced indirectly from their vapour pressures, and the relation connecting the osmotic and vapour pressures is quite independent of the "gas laws holding for solutions."

Leaving out of consideration the experiments made before the solutions were stirred—for on Prof. Kahlenberg's own showing these are not good—his conclusion that the gas laws do not hold for dilute solutions in pyridine is based on four experiments. If one may take No. 59 (p. 201) as a type of these, it is easy to show that the experiment is valueless.

The sugar solution used is 0·125 grm. mol. per litre, and a pressure of 98 cm. of mercury is reached, but the theoretical value is some 3 atmos. Now on p. 184 the diameter of his gauge is given as 0·5 mm., and he says that at the end of three days 0·115 grm. sugar has come through the membrane—this quantity represents 2·8 c.c. of solution. If we assume that this volume of solution came through the membrane at a uniform rate, a simple calculation will show that the rate is equivalent to a fall of 20 cm. *per hour* in the gauge. No wonder the theoretical pressure was never reached!

Berkeley.
Foxcombe, near Oxford. E. G. J. Hartley.

Diurnal Variation of the Ionisation in Closed Vessels.

In his letter on this subject published in Nature of May 3 (p. 8) Mr. G. C. Simpson is, I venture to think, under a misapprehension regarding the conditions which determine the variations of the earth's electric field. His statement of the problem, which I have slightly abbreviated, is as follows:—"It is usual to accept that there is a negative charge on the earth's surface, and the corresponding positive charge is a volume charge distributed in the atmosphere. There is very little volume charge in the air close to the earth's surface, so the relation between potential gradient and charge on the earth's surface is given by $dv/dh = -4\pi\sigma$. Hence it follows that with a given charge on the earth's surface and the corresponding charge in the atmosphere above, the vertical distribution of the charge and the conducting state of the upper atmosphere do not in the slightest affect the potential gradient within a few metres of the earth's surface."

All this is very true, but it is equally true that *with a constant charge on the earth's surface* nothing whatever will affect the potential gradient close to it. Since the potential gradient is a constant multiple of the surface density, it is absurd to consider the variation of the one whilst the other is kept constant. The only assumption that it seems safe to make about the state of the earth's surface is that, owing to the relatively high conductivity of the earth's crust, for purposes of atmospheric electricity it may be treated as an equipotential surface. The charge in any particular region will be determined by the distribution of electrification and ionisation in the atmosphere, and will readjust itself almost instantaneously when any change takes place in the external conditions. It will not, as an incautious reader might gather from Mr. Simpson's letter, behave as if it were glued to the surface of the earth.

In my letter of April 22 I illustrated my point by considering the analogy with the case of ionised air between two parallel plates maintained at a constant difference of potential. As this comparison is inaccurate, I shall take the liberty of putting the case in another way, in the hope that it may prove more convincing. The earth is to be regarded as a conducting sphere which is continuously receiving a negative charge in certain areas—probably those in which rain is falling—and losing it again by conduction through the atmosphere from all the rest of its surface. Since the observations on the earth's field only refer to fine-weather regions, we need only consider what happens over them. There will be an earth-air current which, under specified conditions, will have attained a steady value, the charge on the earth's surface being that required to give the necessary potential gradient to drive the current. Suppose that by some means the ionisation at some distance from the surface suffers a permanent increase locally, whilst the air close to the surface is unaffected. It is clear that, whatever view is taken of the distribution of the charges producing the earth's field, the increase in the ionisation will produce a local increase in the earth-air current; but by hypothesis the conductivity of the air close to the earth is unaltered, so that the increase in the current must be accompanied by an increase in the potential gradient close to the surface. This is, of course, produced by negative electricity flowing from other parts of the earth.

The above, I imagine, is an exaggerated but otherwise trustworthy picture of the effect an ionising radiation from outside would have on the earth's electric field. The conductivity produced by the rays in the upper atmosphere must be enormous compared with the effects close to the earth. Even if the rays were homogeneous, only a mere trace would remain after passing through a layer of air roughly equivalent in absorbing power to 76 cm. of mercury. But it is far from probable that they are homogeneous, and any want of homogeneity would exaggerate the effect. Other factors conspire to this end: the presence of dust near the earth loading the ions and the smaller rate of recombination at low pressures; whilst the increase in the mobility of the ions at low pressures would just compensate for the feebler absorbing power of the upper atmosphere.

It will be observed that the effect on the earth's field of an increase in the ionisation of the atmosphere depends entirely on where that increase takes place. If the conductivity increases in a greater ratio close to the earth's surface than it does further away, the result ought to be a fall in the potential gradient. Mr. Simpson rightly points out that such a relation between the potential gradient and the leakage of electricity near the earth's surface has been shown to exist. From my point of view this indicates that the bulk of the ionisation near the earth's surface is not caused by radiation from an external source.

O. W. Richardson.
Trinity College, Cambridge, May 12.

Defects in Ostrich Feathers in South Africa

The domestication of the ostrich on a practical basis was undertaken in Cape Colony about 1867, and since then ostrich farming has become one of the most important industries in the eastern province. The census of 1904 gave 357,970[1] tame ostriches in the colony, while the export of feathers reached 470,381 pounds, practically the whole of which came from tame birds; the estimated value of the feathers was 1,058,988*l*., giving about 3*l*. 10*s*. per bird of feather-producing age. During the forty years of domestication the instincts of the ostrich have apparently undergone no change, though its habits are much altered. The feathers cut from the tame bird are shorter, weaker, and not so fluffy as those taken from wild birds, but probably these differences are to be correlated with the greater frequency of plucking, and not with any constitutional change resulting from domestication.

Within recent years much concern has arisen from the prevalence of a defect in the growth of the feather, which seriously reduces the value of the plumes to the farmer. The imperfection, technically known as "barring," takes the form of a series of narrow, chevron-shaped bars or malformations across the whole feather. The general appearance of a moderately affected plume is shown in the accompanying photograph (Fig. 1). Examined closely, it is seen that the regularity of the individual barb is much disturbed at the bars, and that the barbules are there defective and only partly differentiated from the barbs. The appearance is such as to suggest that the barbs have been constricted at these particular regions, and that in the development of the feather the barbules have failed to become differentiated and open out, though with a needle their separation can sometimes be effected. Occasionally several barbs will remain joined together at the bars, they also having failed to differentiate. In many cases some of the barbs are shortened, the missing part having broken

[1] The statistics are taken from a paper by the Hon. Arthur Douglass read before the recent meetings of the British Association at Cape Town. Mr. Douglass is the author of a well-known work, "Ostrich Farming in South Africa," and was one of the pioneers in the domestication of the ostrich, and probably the first to hatch the chicks by artificial incubation. His death, shortly after the meetings of the Association, is a great loss to the agricultural and political life of Cape Colony.

off at one or other of the bars, showing these to be places of weakness.

The extent of the barring varies much on different birds and according to locality and season. Sometimes all the wing, tail, and covert feathers are affected, while in others only a few plumes exhibit the imperfection. Again, the number of bars on different feathers varies greatly; frequently they occur at fairly regular intervals along the entire length of the feather, or only a few are present and the rest of the feather is perfect. Where the barring is close, a single barb will be irregular at five or six places along its length. The deficiency can be overcome to a large degree by juxtaposition in the process of "dressing" before the feathers are retailed, but buyers estimate that, as a result of the presence of the bars, the value of the feather to the farmer is frequently diminished from 20 per cent. to 50 per cent., probably an average of about 25 per cent. As the trouble is very general over all the ostrich-farming districts in South Africa, it is manifest that the subject is one which calls for thorough scientific investigation.

The development of the ostrich feather has not yet been

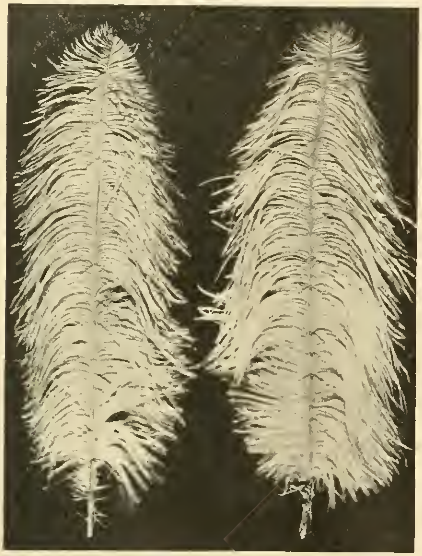


FIG. 1.—Ostrich feathers showing barring.

worked out, but from our knowledge of that of feathers generally there can be no question that the barring represents some interference with the normal growth of the plume at an early stage, an interference which prevents the proper differentiation later of the feather into rachis, barbs, and barbules; moreover, these must recur from time to time during the growth of the feather. As to the cause, the evidence mainly points to impaired nutrition of the feather germ during its early stages. Farmers universally acknowledge that an insufficiency of food during the time the feathers are forming, as from a drought, will result in a plucking full of barrings, breakages, and other malformations. In a general way it is recognised that the better fed the bird the less likely are its feathers to show any defects. Furthermore, from correspondence with Dr. R. M. Strong, of the University of Chicago, who has been engaged upon a study of the development of feathers for years, I learn that experiments have been conducted by Prof. C. O. Whitman and himself upon malformations in other birds exactly similar to those of the ostrich. Ring-doves, after hatching, were alternately starved and fed for some days at a time when the feather was in process of formation, with very remarkable results. On the feathers developing, similar bars were produced in very striking fashion and in great profusion. The results of the experiments were such as to leave no doubt that the barring in this case was due to malnutrition or some disturbance in the metabolism of the bird.

The ostrich farmer, however, is convinced that insufficiency of food is not the only factor involved. Frequently bars appear on the feathers of birds which apparently have been well fed all the time. A general opinion prevails that the ostrich fly, *Hippobosca struthionis*, is often responsible for the trouble, and also the ostrich mite, *Pterolichus bicaudatus*, both of which sometimes infest the birds in large numbers. It is difficult to see how these external parasites can act directly upon the feather germ, but it is undoubted that the progressive farmer who dips or sprays his birds against the pests produces a plumage much less subject to imperfections, and consequently of higher value. Whether the fly or mite can affect the feather directly or only indirectly by lowering the general condition of health of the bird is a subject for investigation, as is also the influence of the tape-worms and thread-worms (*Strongylus douglassi*) which frequently infest the animals. The influence of in-breeding and heredity will also have to be considered. It is significant to find that a similar barring occurs on the ostrich farms in Pasadena, California, among birds which have been ill fed, and the trouble is general on the ostrich farms in Florida, where conditions are not so favourable for birds. A much rarer defect is where the parts of a feather have failed to differentiate along one or more vertical lines extending the whole length of the vane. This irregularity is in all probability the result of some permanent injury to the feather germ or its socket, and occurs independently of the nutritive condition of the bird.

The production of these irregularities in the growth of feathers as epidermal derivatives is of much zoological interest in connection with pathological conditions of epidermal structures generally. As is well known, the enamel of the teeth of children is frequently grooved or pitted in transverse rows, a condition which can usually be traced to some error in feeding, congenital disease, or ailments affecting the general nutrition of the body during the time the teeth were forming; the finger nails are often transversely grooved after an illness or injury, pointing to a response to malnutrition; hair frequently breaks, falls off, or changes in character after an illness from the same cause; the horns of cattle and antelopes occasionally show one or more narrow constrictions representing a diminution in the amount of horny material. All these defects can be correlated with some low condition of health of the animal at the time, and serve to establish that the imperfections in the feathers of ostriches are not an isolated phenomenon, but, *mutatis mutandis*, can be compared with imperfections in the epidermal products of other vertebrates.

While it may be rash to predict before the experiments in hand are completed, yet from the facts already known there seems good reason for expecting that the trouble will be found to rest very largely with the farmer, and that the remedy will be mainly a question of a proper and regular supply of food—not an easy matter in time of droughts. Without question there exists an extremely sensitive relationship between the production of a perfect feather and the proper nutrition of the bird; artificial selection in breeding may also assist towards the production of a strain in which the feathers are less influenced by constitutional changes in the bird. J. E. DUERDEN.

Rhodes University College, Grahamstown, Cape Colony.

Origin of the Term "Metabatic."

My attention has been directed to the word *metabatic* as relating to the transfer of energy. I should be much obliged if anyone could give me information as to the author of the term, the date of its introduction, or any scientific paper in which it occurs in such form as to betoken its exact meaning. ROBERT E. BAYNES.

Christ Church, Oxford.

THE PEARL FISHERIES OF CEYLON.[1]

THE important series of reports on the pearl-oyster fisheries and on the marine biology of Ceylon, prepared under the direction of Prof. Herdman, which is being published by the Royal Society at the request of the Colonial Government, continues to grow both in size and value. Parts iii. and iv. have been recently issued, and although in the preface to part iii. Prof. Herdman expresses the hope that the whole will be completed in four parts, this has not proved possible, and a fifth part is now contemplated, to contain the concluding sections of the pearl-oyster work, several more supplementary reports of a faunistic character, and a general discussion of the faunistic results.

The two parts of the pearl-oyster report now under review give a summary of the results of the more recent investigations and inspections carried out by Mr. Hornell on the banks in the Gulf of Manaar, together with an account of the pearl fishery of 1905, which proved to be far in excess of any recorded fishery, both in the number of men and boats engaged, and in the quantity and value of the oysters taken, the nearest approach to it being the fishery of the previous year, 1904.

Prof. Herdman and Mr. Hornell have been exceedingly fortunate in being able, so soon after the commencement of their investigations, to study the exact conditions under which these two most successful fisheries have been carried out, and although they state that it does not seem likely that the 1905 results will be rivalled by any prospective fishery of the oysters now in sight upon the grounds, yet the knowledge and insight into the nature of the factors leading to a great and profitable fishery which have been obtained will be of the very highest value in suggesting rational measures for the future control and improvement of the beds; and a careful perusal of Prof. Herdman's reports leaves little doubt that in the case of these pearl-oyster beds, practical measures carried out upon a sufficiently large scale under adequate scientific control will be capable of effectively preventing, in most years, such total failures of the fishery as have been so often recorded in the past, and of ensuring to those engaged in the work a much more certain and uniform return for the labour and capital employed.

The investigations already made show clearly that the different beds or "paars" are subject to very different conditions, and whilst some, which are specially favourable for the growth and development of the oysters, are liable to receive only a small and inadequate fall of "spat," others almost invariably become covered at the breeding season with an abundant supply of the young brood. Since, however, the latter beds are situated further seawards and close to the deeper water, the young brood is frequently, if not generally, destroyed by the action of currents or by being overwhelmed by sand, so that the oysters never attain maturity. These circumstances naturally suggest that the transplantation of young brood oysters in large quantities from the outer exposed beds to the inner ones, which are favourable for their growth and development, will be a highly profitable operation in those years when the inner beds do not receive a natural fall of spat. Such transplantation constitutes one of the principal recommendations which Prof. Herdman and Mr. Hornell make for the development of the fishery, and work on these lines has already been commenced, although in 1905 it was not particularly called for, excepting on the grounds actually cleared during the fishing of the year, owing to a very extensive natural fall of spat on all the beds which had taken place in the autumn of 1904.

Other practical measures which are recommended include "cultching," or the deposit of suitable solid material, such as shells or broken stone, to which the young oysters can attach themselves, the thinning out of overcrowded beds, and the cleaning of the oyster banks by means of the dredge, thereby removing in as large numbers as possible such enemies of the oysters as starfishes, and also other animals which would compete with the oysters for the available supply of food.

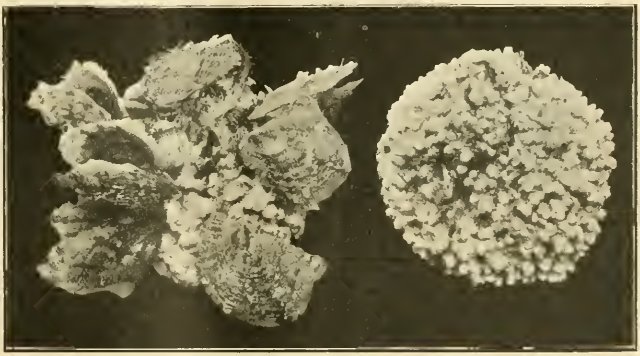


FIG. 1.—Natural cultch (Lithothamnion), and, to the left, a similar Nullipore ball with a dozen young pearl oysters attached. From "Report to the Government of Ceylon on the Pearl Oyster Fisheries of the Gulf of Manaar."

If we may venture upon a word of suggestion, we would express a hope that in the concluding volume Prof. Herdman will furnish us with a concise and sufficient summary of the whole of the pearl-oyster reports, since from the nature of the circumstances in which the series has been produced it is a little difficult to extract from them the essential features of the valuable work accomplished. We wander along pleasantly enough with Prof. Herdman on his explorations in the Gulf of Manaar, and accompany Mr. Hornell with pleasure during his inspections of the pearl banks from year to year; we traverse many an agreeable by-way under Mr. Hornell's direction, and not infrequently retrace our steps along the same paths with Prof. Herdman for our guide; we are allowed to see, as it were, the ideas gradually developing in the minds of the two investigators, and we watch with interest the new facts and suggestions of Mr. Hornell's various letters and reports becoming gradu-

[1] "Report to the Government of Ceylon on the Pearl-Oyster Fisheries of the Gulf of Manaar." By Prof. W. A. Herdman, F.R.S. With Supplementary Reports upon the Marine Biology of Ceylon by other Naturalists. Part iii., pp. viii+328 and plates; and part iv., pp. xvi+242 and plates. (Published at the request of the Colonial Government by the Royal Society, London, 1905.)

ally assimilated into Prof. Herdman's general scheme—all of which would be entertaining enough on a warm afternoon in summer, when we lay on some grassy cliff within sound of the sea, but is, it must be confessed, a little trying to busy individuals anxious to arrive at the kernel of the business in hand.

Of the supplementary reports in parts iii. and iv. the most important is probably Prof. Dendy's monograph on the sponges, which occupies some two hundred pages and is illustrated with sixteen plates. Prof. Dendy describes 146 species from Prof. Herdman's collection, of which 77 are new, and he considers that the most striking feature of the sponge-fauna of Ceylon, next to its richness, is its close relationship with that of Australia and the adjacent islands. On the other hand, it differs considerably from the sponge-fauna of the Red Sea, as well as from that of the south and east coasts of Africa.

In the case of the Alcyoniidæ, on the other hand, Prof. Arthur Thomson notes that there is a great difference between the Ceylon collections and those made off the Maldives by Mr. Gardiner and off New Britain and New Guinea by Dr. Willey.

It is impossible to refer in detail to all the memoirs in these volumes, which contain descriptions of a great number of new or little-known species, and it would be premature to attempt to anticipate the general discussion on the fauna of Ceylon which Prof. Herdman promises for the concluding part of the report. All the memoirs are well illustrated with a number of lithographic plates, of which the very beautiful series accompanying Mr. E. T. Browne's account of the Medusæ may be specially mentioned as doing credit to artist and lithographer alike.

THE ABORIGINES OF UNEXPLORED NEW GUINEA.[1]

In this work Mr. A. E. Pratt gives an account of the time he, with his son, a youth of seventeen, spent in New Guinea collecting zoological specimens during the years 1901–3. A short visit was paid to the Dutch settlement of Merauke, newly established among the Tugeri tribes of Netherlands New Guinea to check the raids into British territory of these enterprising savages, but owing to the unsettled condition of the country no attempt to leave the settlement was made. Mr. Pratt then shifted his quarters to Port Moresby, in British territory, whence moving to Yule Island he organised his expeditions to the mountainous hinterland of the Mekeo district of the Central Division, where almost the whole of his time was spent and where his collections were principally made. A large number of new Lepidoptera, a new fish, and a couple of new reptiles rewarded Mr. Pratt's efforts; but although the object of the expedition was to collect zoological and botanical specimens, Mr. Pratt devotes little space in his book to natural history, its bulk being given to a gossipy description of the author's journeyings, with remarks, too often inaccurate, on the natives he came in contact with.

Mr. Pratt on p. 291 points out that he "cannot pretend to be a trained ethnologist . . .," while his "notes, too, were fragmentary . . . owing to the stress of . . . journeyings and the pressure of work. . . ."

In these circumstances it is easy to forgive the omission of any mention of many problems of the greatest interest, *e.g.* the provenance of the Mekeo stone adze and "pineapple" club, upon which some light might have been thrown in the country visited by Mr. Pratt in his furthest journeys; but, reasonable as are these claims to consideration and forbearance, and difficult and trying as the present writer knows the Mekeo hinterland to be, they do not palliate the publication of such a mass of misstatements and inaccuracies as occur in this book, and are absolutely no excuse for such apparent "faking" of photographs or drawings as produce the ridiculous results shown in the plates facing pp. 168, 262, and 268.

Again, with a perversity that is as determined as it is misplaced, in the map given at the beginning of the volume a number of such well-known Mekeo villages as Aipiana, Inawi, and Rarai are bodily transferred from the right to the left bank of the St. Joseph River, to which Nara village is shifted some twenty miles northwards of its actual site.

Certain of the more glaring inaccuracies in print and picture may now be specified.

The description on p. 71 of Motu pot-making is inaccurate, nor are "several hundred large dug-out canoes brought together and moored side by side at the landing stages in groups of six or seven" (p. 72) to form the lakatoi used on the annual Motu trading expedition to the Papuan Gulf. The present writer has seen many Motu dances, and in 1903 watched the departures of a number of lakatoi from Port Moresby, but certainly never saw a Motu girl "spin round with a dizzying rapidity," and finds it difficult to believe that Mr. Pratt did; while Mr. Pratt's statement is not borne out by the plate, obviously a photograph, he quotes in support of it.

The plate facing p. 168, with its attached legend, "A piebald tribe: The Motu-Motu people of Hoods Bay . . ." constitutes perhaps the most grotesquely erroneous statement in the book, and is not unworthy of an imaginative traveller of the fifteenth century. The plate shows two natives, irregularly spotted with patches of white, wearing a form of perineal bandage which is not worn at Hulaa or anywhere on the Hood Peninsula; and the accompanying letterpress is scarcely less frankly imaginative; "the piebald people are one of the mysteries of New Guinea," says Mr. Pratt, "and their origin is unexplained." The origin of a piebald tribe in Hood Bay is pretty obviously in the fertile imagination of the author, who calls the tribe he has brought into existence the Motu-Motu, this as a matter of fact being the Motu name for the Toaripi of the Papuan Gulf living about 150 miles west of Hood Bay.

Of course "albinos," though they never have pink eyes, occur sporadically all over New Guinea, and are particularly abundant at Hulaa, where there are at least four of these "albinotic" individuals. But apart from elderly folk, in whom leucoderma of the hands and feet, spreading to the forearm and leg, is by no means rare all over British New Guinea, the writer, who has twice visited Hulaa, knows of but one case of partial albinism, a child of about eight years of age belonging to the Sinaugolo, a tribe in no way closely related to the Hulaa folk.

The astounding and wildly unnatural plates which face pp. 262 and 268 cannot be passed without remark. A glance at the latter plate will convince anyone that it represents no tropical jungle, while the whole story of the fishing-nets spun by spiders on bamboo loops erected for this purpose in the jungle, which these two plates illustrate, seems to be a far-off reminiscence of the kite-fishing with a bait of spider's web which skips along the surface of the water practised in the D'Entrecasteaux and other archipelagoes off south-eastern British New Guinea. There are many other inaccuracies and misstatements in the

[1] "Two Years among New Guinea Cannibals." By A. E. Pratt, with Notes and Observations by his Son, H. Pratt. Pp. 360; illustrated. (London: Seeley and Co., Ltd, 1906.) Price 16s. net.

book which for lack of space must pass unnoticed, but the above are probably the most glaring examples.

After such defects as have been discussed it seems almost hypercritical to mention minor blemishes, but it may be pointed out that proper names are often misspelt, and this is the case even with the names of such well-known New Guinea worthies as the Rev. Dr. Lawes. The frequency with which such slips occur suggests that the author may again be travelling, or at any rate that he has not had the opportunity of revising his book. The get-up of the book is good, and where the plates are not imaginative they are often interesting, as is the case with those facing pp. 108, 120, 144, 176, 236, and 244.

C. G. SELIGMANN.

FIG. 1.—The native village of Dinawa. From "Two Years among New Guinea Cannibals."

THE ROYAL SOCIETY CONVERSAZIONE.

ON Wednesday of last week, May 9, there was a large assembly at the Royal Society on the occasion of the first of the two conversaziones held annually in the society's rooms at Burlington House. The guests were received by the president, Lord Rayleigh, and included, not only leading men of science, but also representatives of other branches of intellectual activity and national interests. There were numerous exhibits of objects and apparatus illustrating recent scientific work, and the following notes will give an indication of their character. Descriptions relating to exhibits belonging to the same departments of science have so far as possible been brought together. During the evening lantern demonstrations were given by Mr. G. W. Lamplugh, F.R.S., on the Batoka gorge of the Zambezi river, and by Prof. S. P. Thompson, F.R.S., on the electric production of nitrates from the atmosphere. For an account of the Batoka gorge reference should be made to a paper by Mr. Lamplugh in NATURE of November 30, 1905 (vol. lxxiii., p. 111); and the subject of Prof. Thompson's lecture will be found dealt with in NATURE of February 8, 1906 (vol. lxxiii., p. 355), and p. 65 of the present number. In several other cases descriptions of instruments and other objects exhibited have already appeared in the columns of NATURE, and references are given to them in the subjoined summary of the official catalogue.

Mr. T. E. Heath: Stereoscopic star charts and spectroscopic key maps.—*Rev. A. L. Cartie:* Photographs of the solar corona, 1905, August 30, taken at Vinaroz, Spain, with a 4-inch lens and 20-feet coronagraph.—*The Solar Physics Observatory, South Kensington:* (1) Photographs illustrating the eclipse camp at Palma, Majorca (August 30, 1905), and some of the results obtained. (2) Examples of stellar spectra taken with the 6-inch two-prism prismatic camera. (3) Some photographs taken with the spectroheliograph. These include a "disc" photograph taken on August 31, 1905, the day after the total solar eclipse of that year. (4) Curves to illustrate long-period barometric changes in operation in India, East Indies, Australia, and South America. They show the possible evolution of the nineteen-year variation in Australia from the eleven-year (about) variation in India, and the relation of the Australian to the South American changes. (5) Photographs and diagrams illustrating recent work done on the orientation of some British stone circles.—*The Royal Astronomical Society:* Six photographs of the Milky Way taken in 1905 by Prof. E. E. Barnard at Mount Wilson, California.—*The Astronomer Royal:* Photographic prints of the total solar eclipse of 1905, August 30, from negatives taken at Sfax, Tunisia.—*The Director, Meteorological Office:* (1) Antarctic meteorological records with charts and diagrams prepared in connection with the discussion of the results of the Antarctic expeditions. (2) Some recent meteorological results. (*a*) Meteorological charts of the Indian Ocean and Red Sea for the month of May, showing average winds, currents, and other meteorological information, including a reproduction of the chart for May of the tracks of hurricanes prepared by the late Mr. C. Meldrum, F.R.S. The chart is the first of a monthly series to be issued by the Meteorological Office for the use of seamen. (*b*) Diagram exhibiting the relation between Admiral Beaufort's numbers for wind force and the corresponding wind velocity and wind pressure.

Mr. R. Kerr: A torsion spring for transference of energy. (Exhibited on behalf of Prof. L. R. Wilberforce, of University College, Liverpool.)—*Mr. Joseph Goold:* Vibration experiments. Two distinct systems of vibration in the same steel plate are tuned closely to the same pitch. When either system is excited the other also becomes active: and their respective intensities go through a variety of fluctuations, producing remarkable disturbances of the compound node-lines.—*Prof. G. Forbes, F.R.S.:* Model of naval gun-sight, giving correct elevation for any variations of muzzle velocity, air density, and time of flight, as arranged for the 6-inch B.L. gun, Mark XI., under construction at Elswick for trial on H.M.S. *Africa*.—*Sir James Dewar, F.R.S.:* Metallic jacketed vacuum vessels. In these metallic vessels filled with liquid air the vacuum is produced by the use of cooled charcoal. The envelopes may be made of brass, copper, nickel, or tinned iron, with necks made of a bad conducting alloy. The necks can be covered with silvered glass vacuum cylinders which act as stoppers and at the same time utilise the cold of the slowly evaporating liquid. The efficiency of the best metallic flasks is equal to that of the average silvered glass vacuum vessels now generally used in low temperature investigations. Vessels of this type may be useful in industrial cryogenic operations and for the storage and safe transit of liquid air and oxygen.—*Mr. C. V. Boys, F.R.S.:* A gas calorimeter (see vol. lxxiii., p. 354, February 8, 1906).

Mr. G. F. Herbert Smith: A refractometer for liquids. By means of this instrument the refractive indices of liquid and semi-liquid substances may be easily and quickly determined in sodium light to the fourth place of decimals. —*Prof. W. F. Barrett, F.R.S.:* Entoptiscope, for the self-examination of obscurities and defects within the eye.—*Sir William Crookes, F.R.S.:* (1) The ultra-violet spectra of the metals, photographed with a quartz train of five double prisms. The spectrum of pure iron used as a standard. (2) Stereoscopic photographs, taken by Sir W. Crookes on the occasion of the visit of the British Association to South Africa in the autumn of 1905.—*Lord Blythswood:* Photographs of certain arc spectra. The spectra were produced by means of a Blythswood concave diffraction grating, the work being undertaken as a practical test of the gratings. The radius of the grating was 10 feet, the first-order spectrum being photographed. The total length given was about 40 inches, from λ 2100 to λ 7400. —*Dr. W. Marshall Watts:* Binocular spectroscope. The instrument consists of a field-glass, or other form of binocular, in front of the object-glasses of which two exactly similar transparent diffraction gratings are mounted on optically-worked plane glass. As the instrument has neither slit nor collimator it is applicable, in the first instance, only to luminous objects of definite form, such as vacuum tubes. For ordinary observations of flame spectra, or spark spectra, a metal or ebonite plate, with a slit, in front of the Bunsen or spark is employed.—*Mr. Edwin Edser and Mr. Edgar Senior:* Specimens of colour photographs, and photomicrographs. The exhibit included (1) Lippmann spectrum photograph bleached after Neuhauss's method; (2) colour photograph produced by exposing Lippmann film successively to two continuous spectrums, the red end of one being superposed on the blue end of the other; (3) three-colour photographs of coloured objects, including crystals under polarised light; (4) photomicrographs obtained through red, green, and blue colour screens; (5) photomicrographs obtained by the aid of Zeiss apochromatic objective, and other objectives.

Royal Microscopical Society: Micro-Daguerreotypes of blood, milk, and crystals, made by Léon Foucault in 1844. —*Messrs. R. and J. Beck, Ltd.:* Ultimate microscope resolving power with light of different wave-lengths. A specimen of *Amphipheura pellucida* was shown under 1/12 oil immersion 1·25 N.A. A single filament Nernst lamp on a small optical bench was the source of illumination. The beam was split up into a brilliant spectrum by means of a Thorp replica grating, and any portion of the spectrum can be used for illuminating the object. The experiment showed that whereas the diatom is brilliantly resolved with green light, the whole structure is invisible with yellow light.—*Mr. Julius Rheinberg:* (1) Production of achromatic interference bands by the double grating method; (2) photographs chiefly of diatoms, taken by Dr. A. Köhler with the Zeiss apparatus for ultra-violet light.—*Mr. W. Rosenhain:* Improved metallurgical microscope designed for the examination of metal specimens. The base and limb are of particularly rigid construction, and the tube is rigidly attached to the limb. The stage racks on the broad flange of the limb, and is provided with a fine adjustment placed in the line of the optic axis of the microscope. The internal reflectors employed for obtaining "vertical" illumination, instead of being carried on a detachable fitting, are inserted into the tube of the instrument, and are provided with adjusting movements which allow of complete control of the lighting. Special devices for the easy attachment and adjustment of oblique and other illuminators for low-power work are provided, while a detachable bridge can be fitted to the stage so as to adapt it for work with transmitted light. For purposes of photomicrography a focusing motion is provided whereby the eye-piece may be moved relatively to the objective.—*The Director of the National Physical Laboratory:* (1) Photomicrographs of the polished and etched surface of specimens of iron and steel taken during the progress of alternating stress tests, Dr. T. E. Stanton. (2) Photomicrographs, Dr. H. C. H. Carpenter. (3) An apparatus for tests on the strength of materials at very high temperatures, Dr. J. A. Harker. (4) *a*, Picou permeameter (by kind permission of Mr. J. H. Agar Baugh), *b*, Bifilar galvanometer free from zero creep, Mr. A. Campbell.

Dr. P. E. Shaw: An electrical measuring machine (see May 3, p. 22, and vol. lxxii., p. 495).—*Sir Oliver Lodge, F.R.S., and Dr. Alexander Muirhead, F.R.S.:* Wireless telegraphy apparatus for military field purposes. (1) A portable pack-transport set of wireless telegraphy apparatus for military field purposes, available for communications across country for distances up to fifty miles, or 150 miles over sea; with electric valves employed to accumulate the impulses of a small coil and battery, or small dynamo, so as to give discharges of energy only otherwise obtainable from a large and heavy source of electric supply. The arrangement needs no earth connection, nor must it have any when it is required to work over long distances with the greatest efficiency. (2) A vibrating needle point-oil-mercury coherer with telephone receiver.—*Mr. W. Duddell:* Some mechanical and electrical phenomena occurring in the telephonic transmission of speech. The apparatus is intended to demonstrate as curves on a screen the simultaneous movement of the microphone transmitter diaphragm, the current flowing into the telephone line, the current received at the far end of the line, and the movement of the receiver diaphragm when sounds or speech are being transmitted. The similarity of and the difference between these four curves can be examined by the aid of the apparatus, and the distortion and attenuation produced by the resistance, capacity, and self-induction of the line can be demonstrated, as well as the distortions produced by the diaphragms of transmitter and receiver. The characteristic shapes of the curves corresponding to the different vowel sounds and their dependence on the pitch on which they are sung can also be exhibited.—*Mr. L. H. Walter:* New magnetic detector, giving both alternating currents for telephonic reception and continuous currents for recording or visual signals. The detector is a form of differential dynamo in which electric oscillations are made to act upon one armature core only.—*Mr. K. J. Tarrant:* Photographs of electrical discharges, at atmospheric pressure and *in vacuo*.—*Mr. E. G. Rivers:* A new electric heater. The principle of construction departs from that usually adopted. The object in view is to secure a large heating surface at a moderate temperature, and the method exemplified is the use of silicated carbon upon a terra-cotta base, forming an "element." These "elements" assembled together constitute the heater.

Mr. J. E. Stead, F.R.S.: A triple alloy of tin-antimony-arsenic, polished and etched, showing bright curved crystals embedded in a soft matrix or eutectic.—*Dr. G. T. Moody:* Specimens illustrating the indifference of oxygen towards iron in presence of water and the effect of the admission of carbonic acid.—*Messrs. Wallach Bros.:* Oxygen rescue apparatus and other appliances. (1) The "Evertrusty" oxygen apparatus, used by the rescue parties at Courrières, consisting of two oxygen cylinders filled with oxygen, two regenerators through which the vitiated air passes and is regenerated, and which at the same time serve the purpose of ascertaining if the apparatus is in working order prior to use. (2) "Evertrusty" oxygen first-aid case for use in case of carbonic oxide poisoning, or after inhalation of smoke, poisonous fumes, &c., consisting of oxygen cylinder, reducing valve, pressure gauge, bag and mask, with back-pressure valve.—*Dr. O. Silberrad and Mr. H. A. Phillips:* A series of picrates. The salts of picric acid are of interest as having been the probable cause of some of the most disastrous lyddite explosions on record. The specimens exhibited were in many cases prepared in the course of an exhaustive investigation recently carried out at the research laboratories of the Royal Arsenal. Several of the salts exhibited have never before been prepared, and the majority have never previously been obtained pure or correctly analysed.

Director of the Geological Survey of Great Britain: Geological maps, recently issued by the Geological Survey and Museum.—*Prof. John Milne, F.R.S.:* Seismograms of recent earthquakes. (1) North-south and east-west components of the Formosa earthquake of March 16, 1906. (2) Two components of the Colombian earthquake of January 31, 1906. (3) An enlargement of the terminal vibrations of the upper part of Fig. 2. It shows the extinction of an earthquake in wave groups. Each group has a duration of about 2·5 minutes to 3 minutes, and contains about seven waves. One set of groups may approximately resemble another set of groups. (4 and 5) Open diagrams of the same earthquake. The pendulum which recorded the upper part of Fig. 4 weighs 8olb., and has a period of twenty-five seconds. That which recorded Fig. 5 weighs a few ounces, and has a period of fifteen seconds. Both have recorded the period for the large waves as seventeen seconds. (6 and 7) Open diagrams of the San Francisco earthquake of April 18, 1906. *Royal Observatory, Edinburgh:* Seismograph records. (1) Indian earthquake, April 4, 1905; (2) earthquake in Siberia, July 23, 1905; (3) earthquake in Calabria, September 8, 1905; (4) earthquake in Greece, November 8, 1905; (5) San Francisco earthquake, April 18, 1906.—*Mr. J. Stanley Gardiner:* Dredged rocks off Providence Coral Reef, 844 fathoms (H.M.S. *Sealark*). These rocks were obtained off the outer slope of a coral reef, half-way between the Amirante Bank and Madagascar. They consist of (1) volcanic ash in various stages of consolidation; (2) manganese nodules round nuclei of ash; and (3) coral rock coated with manganese.—*Prof. Wyndham Dunstan, F.R.S.:* (1) New or rare minerals from Ceylon. Many of the minerals exhibited have been collected during the progress of the mineral survey now proceeding in Ceylon in connection with the Imperial Institute. Others have been found in river gravels sent for examination to the Imperial Institute. These minerals illustrate the wide distribution of thorium in Ceylon. (2) Minerals from Canada.—*Dr. A. S. Woodward, F.R.S.:* Hind limb of the gigantic extinct marsupial *Diprotodon australis* from Lake Callabonna, South Australia. *Mr. F. J. Lewis:* Late Glacial and post-Glacial plant remains from the Scottish peat deposits and from Cross Fell. The remains were met with during an investigation of the peat deposits in Scotland and on Cross Fell, Cumberland. All the deposits so far examined show definite stratification—each layer has its own set of plants, and very different conditions are frequently shown by strata at different horizons in the same peat deposit.

The Director, Royal Botanic Gardens, Kew: (1) Precocious flowering of plants (exhibited by Mr. W. B. Hemsley, F.R.S.). (*a*) Seedling mahogany tree in flower when about 6 inches high. Leaves simple instead of pinnate; flowers very similar to those of the adult tree. (*b*) Seedling *Ailanthus glandulosa* in flower when about 3 inches high. Leaves trifoliolate instead of multifoliolate; flowers male. (*c*) Lilac flowering from the young suckers, with or without leaves; flowers normal in structure, fragrant. (*d*) Coco-nut flowering on its appearance from the shell of the seed. (2) Exalbuminous grass-seeds (exhibited by Dr. Otto Stapf). The structure of the seed is very uniform throughout the Gramineæ, the presence of a very copious farinaceous endosperm or "albumin" being characteristic of it. A remarkable exception (*Melocanna bambusoides*, which is exalbumiпous and at the same time viviparous) was recently described by Dr. Stapf, who has since discovered three more examples of exalbuminous grass-seeds, all in Bambuseæ.—*Prof. Wyndham Dunstan, F.R.S.:* Cyanogenetic plants. The specimens illustrated an investigation conducted by Prof. Dunstan and Dr. T. A. Henry to throw light on the origin of the prussic acid which is produced by certain plants. All the plants shown contain the same cyanogenetic glucoside (dextrose ether of acetone cyanhydrin), which has been named "phaseolunatin." Accompanying it in each plant is an enzyme capable of effecting its decomposition.—*Mr. J. Stanley Gardiner and Mr. H. P. Thomasset:* Photographs illustrative of the vegetation of the Seychelles Islands.

The Marine Biological Association: The habits of some fishes from the inshore waters. A small collection of living fishes from the shore and from shallow water was shown to illustrate the differences in habit and mode of life adopted by different species.—*Mr. Cecil Warburton:* Berlese's apparatus for capturing minute insects and arachnids.—*Prof. W. C. McIntosh, F.R.S.:* Thirteen coloured plates (original) for part iii. of the "British Annelids," to be published by the Ray Society, 1907. These are drawings, from life, of specimens procured from Shetland to the Channel Islands.—*Mr. J. E. S. Moore and Mr. C. E. Walker:* Recent researches in cell-division. (1) Leucocytes lying in cytoplasm of tissue cells in early stage of cancer. (2) First maiotic (heterotype) division in cancer of breast. Division figures in this form of cancer have been supposed to be rare. (1 and 2, joint research with Prof. Farmer, F.R.S.) (3) Specimen showing characteristic permanent forms in chromosomes of first maiotic (heterotype) division. (4) Specimen showing pluripolar mitoses and amitoses in myeloplaxes (bone marrow). (5) Specimen showing division figures in germinal area of lymphatic gland. (6) Specimen showing cells destined to become foot-cells in testis of embryo guinea-pig.—*Dr. Albert A. Gray:* Series of stereoscopic photographs of the membranous labyrinth illustrating the comparative anatomy of the organ. The examples shown were illustrative of Amphibia, reptiles, birds, and Mammalia.—*Dr. G. C. Chubb:* Yolk-nucleus in the oocyte of Antedon. The yolk nucleus of Antedon was shown to be merely a region of the egg-cytoplasm on to which has diffused a part of the material discharged from the nucleolus throughout the growth of the oocyte.

NOTES.

MME. CURIE has been nominated by the council of the University of Paris to succeed her husband, the late Prof. Curie, in the chair of general physics held by him at the time of his death. The nomination has been accepted by the Minister of Public Instruction.

DR. A. C. HADDON, F.R.S., university lecturer in ethnology, Cambridge, has accepted an invitation to give a course of Lowell lectures in Boston, Mass., during November next. He will discourse on racial problems, distribution of culture, and social and religious evolution in Melanesia.

THE Croonian lecture of the Royal Society will be delivered on Thursday, May 24, by Prof. J. N. Langley, F.R.S., "On the Presence of Special Excitable Substances in Striated Muscle and in Tissue Cells."

THE Cleve memorial lecture will be delivered at the Chemical Society by Prof. T. E. Thorpe, C.B., F.R.S., on Thursday, June 21.

PROF. J. B. FARMER, F.R.S., who is giving special attention to parasitic growths, would be glad to receive specimens of such growths. The specimens should be forwarded to Claremont House, Wimbledon Common, Surrey.

MR. R. MCG. DAWKINS, fellow of Emmanuel College, Cambridge, has been elected director of the British School in Athens, in succession to Mr. R. C. Bosanquet, lately appointed to the chair of archæology in the University of Liverpool.

ON Thursday next, May 24, Prof. W. J. Sollas will begin a course of three lectures at the Royal Institution on "Man and the Glacial Period." The Friday evening discourse on May 25 will be delivered by Mr. Leonard Hill, on "Compressed Air and its Physiological Effects."

A COMMITTEE has been appointed to make arrangements to commemorate the distinguished services rendered to archæology by Dr. Arthur Evans, F.R.S. It is proposed to place a portrait of Dr. Evans in the Ashmolean Museum, Oxford, of which he has long been keeper. The world-famed discoveries at Knossos have made Dr. Evans well known to students of archæology everywhere, and it may be expected that the plan suggested will meet with wide approval. Subscriptions may be paid to the hon. treasurer, Mr. G. A. Macmillan, St. Martin's Street, W.C., to the account of the "Arthur Evans Portrait Fund," London and County Bank, Henrietta Street, Covent Garden, W.C., or to Messrs. Barclay and Co., Old Bank, Oxford. The hon. secretaries of the movement are Messrs. D. G. Hogarth and C. F. Bell, Magdalen College, Oxford.

THE German chief burgomasters, burgomasters, and councillors who are paying a visit to England as the guests of the British committee for the study of foreign municipal institutions were entertained on Monday at a banquet over which Lord Avebury presided. Mr. Haldane proposed the toast of "The German Emperor and the German Empress and the other Members of the German Royal Family."; and in the course of his remarks he said that the present Kaiser united in himself the thinker and the man of action, and has organised his empire on an educational basis, paying great attention to technical and scientific instruction and investigation. Such institutions as that at Charlottenburg are instances of what is being accomplished in Germany to-day. The toast was acknowledged by the Ober-Bürgermeister of Berlin, who said that Mr. Haldane possessed a deep knowledge, not only of German history, but also of the German heart.

THE eleventh annual congress of the South-Eastern Union of Scientific Societies will be held at Eastbourne on June 6–9. The president-elect, Dr. Francis Darwin, F.R.S., will give his presidential address on June 6 at the Town Hall. The following papers will be presented:—Nature near Eastbourne, J. H. A. Jenner; the birds of Sussex compared with the list for Great Britain, W. Ruskin Butterfield; the educational value of museums, Dr. Jonathan Hutchinson, F.R.S.; sea erosion and coast defence, E. A. Martin; the geology of the Upper Ravensbourne valley with notes on the flora, W. H. Griffin; the flora of the Eastbourne district, Dr. Whitney; bird architecture, E. J. Bedford; nature-study, W. Mark Webb. The hon. general secretary is the Rev. R. Ashington Bullen, from whom all information can be obtained. The museum secretary, Mr. E. W. Swanton, Educational Museum, Haslemere, will have charge of the congress museum at the town hall. The photographic surveys of Surrey, Kent, and Sussex will be represented by a large series of photographs of scientific and antiquarian interest.

BARON TAKAKI, the Director-General of the Medical Department of the Japanese Navy, delivered last week a series of three lectures on the preservation of health amongst the personnel of the Japanese Navy and Army at St. Thomas's Hospital, at which medical school he was formerly a student. The subject of kak'ke or beri-beri was dealt with exhaustively. This disease was formerly very prevalent in the Japanese Navy, and, as the result of observations, Baron Takaki had come to the conclusion that its prevalence was largely due to a disproportion between the non-nitrogenous and nitrogenous elements of the food. By adding a larger proportion of nitrogenous elements to the food the disease has now almost disappeared from the Navy. Other diseases, such as typhoid, dysentery, and cholera have also almost disappeared in consequence of careful hygienic measures.

SINCE the discovery of a spirillar organism, the *Spirochaeta pallida*, in syphilitic lesions, a great deal of work has been done on the transmission and prophylaxis of this malady. Whether or no this microbe be the ætiological agent of the disease, and it cannot yet be said to have been proved definitely, its discovery has undoubtedly stimulated research, and it is now certain from a number of experiments, both in this country and abroad, that syphilis can be inoculated on the higher apes. Recently Prof. Metchnikoff, of the Pasteur Institute, demonstrated that the application of an ointment composed of calomel ten parts and lanolin twenty parts to the point of inoculation will prevent the development of the disease. This was proved by inoculating apes and also a healthy medical student (who offered himself as a subject for experiment) with syphilitic virus, and an hour later rubbing the inoculated spot with this ointment in the case of the student and of one ape. Neither man nor monkey suffered any evil effect, whereas the other inoculated monkeys which were untreated contracted syphilis. In the case of monkeys the ointment must be applied within twenty hours after inoculation, otherwise infection follows, but if this time limit be observed immunity is complete. It is noteworthy that Prof. Metchnikoff will shortly be visiting this country in order to deliver the Harben lectures at the Royal Institute of Public Health, 37 Russell Square, W.C. The lectures, which are delivered at 5 p.m., are as follows:—May 25, the hygiene of the inner tissues of organisms; May 28, the hygiene of the intestinal tract; May 30, syphilis.

THE proceedings on Commemoration Day at Livingstone College, Leyton, E., on Thursday, May 31, will include an address by Mr. James Cantlie, editor of the *Journal of Tropical Medicine*, whose opinion as to the necessity for the training given at the college is of special value, owing to his experience of the conditions of living in tropical countries. Cards of invitation may be obtained by writing to the principal of the college.

ON the morning of May 2, in the dynamite factory of the Nitroglycerine Company, Ltd., of Vinterviken, near Stockholm, there occurred three explosions in quick succession, which were heard all over the town, and resulted in the total wreck of the factory and the death of many of the workers; the cause of the explosion is at present unknown.

THE prize of 3000 francs offered by the International Medical Congress at the Paris meeting has been awarded by the Lisbon meeting to Prof. P. Ehrlich, of Frankfort-on-Main, for his researches on leucocytosis. British physiologists will approve of this recognition of the work of the great experimentalist and worker on the borderland of physiology and chemistry.

THE opinion has been frequently expressed that Scandinavia, with its huge waterfalls, will before very long be one of the most suitable places for large chemical works; indeed, it is claimed that with the future developments of electrochemical technology the greater part of the world's supply of soda, chlorates, nitrates, calcium chloride, and iron will be produced in the northern peninsula. Hence it is easy to understand the action of the Swedish and Norwegian Governments in protecting the falls against foreign capitalists. Sweden has passed a law that the use of the falls is reserved to the State, while a Bill is before the Norwegian Storthing in which it is prescribed that at least one-half of the capital laid out on the falls shall be Norwegian money, and the direction of the works be in the hands of Norwegians who are living in the land.

IN the *Chemiker Zeitung* for May 9 is an appreciative note from the pen of Prof. van 't Hoff on his conscientious co-worker and former student, the late Prof. Wilhelm Meyerhoffer, who, at the early age of forty-one, died of heart disease on April 21 in Meran, where he had gone for the benefit of his health. Meyerhoffer, although born in Russia, was on his father's side of Austrian descent, and was educated in German schools until his seventeenth year; after passing three years in the gymnasium of Czernowitz, he studied first under Bunsen at Heidelberg and then under Fittig at Strassburg, going from thence to Leipzig, Amsterdam, Paris, Vienna, and Berlin. A few years ago he declined an invitation to go to Prague, and only a few months ago received a call as *ordinarius* to the University of Aachen. In recognition of Meyerhoffer's experimental developments of Guldberg and Waage's principle, he was elected a corresponding member of the Scientific Society of Christiania, and at a more recent date to a similar honour by the society in Rotterdam.

DR. W. N. SHAW'S third lecture was delivered at the University of London on May 15, the subject under consideration being the normal general circulation of the atmosphere at the surface and in the upper air, and, in connection therewith, the relation of temperature and rainfall to the general circulatinn and local disturbances. We can only refer here to one or two of the many interesting points brought forward, *e.g.* the diagrams of the distribution of barometric pressure at the surface of the earth and at a height of 4000 metres showed that the gradients were quite opposite in character, but it was explained that when these two pressure distributions were combined they produced the general circulation observed at the surface. Another interesting feature of the lecture was a lantern slide showing the easterly drift of the surface wind-current at the winter quarters of the *Discovery* in the recent Antarctic expedition, and the westerly drift of the upper air shown by the smoke at the summit of Mount Erebus, also the confirmation of the latter motion by the observation of the upper clouds.

GRASSHOPPERS and crickets (Locustidæ and Gryllidæ) from Paraguay, by Mr. A. N. Caudell, form the subject of No. 1450 of the Proceedings of the U.S. National Museum.

THE life-history of the warble-flies, *Hypoderma bovis* and *H. lineata*, the larvæ of which do so much mischief to cattle in this country, is discussed by Mr. A. D. Imms in part ii. of the first volume of the *Journal of Economic Biology*. Although "warbles"—the tumours in the skin of cattle produced by the grubs of these insects—have been familiar to stock-owners and butchers from time immemorial, it appears that we are still completely in the dark as to the mode in which the larvæ effect an entrance into their hosts, as it is still undecided whether they do so by penetrating the skin or by way of the mouth.

THE *Naturalist* for May contains an excellent portrait and biography of Mr. H. C. Sorby, in the course of which reference is made to the fact that the mechanical theory of slaty cleavage is due to him, and that he was the first to make microscopic rock-sections. The articles include one on chalk belemnites, by Mr. C. D. Sherborn, and one on the senses of bats, by Mr. A. Whitaker, both illustrated. In the latter it is stated that bats "are now ranked as the first suborder of the second great order Carnaria, instead of the last suborder of the first order Primates," which leads us to wonder what text-book the author is in the habit of using.

OF the five articles in the March issue (vol. iv., part iv.) of *Biometrika*, three are devoted to the subject of heredity. In one of these Mr. E. Schuster, dealing with hereditary deafness in man, points out, in the first place, that deaf-mutes generally marry with persons similarly afflicted, with the results that might be expected; and, in the second place, brings out the normal, or even more than normal, fertility of such unions. A paper on Shirley poppies, by several workers, affords additional evidence of heredity in plants. On the other hand, Messrs. Barrington and Pearson, in discussing the heredity of colour in cattle, as exemplified in shorthorns and certain shorthorn crosses, do not find that this comes under the Mendelian law, at least in the shape of any simple formula.

PARASITIC invertebrates, or nearly related free-living forms, constitute the subject of the three articles in the April issue (vol. l., part i.) of the *Quarterly Journal of Microscopical Science*. The life-history of one of the Gregarinida, *Cystobia irregularis*, a species infesting the holothurian locally known in this country as the "cotton-spinner," has recently been investigated by Dr. H. M. Woodcock, who in the communication before us states that he has brought to light several interesting points in the life-cycle of the group in general. The hope of adding to our knowledge of the nature of the "cœlom" and the "nephridea" appears to have been the inducing cause which led Mr. F. H. Stewart, I.M.S., to take up the study of the free nematode worm *Oncholaimus* (or *Oncholaemus*) *vulgaris*. The author's conclusions are summarised at the end of his paper. In the third article Dr. Woodcock publishes the first part of a comprehensive review of the present state of our knowledge of the blood-parasites known as the hæmoflagellates, or trypanosomes. The author lays stress on the extreme rapidity with which investigations into the life-history of these minute organisms have been carried out, the realisation of the extreme importance of such knowledge in respect to the prevention of disease being mainly responsible for this advance.

CAPTAIN LAMB and Assistant-Surgeon Kesava Pai discuss the occurrence of Mediterranean fever in India (Sc. Mem. Gov. of India, No. 22). In seventeen cases carefully investigated, complete agglutination reactions (carefully controlled against normal individuals) were obtained, and, in addition, from eleven of these cases a coccus corresponding in all its characters with the *M. melitensis* was obtained by splenic puncture during life.

A CATALOGUE of microscopical slides, microscopes and accessories received from Messrs. Flatters and Garnett, Manchester, indicates that they are prepared to provide all requisites for microscopical work. The list of botanical and zoological slides is one of the most comprehensive and practical we have seen; a variety of articles for nature-study workers are also supplied.

WITH the view of helping visitors to appreciate the Royal Botanic Gardens, Glasnevin, a short guide, with plan of the gardens, describing the more important attractions, has been published by the director of the Science and Art Institutions, Dublin. In addition to the features of interest that the Glasnevin gardens show in common with similar institutions, the specimens of *Nepenthes distillatoria* raised from seed at Glasnevin, the original golden yew, and the fine collection of palms are especially worthy of notice.

DR. D. H. SCOTT paid a graceful tribute to a fellow-worker in fossil botany in presenting a sketch of the life and work of the late Dr. B. Renault as his presidential address to the Royal Microscopical Society. Renault's work ranged over the field of fossil vascular cryptogams and gymnosperms, within which the real triumphs of fossil botany have been won. To Renault we owe the reconstruction of that unique family the Botryopterideæ, at present regarded as the most authentic group of Palæozoic ferns, also the extraordinarily perfect knowledge that we possess of the gymnospermous Cordaiteæ. Dr. Scott's address, together with a list of Renault's more important contributions, is published in the April number of the Journal of the society.

Dr. R. Perotti, writing in the *Atti dei Lincei*, xv., 5, describes observations on the distribution of nitrifying bacteria in Italy. Samples of soil were taken from various districts, and cultures made by Beyerinck's method, and in every case nitrifying bacteria were found in greater or less abundance, the best results being obtained from Rieti, Messina, and Cerignola.

Prof. Giacinto Martorelli has had the rare fortune to obtain a specimen, believed to be the first, of Ross's polar gull (*Rhodostethia rosea*, Macgill.) from the Mediterranean, killed in the neighbourhood of Sardinia. The specimen in question reached him on January 10 of this year in the flesh, though decomposition was setting in. It appears to be a young bird, being 30 centimetres in length, and possibly this may account for its being found so far from its northern haunts. The discovery is announced in the *Rendiconto del R. Istituto Lombardo*, xxxix., 4, and the specimen has been stuffed and given to the Turati collection.

Dr. F. Eredia, of the Central Meteorological Office at Rome, has published in the official reports an account of a fall of dust on February 6. The occurrence was considered to be of sufficient importance to issue circulars to various observatories requesting particulars of the fall; the reports show that the dust was observed in Sicily, Lower Calabria, and other places, accompanied by thunderstorms, rain or hail, and strong south-easterly and south-westerly winds. The cyclonic conditions existing at the time would favour the conveyance of dust from Africa over the Mediterranean in the upper regions of the atmosphere, and although no analysis appears to have been made, the distribution of barometric pressure and other conditions seem to confirm the African origin of the phenomenon.

The director of the Mauritius Observatory contributed to the eighth International Geographic Congress a useful paper on the climate of Pamplemousses. The results of the observations at Port Louis for 1860–6 were communicated to the British Association in 1867 by the late Dr. Meldrum; those commenced at Pamplemousses in 1874 form the basis of the present paper. The following are the mean annual and absolute extreme values of some of the meteorological elements:—air temperature 73°·4, 94°·7 in December, 50°·8 in June; humidity 75·1 per cent., 98·5 per cent. in January, 34·0 per cent. in November; resultant wind velocity 9·2 miles per hour; the maximum velocity recorded in an hour was 103·3 miles (old factor 3) on April 29, 1892. Cyclones are said to be of immense benefit to the island, as one of the principal sources of rainfall. Taking an area of 20° square, of which Mauritius occupies nearly the centre, 237 cyclones were recorded in the years 1854–1903. The greater number occurred between December and March, and not one was recorded between June and September; their occurrence appears to be most frequent five years after, and least frequent one year before, the epoch of minimum solar activity.

The principal article in *Concrete and Constructional Engineering* (vol. i., No. 2) is by Captain Sewell, of the United States Army. It deals with the introduction of reinforced concrete in the United States, and is a commentary on the various systems and methods of applying this material adopted in that country. The article is illustrated by views and details of important buildings.

At the last meeting of the Institution of Mechanical Engineers an interesting paper was read by Mr. Louis Greaven on petroleum fuel in locomotives on the Tehuantepec National Railroad of America. It gives the actual results of a year's experience, and the information should prove of service to others who contemplate adopting oil fuel in railway working.

In a paper read before the Birmingham section of the Institution of Electrical Engineers on April 25, Dr. D. K. Morris and Mr. G. A. Lister proposed a standard test for transformers and transformer iron. The method involves but one set of connections, three instruments, and the normal supply, and necessitates the use of two similar transformers. It is a modification of that first described in 1892 by Ayrton and Sumpner, and is an application of the Kapp-Hopkinson or differential method of testing direct-current machines. The behaviour of a transformer when loaded at various power factors is, they find, best considered by means of a regulation diagram which they have constructed. The short-circuit test can equally well be carried out with the transformer core excited. The three-point wattmeter method is probably the most accurate means of measuring power factor and current when carrying out single-phase tests on transformers or motors from a three-phase supply. By bringing the supply to the middle point in the testing transformer when carrying out the differential test, symmetrical conditions are obtained, thus permitting of a normal determination of the various losses. By varying the voltage only and taking wattmeter readings the core loss of a transformer may be separated into hysteresis and eddy-current loss by the method of the total index. Wattmeter readings in combination with the three-point method serve as the best means of measuring the temperature rise in heating tests. The method of constant induced voltage affords a ready means of finding the true hysteresis loss, and is probably the best way of testing iron samples.

OUR ASTRONOMICAL COLUMN.

Comets 1906*b* and 1906*c*.—A set of new elements for the orbit of comet 1906*b* is published by Herr M. Ebell in No. 4087 of the *Astronomische Nachrichten*. An ephemeris for alternate days is also given, extending from May 4 to July 7, and shows that this comet is still in the southern part of the constellation Leo, about half-way between τ and υ Leonis. It is moving very slowly in a south-eastern direction, its present brightness being about 0·5 of that at the time of its discovery.

A set of new elements for comet 1906*c*, computed by Miss Lamson, of the U.S. Naval Observatory, appears in No. 4086 of the same journal.

The Astronomical and Astrophysical Society of America.—At the seventh annual meeting of this society, held in December last at New York, some forty papers on astronomical subjects were submitted.

Short abstracts of thirty-three interesting papers are given by Prof. H. Jacoby in No. 586 of *Science*, and amongst those which have not been noted previously in these columns may be mentioned the following:—A note on Prof. Burnham's forthcoming catalogue of double stars; a brief description of the vacant regions of the sky, by Prof. Barnard; an announcement concerning the publication of the observations of sun-spots made by the late Dr. C. H. Peters, extending over the period 1860–1870, and including the determination of more than 13,000 heliographic positions of spots on more than 1100 days; a paper by Prof. W. H. Pickering on planetary inversion, which the author illustrated by experiments with a gyroscope; and an account of the foundation, and the partial destruction by fire, of the Philadelphia Observatory, by Prof. M. Snyder.

SOLAR PROMINENCES DURING 1905.—The usual annual summary of the prominence observations carried out at the Catania Observatory during the past year is published by Prof. Mascari in No. 4, vol. xxxv., of the *Memorie della Società degli Spettroscopisti Italiani.*

The results show that the mean daily frequency of prominences observed was greater in 1905 than in 1904 and 1903, but the increase was not so great as might have been expected. As in previous years, it is seen that the increase in mean daily frequency corresponds with a decrease in heliographic latitude. In 1904 the mean daily frequency was 2·90 and the mean latitude 36°·6, whilst for 1905 the corresponding figures were 3·05 and 30°·8. The mean altitude of the prominences during 1904 was 43″·7, and in 1905 it was 44″·1; the corresponding extensions of the prominences along the solar limb were 7°·27 and 8°·77.

The greater frequency of prominences in the sun's northern hemisphere still persists, the values for 1905 being 1·77 for the northern and 1·28 for the southern hemisphere.

THE PERIOD OF β LYRÆ.—Referring to the recent note by Mr. Roberts on the increasing period of β Lyræ, Prof. Schaeberle suggests another possible cause which may account for that phenomenon.

It is now generally accepted that incandescent bodies have the power of repelling fine particles of their component matter to great distances, and Prof. Schaeberle suggests that, at a certain stage in the life-history of such a body, the decrease in mass may be so rapid as to cause an increase in the periodic time of any other body belonging to the system. If part of the ejected mass afterwards returns to the parent body other changes will obviously occur (*Observatory*, No. 370).

THE SIXTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY.

WHEN the International Congress of Applied Chemistry, assembled at Berlin in 1903, chose Rome as its next meeting-place, the fear was expressed by some that the Italian chemical industry might not perhaps be of sufficient magnitude to ensure a large attendance at the next congress. The brilliant success of the meeting which has just terminated has shown, however, that these fears were entirely without justification, and the number of important communications from the Italian members of the congress proves the reality of the progress which Italy has made of late years in chemical industry.

The meeting was opened on April 26 under the most favourable auspices by the King and Queen in person, accompanied by the Minister of Public Instruction and other high officials. The place of meeting was the magnificent Palace of Justice, then brought into use for the first time; in fact, it is not yet wholly completed as regards the internal decorations. There being a large number of rooms in the building, space was easily found for the sixteen sections into which the congress was compelled to subdivide itself. The number of British members was more than thirty, and on the whole the attendance from other countries was very satisfactory, even China being represented. It is somewhat of a novelty to hear speeches in Chinese at European scientific meetings, and shows that the awakening of the Celestial Empire is becoming an accomplished fact. Such a congress is an interesting study in ethnology as well as philology. Officially only four languages are supposed to be used, namely, English, French, German, and Italian; but the greatest leniency is shown in this respect, and the reporters must sometimes rely on summaries made by the speakers themselves.

Among the papers read before the full meeting of the congress the most important was undoubtedly Dr. Adolph Frank's description of his process for the direct utilisation of the nitrogen of the atmosphere for the production of artificial manure and other chemical products. Dr. Frank's invention is not only ingenious, but its effects on the future of the human race will probably be of the greatest importance. The inventor is a veteran in agricultural chemistry; he it was who, more than fifty years ago, introduced the potash salts of Stassfurt to the notice of agriculturists. Now nearly three million tons of these salts are used annually by agriculturists all over the world. The problem of the fixation of atmospheric nitrogen has often been attacked, for the first time on a large scale during the French Revolution. At that time France, surrounded by her enemies, was cut off from the supply of saltpetre necessary for national defence. A committee of French chemists then established the saltpetre farms where the nitrifying organisms, with which we have since become more intimately acquainted, produced the necessary means of defence. We in Great Britain, however, are still entirely dependent upon foreign sources for the explosives necessary for our national defence, and it is only by the establishment of some such process as Dr. Frank's in Great Britain that we shall place ourselves in safety in this respect. The invention is not a complicated one, the difficulties consisting chiefly in the solution of new problems of chemical engineering. Calcium carbide is first produced and then heated with nitrogen obtained by the fractional distillation of liquid air. During this distillation oxygen is obtained as a by-product, and may be utilised for the production of nitric acid from ammonia, which, again, is one of the substances produced by Dr. Frank. The first raw material obtained is calcium cyanamide, and it is this that is used as a nitrogenous manure, numerous experiments having shown that the nitrogen which it contains can be easily assimilated by plants. For countries such as Italy, and more especially India, with large agricultural populations who do not possess sufficient cattle to supply the requisite nitrogenous manure, this direct utilisation of the inexhaustible nitrogen of the atmosphere cannot fail to be of enormous importance; but to the chemist the calcium cyanamide has other attractions. From it have been produced, not only ammonia and nitric acid, but also urea and guanidine. We are therefore on the high road towards the artificial production of the alkaloids, and the next step will probably be the building up of substances directly assimilable by human beings, in other words, artificial foods.

But while chemists revelled in these anticipations they did not forget more practical subjects. An excellent paper by Sir William Ramsay gave a clear and exhaustive account of the present state of the sewage question in Great Britain. Special attention was given by the author to the bacterial methods of sewage disposal which are now being so widely adopted. M. Moissan, whose work with the electric furnace is so well known, gave the results of his experiments on the distillation of metals. All metals, indeed all substances, are volatile at a temperature below 3500° C., therefore M. Moissan draws the conclusion that the temperature of the sun cannot exceed this; it must, indeed, be somewhat less, as the bulk of the elements of which it consists are volatile at a lower temperature than the maximum mentioned. No doubt the data with which Prof. Moissan has furnished chemists will be utilised for practical purposes, especially in the purification of metals.

Many of the papers read before the various sections contained matter of great scientific interest. The report of the International Committee on the Unification of Analytical Methods was presented by Dr. Lunge, and will be of great assistance to analysts in different countries who wish to secure uniform results. Prof. W. N. Hartley's paper on the use of the spectrograph in analysis aroused much interest in the photographic section. It is certainly a great advantage to be able to make a quantitative analysis of a rare object in metal without defacing it in any way, and the convenience of the method will no doubt ensure it general acceptance when it becomes better known. Another communication made to the inorganic chemistry section was of interest, inasmuch as it holds out hopes of a considerable reduction in the price of photographic and other glass of high quality. Hitherto such glass has been made in the expensive pot furnaces, but the author of the paper, Herr F. Heller, states that he has succeeded in making such glass in the cheaper tank furnaces. In order to do this he divides the melting operation into three phases, each of which is carried out in a separate tank furnace at a definite temperature. The raw materials are first melted down at about 1400° C., the fused mass is then run into a second furnace at about 1200° C., in which the glass is clarified, and finally the clear glass is run into a working tank furnace of about 1000° C. The hope was expressed that the principle might be applied to optical glass of high quality. To the same section Sir William Ramsay contributed a paper on the Bischof process for manufacturing white lead, one of the chief advantages of which is that the workpeople are not exposed to the deleterious action of the dust which renders such stringent precautions necessary in other works. Messrs. G. Giorgis and G. Gallo contributed an essay on the hydraulic properties of various kinds of puzzuolanas, between some of which there are great differences both in time of setting and in the ultimate strength attained. The subject is of great importance in Italy, where puzzuolana mortars largely replace those made in other countries with Portland cement. Sands of the nature of puzzuolana are to be found in other volcanic countries, and merit more attention than they have hitherto received. The remarkable state of preservation of the old Roman buildings in Italy is largely due to the fact that the mortar used in their construction was hydraulic.

The sulphur industry being of such importance to Italy, it was to be expected that it would receive considerable attention. Mr. B. Reinitzer discussed the origin of natural deposits of sulphur, and Prof. N. Rossi described a new method of extracting poor sulphur ores by means of bisulphide of carbon. It was stated that there are very considerable quantities of sulphur ores containing less than 20 per cent. of sulphur, below which percentage it is not at present remunerative to work them. The author proposes to lixiviate these by means of bisulphide of carbon, and has designed plant for that purpose. It must be remarked, however, that similar efforts have hitherto resulted in failure, and the author's apparatus met with some adverse criticism by chemical engineers familiar with such subjects. It is to be hoped that a practical test may be made with the apparatus, as the Sicilian sulphur industry is being seriously threatened by the discovery of the Louisiana deposits.

Prof. L. Ricciardi, of Naples, communicated the results of a number of analyses of eruptive rocks, from which he draws the important conclusion that volcanoes at first emit rocks of an acid nature, but that subsequently the products are basic in their character. The author is of opinion that volcanic phenomena are similar throughout the world, and the rocks which give rise to them are granitic in their nature.

Prof. A. C. Vournasos, of Athens, reported the discovery of a large deposit of asphalt in Greece, which is already being worked on an industrial scale, and appears to be a valuable addition to our supplies of that useful substance. At the same time the author communicated a new method for testing asphalt which he had recently devised.

The section of the congress dealing with the industry and chemistry of sugar was the medium for the communication of a large number of papers, chiefly of industrial interest. Nearly every European country except Great Britain has now a large sugar industry; in fact, the International Congress of Applied Chemistry originated in a meeting of chemists engaged in the sugar industry. A paper by Mr. C. H. Neumann on the testing of the germinating power of sugar-beet seeds shows the amount of specialisation which has taken place. The author found that the best medium for ensuring the regular germination of the seeds was a damp mixture of sand and sawdust, the temperature being carefully regulated.

In the section on explosives Mr. R. Villanis presented a detailed memoir on the state of the explosives industry in Italy in which the various factories and their products were described, together with the regulations in force. The erosion and corrosion of firearms by smokeless powders gave rise to two communications by Dr. V. Reuhi and by Mr. Gey van Pittius. The former referred to the use of nitro-guanidine as an explosive, this being one of the products of Frank's discovery mentioned already.

Several authors dealt with the use of alcohol and petroleum products as sources of power. In Great Britain, where petroleum is admitted free of duty, there can be no doubt that it is at present the cheapest liquid in use for the production of power. Some Continental countries, however, in order to foster the alcohol industry and the important agricultural interests depending upon it, have imposed heavy duties on all competing liquids, and there is naturally continuous rivalry between the various interests thus created.

The section dealing with wine was also of more importance to Continental than to British members, and the same may be said of the agricultural chemistry section, in which matters connected with Continental husbandry were fully discussed. Prof. J. Stoklasa dealt with the enzymes which produce lactic and alcoholic fermentation in the tissues of plants. The author agreed with Messrs. C. Golenski and Mazé that such fermentation is in reality the intramolecular respiration of plants, and a number of experiments were described corroborating this view.

The final plenary sitting of the congress was mainly occupied in passing resolutions confirming recommendations by the sectional committees. Among these may be mentioned the appointment of a committee to elaborate uniform methods of testing explosives, the unification of methods of sugar analysis, especially between the Custom House officials of different countries, and the unification of methods for the analysis of malt in breweries. The transport of dangerous substances by rail was also referred to, and recommendations made as to the patenting of inventions by employees and upon international trade marks.

At the close of the meeting an invitation to the congress to meet in London in 1909 was given by Prof. Tilden, as representing the British Government, and Dr. L. Mond, Prof. E. Divers, and Prof. R. Meldola as representing a joint committee, consisting of practically every British society connected with chemistry, which had been formed on the initiation of the Society of Chemical Industry. The invitation was unanimously accepted.

During the session of the congress a number of social gatherings and excursions took place which afforded excellent opportunities for the delegates of the various nations to become acquainted with each other. The largest excursion was to Tivoli, where about 1500 members were present. The beauties of that lovely spot are too well known to require description, but the remarks of some of the electrochemists led one to believe that they considered a large amount of water-power was being wasted. It would be well, in view of the utilitarian character of modern industry, if the different States were to secure one or two of their most picturesque waterfalls before they have all been absorbed for the production of electrical energy. Many members of the congress visited the sad scenes in the neighbourhood of Vesuvius. One member who had collected the volcanic dust, soon after the eruption, at Addlestone, in the Thames valley, and again on a roof at Turin, was enabled to satisfy himself of the identity of these specimens with the Naples dust.

Excursions were proposed to Sicily and to Elba, but an inopportune strike of the sailors of the Italian Steam Navigation Company put an end to these. Many who were visiting Rome for the first time found many objects of interest, apart from the inexhaustible art treasures of the city. One naturalist collected three varieties of Helix on the walls of the castle of St. Angelo, while a botanist directed attention to the presence of pellitory of the wall on the same building. English tradition says that it was introduced into England by monks, and in some districts it is only found on old monastic buildings. In some rubbish that was being cleared out of the dungeons of St. Angelo numerous fragments of marble cannon-balls were found. During times of siege it is related that large numbers of statues were converted into cannon-balls, and the great variety of marbles to be found among the fragments lends support to this statement. Another enthusiastic lover of nature in all her forms collected a number of live scorpions in the Forum. He stated that they soon became tame, and took live ants from the fingers. His statements were accepted without discussion.

The meeting of the congress was brought to a close on May 5 by a state banquet given by the King of Italy at the Quirinal to the delegates of foreign Governments and societies. Both the King and Queen received the visitors, among whom were six British delegates. After the banquet the King, who takes great interest in the industrial revival now taking place in Italy, held a reception, several of the Italian ministers being present. The next day most of the members of the congress departed from the beautiful and hospitable city which had been the scene of their labours, many with the intention of returning if possible.

THE SURVEY OF INDIA.

THE report[1] of the Indian Survey Committee recently received is contained in two volumes, the size of which should be sufficient testimony to the exhaustive nature of the inquiry. The result, on the whole, should be satisfactory to those who for years past have been protesting against the short-sighted policy of the Indian Government, which, under financial pressure, has often forced reductions on the Survey Department until its efficiency has become seriously impaired. There is hardly a reform suggested by the committee which has not been urged previously in India. Sir John Farquharson (president of the committee, whose death so soon after his return to England was almost tragic) but expressed the opinions of many who have been closely associated with the Indian Survey Department, modified more or less by his own experiences as chief of the Ordnance Survey in England.

The main results of the committee's recommendations are, first, the strengthening of the department in men and money, and secondly, the separation of the cadastral (or revenue) from the topographical and trigonometrical branches in order that proper supervision may be given to the latter, and that the general military maps of the peninsula and the frontier may be brought (and kept) up to date. Cadastral surveys will in future be relegated to local governments, who will be responsible for the maintenance of their own revenue maps; but scientific supervision of this local work will be provided from the department. This indeed is essential, as everybody knows who has had experience of the terrible results of local meddling with original survey mapping by half-trained, or wholly ignorant, native employees. Nor is the fact overlooked that all the extreme refinement of the most accurate geodetic triangulation has its final expression in these revenue maps. The larger the scale and the more restricted the area, the greater the necessity for a positively accurate basis for local traversing. Every little village plan must take its place accurately in the provincial map if titles to property are to be of any account.

The recommendations of the committee regarding the topographical mapping of India and the reproduction of maps appear on the whole to be excellently well adapted to the end in view, in spite of a certain amount of dissent in matters of detail recorded by the present Surveyor-General. Due acknowledgment is made to the late Surveyor-General (Colonel Gore) for the accuracy of his estimate of the amount of revision necessary, and the cost in time and money of carrying it out; and a most appropriate despatch from a former Secretary of State for India (1876) is quoted, in which the fallacy of expecting to effect economies by the reduction of well-trained survey parties is emphatically maintained. That fallacy was, however, supported by the then Government in India, and was supported by every Government since, until the arrival of a geographical expert as Viceroy in Lord Curzon. The topographical maps of all India, on the 1-inch per mile scale, are to be thoroughly revised and completed. It is something of a surprise that mapping on this scale was not completed long ago, as there has been nothing important missing from the general map of India for several years past. The method of reconstruction recommended by the committee is not altogether approved by the present Surveyor-General, who is in favour of more decentralisation in order to gain efficient supervision; but there was no dispute as to the paramount necessity of maintaining one standard map of the whole of India in a state of absolute completeness. Nor can the recommendations with reference to frontier mapping be regarded with anything but satisfaction. The appointment of a special superintendent on the frontier to rank with the superintendent of trigonometrical surveys, with five working parties under him, and three officers attached to each party, and with the headquarters office at Simla in touch with the Intelligence Department, is indeed a big concession to military requirements. A similar, but much smaller, scheme was suggested nearly ten years ago, in the days when two or three officers and one elastic party were considered ample to deal with the Indian borderland from the Indus to the Euphrates; but it was not entertained. Trans-frontier surveys, apart from political boundary requirements, were not recognised as of any importance. It depended entirely on the enterprise of the officer in charge of the frontier party whether any such work was carried out at all; it was regarded as rather beyond the scope of strict departmental business—to be permitted (if no complications with tribes-people were involved), but hardly to be approved.

Any effort to render frontier mapping more effective by ensuring its proper distribution amongst the military offices of the frontier was perhaps beyond the scope of the committee's proceedings, but it can hardly be denied that proper map distribution is only second in importance to map making.

The reproduction of maps has always been the great difficulty of the Indian Survey Department. Climate, material, and personnel are all against the reproduction of clear, readable, and artistic maps from the excellent material which is found in the original field-sheets. Dr. Stein's evidence on this point is very suggestive. Whilst condemning the printed maps, he paid a graceful tribute to the artistic value of the originals. Photozincography has had much to answer for; misplaced economy, resulting in inferior material and a staff absolutely inadequate to deal with the mass of work thrust upon it, has completed the tale of ultimate inefficiency. We doubt if the well-meant efforts of the committee will really do much to raise the low standard of Indian map publishing so long as cheap rates form the ruling motive of the publishing office. Partial engraving and heliozincography are steps in the right direction, however, but it has always appeared to us that the employment of a first-class firm in England to undertake all the finer work of the department is the real panacea for the ills that beset Calcutta map printing. There is no dealing with the inertness of the native by means of committees. Colonel Grant points out that one girl in England will do as much as two (native) men in the Calcutta office. It may be so (so long as girls do not subscribe to trades unions), but he ignores the effects of a climate that affects Europeans and natives alike.

The general report on the Indian Survey for 1903–4[2] serves as a useful commentary on the recommendations of the committee which was sitting at the time that this rather belated report was under compilation. From it we are able to gather an idea of the enormous expansion in the widely diffused work of the department which has occurred within late years, and of the mass of material which has been crowded into the over-weighted publication offices. The report deals with certain administrative changes (such as the amalgamation of the forest surveys) which are unimportant when considered by the light of the subsequent recommendations of the committee; and much of it is concerned with the progress of cadastral, or revenue, surveys, which will in future probably form but an insignificant feature in the general programme.

Referring to the developments that are proposed in topographical (or military survey) branches of the department, we naturally turn to the map published in the report to illustrate the actual position of these surveys at present. The completion and maintenance of a 1-inch per mile map of the whole peninsula area, and the extension of accurate surveys into extra-peninsula regions, is one of the main features of the revised programme. The map, however, for this purpose is rather misleading, for we find a great part

[1] "Report of the Indian Survey Committee, 1904–5." Part i., The Report, pp. vi+151. Part ii., pp. v+223. (Simla: The Government Central Printing Office, 1905.)

[2] "General Report on the Operations of the Survey of India administered under the Government of India during 1903–4." By Col. J. R. Hobday, I.A. Pp. iv+62+xlii. (Calcutta: Office of the Superintendent of Government Printing, 1905.) Price 3s.

of the Madras province left blank as if it had never been surveyed (whereas the old Madras revenue surveys furnish excellent material for any 1-inch reproduction), and a fairly wide area of Baluchistan territory near Quetta, which has been most carefully surveyed on the scale of 2 inches to the mile and has stood the test of a whole series of military manœuvres most successfully, classed as "geographical reconnaissance"—which it certainly is not, nor is the mass of ½-inch work which has been completed in that country.

The fact is that, for the completion of the 1-inch topographical map of all India, only a small portion of the Rajputana desert really requires first survey. There must, however, be an enormous amount of revision necessary.

During the year under review, 34,000 square miles of detail survey were completed, and (according to the general summary) about 24,000 square miles of geographical reconnaissance. Elsewhere we find records of 15,000 square miles of Seistan geography, no less than 58,000 square miles in Tibet, and the invaluable work of Colonel Wahab in South Arabia (of which we have heard so little and would like to know so much), amounting to 6000 square miles. Presumably the 24,000 square miles with which the summary deals is independent of these special outturns. The chief interest of the report lies in the appendix dealing with these special performances, and we cordially welcome a return to even this partial recognition of the absorbing interest which is to be found in the story of Indian surveying. The kernel of the report was extracted when the "narratives" went out of it. Even here we do not find the story of the death of that gallant native geographer and explorer Sheikh Mohiudin, whose determined (reckless, for a surveyor) search after information in Seistan led to his being found at last, dead, with his horse dead beside him—dead of thirst in that thirsty country; whilst his plane-table sheets had been stripped from the board and wound round the body of one of his native assistants, who was finally rescued by a friendly Afghan out of a far-away pool of water in which he was lying insensible. Such little incidents as this, or the death of Colonel Wahab's native surveyor, who was shot at his work in Arabia, excite little public comment in India.

In the scientific branches of the department there is much good work to record. The great arc of principal triangulation which terminates with the Dehra Dun base has been extended into the Himalayas, and connected with the peaks of the Snowy Range. Valuable results have been obtained from the comparison of geodetic with astronomic determinations for latitude, the tendency of them being to prove that large northerly deflections of the plumb-line continue to prevail in the heart of the Himalayas. Pendulum observations to determine the force of gravity have been resumed, and magnetic work has also been a feature of the scientific branch of the department supervised by Lieut.-Colonel Burrard, R.E., F.R.S. That officer has also added a useful chapter to the report on the value of principal triangulation and scientific surveying. All this is most valuable work, and should go a long way to satisfy financial critics that the Government of India gets its money's worth out of the scientific investigations of the Survey Department.

The official report of the observations made by Captain Wood, R.E., in Nepal to determine the position of the Everest peak relatively to the Gaurisankar group is included in this volume. It is hardly necessary to refer again to the conclusions which have been formed on a subject which has already been discussed in the pages of Nature. A most useful map of part of Nepal, and the panoramic views which accompany Captain Wood's report should be convincing evidence of the isolated position of the highest peak in the world, if any further evidence were needed. A re-perusal of the exact conditions under which these observations were made is most interesting, and fully confirms the opinion expressed by Colonel Gore (the late Surveyor-General) that "those who trust to their appreciation of characteristic forms and their mountaineering instincts, as a means for identifying peaks from widely different points of view, are apt to be frequently misled."

THE IRON AND STEEL INSTITUTE.

The annual meeting of the Iron and Steel Institute was held in London on May 10 and 11, Mr. R. A. Hadfield, the president, in the chair. The president referred to the loss the institute had suffered by the deaths of Sir David Dale and Mr. J. T. Smith, past-presidents, and votes of sympathy were accorded. The report of the council, read by the secretary, Mr. Bennett H. Brough, showed that the membership amounted to 2033, and that in 1905 the income was 6271*l.* and the expenditure 5257*l.* The Bessemer medal was awarded to Mr. F. Osmond, the eminent French metallurgist. Carnegie research scholarships of 100*l.* were awarded to Dr. C. A. F. Benedicks (Sweden), Mr. O. Stutzer (Germany), Mr. E. Hess (United States), and Mr. E. F. Law (London). Grants were also made to Mr. H. C. Boynton (United States), Dr. L. Guillet (France), Mr. W. H. Hatfield (Sheffield), Mr. E. G. L. Roberts (London), Mr. W. Rosenhain (Birmingham), Mr. E. A. Wraight (London), and Mr. A. Campion (Glasgow). The Carnegie gold medal for research was awarded to Dr. L. Guillet, and the silver medal to Mr. W. Rosenhain.

In the first paper read Mr. A. J. Capron (Sheffield) described a new method of compressing steel ingots in the mould which has been successfully adopted in Sheffield. The ingot moulds are placed inside the press, the steel being run into the moulds in this position, so that they have not to be transported with the liquid steel in them, and the press practically forms the casting pit.

Prof. T. Turner (Birmingham) gave the results of observations on the volume and temperature changes during the cooling of cast-iron. Apparatus was designed in order to measure the changes of length of a test-bar, whilst cooling curves were taken of the specimens at the same time with a Le Chatelier pyrometer. The curves obtained may be divided into four classes, depending upon the number of arrests observed in the normal rate of contraction of a cooling solid.

Mr. E. Adamson (Seaton Carew) read a paper on the influence of silicon, phosphorus, manganese, and aluminium on chill in cast-iron. The depth of chill is primarily dependent upon the percentage of combined carbon and the temperature of casting. Combined carbon 0·67 per cent. gives 1/16-inch chill, and combined carbon 0·88 per cent. gives ¾-inch and 1-inch, but the latter was cast at a much higher temperature. These figures are taken from the silicon and phosphorus tests. The manganese tests also show an increase in true chill with increasing manganese up to combined carbon 1·60 per cent. The tests described were made from coke irons, and suggest that under proper treatment coke irons are as good as charcoal irons for high mechanical tests and depth of chill.

On May 11 Prof. J. O. Arnold and Mr. F. K. Knowles (Sheffield) read a preliminary note upon the influence of nearly pure metallic manganese alloyed with varying proportions of nearly pure metallic iron. A series of alloys ranging in manganese from 0·3 per cent. to 36 per cent., and in carbon and silicon from 0·05 per cent. to 0·2 per cent. each, was prepared in special crucibles. In the finished bars, each 12 feet long, liquation of a remarkable character took place which rendered the completion of the research difficult. It is possible, but hardly probable, that some of these costly alloys may prove of practical importance.

Mr. C. de Schwarz (Liége) read an interesting paper on the use of oxygen in removing blast-furnace obstructions. The difficulties caused by the tap-hole of a blast furnace becoming closed up by solid iron have been overcome by the application of compressed oxygen. The process has been adopted at several works in England and on the Continent with satisfactory results. At the conclusion of the paper a practical demonstration of the process took place at the works of the Brin Oxygen Co. in Westminster.

Mr. E. F. Law (London) described an extended investigation into the causes which underlie the production of brittle and blistered tin plates. He showed that oxidised steel will give rise to blistered sheets, and that this defect is more liable to occur with Bessemer than with open-hearth steel. Steel high in sulphur and phosphorus will cause brittleness in sheets, especially if the sheets are rolled from large and slowly-cooled ingots in which the maximum of segregation has taken place.

Mr. P. Eyermann (Benoit, Wisconsin) submitted a lengthy paper on the manufacture of solid rolled steel wheels and tyres. The average life of a cast-iron wheel is 56,000 miles in passenger service, while steel-tyred wheels have a life of 265,000 miles. The author considers it probable that before long the solid rolled steel wheel will replace the existing tyres in Great Britain.

Mr. E. Lelong (Couillet, Belgium) described a new method of manufacturing chains by machinery in which the successive convolutions of spiral links are continuous. Chains made by this process are 20 per cent. stronger than those made by the usual methods.

Mr. C. O. Bannister (London) discussed the relation between type of fracture and microstructure of steel test-pieces, showing that valuable conclusions may be drawn from the examination of the fractured surface.

The effect of copper in steel was discussed by Mr. F. H. Wigham (Wakefield). Copper is very difficult to alloy with steel so as to obtain a homogeneous mass containing more than 2 per cent. even with the addition of aluminium. In steel containing 0·5 per cent. or more of carbon it is not of practical value to use more than 0·6 per cent. of copper. The steel with 0·25 per cent. of copper and alloys up to 0·25 per cent. of copper with high carbon (0·70 per cent.) give, with or without a high percentage of manganese, a good quality of wire. In fact, copper to the extent of 0·25 per cent. is no disadvantage in the manufacture of the best classes of steel wire.

The reports of research work carried out during 1905–6 by holders of Carnegie research scholarships, which were submitted, represented a large amount of work of great interest. An exhaustive study of quaternary steels was submitted by Dr. L. Guillet (Paris). For the research 250 varieties of steel were prepared, including nickel-manganese steels, nickel-chromium steels, nickel-tungsten steels, nickel-molybdenum steels, nickel-vanadium steels, nickel-silicon steels, nickel-aluminium steels, manganese-silicon steels, manganese-chromium steels, and chromium-tungsten steels. The area for the commercial employment of these steels is considerably restricted, and is limited to the nickel-vanadium steels, the nickel-tungsten steels, and the chromium-vanadium steels containing comparatively low proportions of foreign elements.

The report by Mr. W. Rosenhain (Birmingham) on the deformation and fracture of iron and mild steel constitutes a continuation of his previous paper on the plastic yielding of iron and steel. He gives further observations on slip-bands, and deals with the modes of fracture under various conditions. In tensile fractures the break runs almost indifferently through ferrite and pearlite, owing to the fact that the previous extension of the metal has weakened, and in part even ruptured, the pearlite; in shock fractures the pearlite is able to assert its superior strength and is avoided by the fracture, while fissures are formed in the ferrite. The features of bending fractures are found to be of an intermediate character. The results of the examination of these fractures are discussed both from the point of view of the relative behaviour and interaction of ferrite and pearlite under breaking stresses and from the point of view of the general theory of deformation and fracture which is presented in the paper. In conclusion, the author points out the possibilities of practical application which his method of studying fractures opens up. This detailed study of fractures makes it possible to locate accurately the causes of weakness and strength in a given microstructure, and by comparing the behaviour of the constituents when broken in different ways to gain a deeper insight into their mutual interaction; while the study of "mysterious" fractures occurring in service—as rendered possible by this method—should make it easier to trace the causes of fracture—if any—which are present in the metal.

Dr. H. C. Boynton (Harvard, U.S.A.) dealt with the determination of the hardness of the constituents of iron and steel with the aid of Jaggar's microsclerometer. Reduced to a common unit, the hardness of pure ferrite, the average hardness of the constituents was found to be as follows:—

Constituent	Present in	Average Hardness	Ratio
Ferrite	Electrolytic iron	460	1
,,	,, ,, quenched	990	2·15
,,	Average of all unhardened samples	610	1·03
,,	Commercial wrought irons	686–1643	1·5–3·6
Pearlite	Series 0·13–1·52 per cent. carbon	842–4711	1·8–10·3
,,	Series 0·35–0·86 per cent. carbon	1745–2150	3·8–4·2
Sorbite	0·48 and 0·58 per cent. carbon steel	2400–24,650	5·2–53·6
Troostite	Steel, 0·58 per cent. carbon	40,564	88·2
Martensite	Series 0·20–1·52 per cent. carbon	17,896–120,330	38·9–261·6
Austenite	White cast iron (3·24 per cent. carbon)	47,590	103·4
Cementite	White cast iron (3·24 per cent. carbon)	125,480	272·8

Mr. J. D. Brunton (Musselburgh) submitted an elaborate report on the heat treatment of wire, particularly wire for ropes. He showed that the usual methods of obtaining the best wire by means of torsion and tensile tests are not altogether trustworthy for determining the best point for the wire to perform useful work. Annealing of the rod before the final annealing does not, in any way, produce better material, as it has been thought to do, and is, therefore, not necessary.

The research carried out by Messrs. E. G. L. Roberts and E. A. Wraight (London) comprised a series of 150 experiments and complete analyses, dealing with the constitution of ferromanganese and the efforts made to deprive this alloy of its carbon.

It was announced that the next meeting would be held in London at the end of July, when members of the American Institute of Mining Engineers would be the guests of the institute.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Prof. William Schlich, F.R.S., St. John's College, has been constituted by H.M. Secretary of State for India professor of forestry so long as he shall be continued in his present position and be resident within the University.

The first of two lectures on "The Teaching of Science in Schools" was given by Dr. Bevan Lean, headmaster of Sidcot School, on May 10 at the lecture room of the delegacy for the training of secondary teachers. The second lecture is to be delivered to-day.

CAMBRIDGE.—A Grace authorising the general board of studies to appoint, subject to confirmation by the special board for medicine, Mr. G. H. F. Nuttall, Christ's College, to be reader in hygiene in connection with the special board for medicine, the University lectureship in bacteriology and preventive medicine to terminate on his appointment as reader, will be offered to the Senate to-day.

Mr. W. J. Sell, Christ's College, has been approved by the general board of studies for the degree of Doctor in Science.

A university lectureship in mathematics will be vacant at Michaelmas, 1906, by the resignation of Mr. Whittaker. The general board of studies will shortly proceed to appoint a lecturer to hold office from Michaelmas, 1906, until Michaelmas, 1911. Candidates are requested to send their applications, with statements of the subjects on which they are prepared to lecture, and with testimonials if they think fit, to the Vice-Chancellor on or before May 31.

The Vice-Chancellor has been informed by the clerk to the Worshipful Company of Girdlers that the company is prepared to continue its grant of 100*l*. a year towards the teaching of economics for a second period of three years. The board of economics is of opinion that this offer should be gratefully accepted.

THERE seems every possibility of the Hamburg University being very quickly established. Three million marks have already been voluntarily subscribed, two millions of which have been given by Mr. Alfred Beit. It is proposed that only one-half of the lectures shall be given for direct preparation for any particular profession, while the other half are to be for the further extension of the general education of the inhabitants of the town.

HIGHER education is mostly left to take care of itself in this country, with the result that our statesmen and Governments do not know exactly where it is being carried on, or what provision has been made for it without their assistance. On the principle that what is everybody's business is nobody's business, no serious attempt has been made to take stock of our national resources as regards higher education, so it comes about that the committee recently appointed by the Chancellor of the Exchequer to advise the Treasury as to the distribution of the sum voted by Parliament for grants in aid to university colleges has sent an intimation to the public Press with the object of bringing the conditions under which grants are made under the notice of colleges which have not as yet communicated with the committee. It is obvious that if our higher education were properly organised by the State, the Minister of Education would have detailed particulars of institutions devoted to it, and such an announcement as that just issued, suggesting that there are many colleges unknown to the official mind, would have been unnecessary. The grants are given only to those institutions which afford education of a university standard in great centres of population in England. To qualify for a grant at present, a college is required to show that its local income for work of a university character is not less than 4000*l.*, and that of this sum at least 1500*l.* is derived from fees. Any college wishing to be included in the list of those receiving grants should send in an application not later than June 13. Applications should be addressed to the secretary to the committee, Mr. R. G. Hawtrey, at the Treasury, S.W.

PRESENTATION DAY was celebrated at the University of London on May 9, when Sir Arthur Rücker, the principal, read his annual report on the work of the University. An important event of the year was the recasting of the schemes of examination for the B.A. degree. Up to the present the course of study from the matriculation stage onward has been, with the exception of mathematics, entirely literary. The opinion that a mixed course of literature and science would be of the utmost value to many pass students has, however, for long been gaining in strength, and effect has now been given to it in the following manner. In future either Greek or Latin, but not both, will be compulsory both in the intermediate and in the final examinations for the B.A. degree. Another language will also be compulsory; while the other subjects required may be chosen from a list of languages, pure and applied mathematics, and the more fundamental sciences. The examinations in science will be identical with those for the corresponding subjects for the B.Sc. degree. It will thus be possible for a candidate for a pass B.A. degree to take either an exclusively literary course or a mixed course including Latin and one other language. Sir Arthur Rücker announced that the Senate has invited the University of Paris and the Collège de France to visit the University of London at Whitsuntide. This will be a unique event, no formal visit having hitherto been made by a French to an English university. A large number of distinguished guests are expected, and it is hoped that the occasion will bind closer the intellectual links which unite the two countries.

A DEPUTATION of the council of the Association of Technical Institutions was received by the President of the Board of Education on May 4. Sir William Anson, as president of the association, introduced the deputation, and stated that its object was to bring before the Board the importance of increasing the rate of grants to the day technical institutions and for instruction in the more technical subjects in evening classes. Sir William Anson referred to the importance of efficiently maintaining facilities for technical instruction, and pointed out the tendency of local authorities to devote their funds chiefly to elementary education, to the possible detriment of higher work. Sir Philip Magnus urged the importance of technological subjects in evening classes, and the great cost involved in their maintenance. Unless education authorities are encouraged to conduct such classes there is grave fear of their being neglected for subjects, not so important to the industries of the country, which receive higher grants. Sir William Mather spoke of the great importance of technical education for the maintenance of the industries of the country, and the need for watching that money intended by Parliament for the maintenance of such work should not be diverted for other work. He thought an appeal might well be made to employers to contribute towards the cost of technical education. Mr. Birrell, in reply, said that the deputation might rest assured that the Board has every sympathy with the request put forward for increased grants for work in day classes in technical institutes. The Board fully realises the importance of the work which is done. Mr. Birrell, however, reminded the deputation that there are many other important branches of education which are in need of increased grants. In conclusion, he cordially supported what Sir William Mather said as to the importance of employers contributing to technical institutes. Mr. F. G. Ogilvie dealt with the way in which the Board is trying to include technical subjects as eligible for their grants, and so far as possible at the same rate as science subjects.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 5.—"On the Distribution of Radium in the Earth's Crust, and on the Earth's Internal Heat." By the Hon. R. J. **Strutt,** F.R.S.

Summary of Conclusions.—(1) Radium can easily be detected in all igneous rocks. Granites, as a rule, contain most radium, basic rocks the least. (2) This distribution of radium is uniform enough to enable a fair estimate to be made of the total quantity in each mile of depth of the crust. (3) The result indicates that the crust cannot be much more than forty-five miles deep, for otherwise the outflow of heat would be greater than is observed to be the case. The interior must consist of some totally different material. This agrees entirely with Prof. Milne's conclusion drawn from a study of the velocity of propagation of earthquake shocks through the interior. (4) The moon probably consists for the most part of rock, and, if so, its internal temperature must be far greater than that of the earth. This explains the great development of volcanoes on the moon. (5) Iron meteorites contain little, if any, radium. Stony ones contain about as much as the terrestrial rocks which they resemble.

Challenger Society, April 25.—Mr. E. W. L. Holt in the chair.—*Exhibits.*—Four species of Cephalodiscus, of which three had recently been described by the author, who also referred to others from the *Discovery* and *Antarctica* expeditions: Dr. S. F. **Harmer.**—Charts of positions in the North Sea, where, by means of a heavy conical dredge with canvas lining, samples of bottom deposits had been taken by the Marine Biological Association's steamer *Huxley*: J. O. **Borley.** Mr. Borley showed in action a sifting machine, designed by Mr. Todd and himself, for grading these deposits; sieves of various mesh, hung in water, were made to vibrate horizontally at high speed by an excentric worked by an ordinary whirling-table. There were also exhibited specimens of the gravel, fine sand, and silt met with, charts of their distribution showing the extreme uniformity of bottom found over large areas in the eastern part of the North Sea, and diagrams indicating the very definite meaning attaching to fishermen's descriptive terms for the bottom.—Preliminary paper on Medusæ collected in H.M.S. *Research* by Dr. Fowler in the Bay of Biscay: E. T. **Browne.** The Trachomedusæ predominated over the other orders, three species forming about 85 per cent. of the specimens collected (*Aglantha rosea*, 42 per cent.; *Aglaura hemistoma*, 27 per cent.; *Rhopalonema coeruleum*, 15 per cent.). These were chiefly taken between 50 fathoms and 100 fathoms. A few rather rare species were taken below 100 fathoms; for example, *Colobonema sericeum*, one of the new deep-sea Medusæ discovered by the *Valdivia*. The most interesting find was a Narcomedusan, probably a new species of Cunoctacantha, which had a number of medusa-buds in all stages of development upon the stomach-pouches; the buds were not parasitic, as in other species of Cunoctacantha and Cunina, but develop directly from outgrowths of the stomach-wall. This forms a straightforward case of asexual gemmation, such as occurs in some Anthomedusæ.

Geological Society, April 25.—Dr. J. E. Marr, F.R.S., vice-president, in the chair.—Trilobites from Bolivia, collected by Dr. J. W. Evans in 1901–1902: P. **Lake**. Several horizons are represented by these fossils. Descriptions are given of the new species and other forms mentioned. It is worthy of remark that, while the earlier forms show affinities with the contemporaneous European fauna, the Devonian species are much more closely allied to those of South Africa and North America.—Graptolites from Bolivia, collected by Dr. J. W. Evans in 1901–1902: Dr. Ethel M. R. **Wood**. In black pyritic shales from three localities several specimens of Didymograptus were collected: one referable to *bifidus*, one of the type of *affinis*, and one of the *Nicholsoni* type. Phyllograptus, Glossograptus, Cryptograptus, and Diplograptus were also obtained. A pale, silky-grey shale shows also rare graptolites, belonging to a species comparable with *Climacograptus confertus*. These forms indicate that both the black and the pale shales belong to horizons in the Upper Arenig rocks (Lower Llanvirn of Hicks).—The Phosphatic Chalks of Winterbourne and Boxford (Berkshire): H. J. Osborne **White** and Llewellyn **Treacher**. Data collected in the district dealt with in this paper suffice to show that the more or less Phosphatic Chalks above the Uintacrinus-band lie in a trough or basin, the formation of which antedates the deposition of the Reading beds. When the area of observation is extended, it is found that the Uintacrinus-Chalk of that tract itself lies in a structural depression. The Phosphatic Chalks of Winterbourne and Taplow evidently mark places on the sea-floor particularly liable to the impingement of strong currents, and may mark places above which the water commonly had a gyratory motion. In any case, their zonal range argues a marked degree of stability in the current-system of the body of water in which they were laid down.

Physical Society, April 27.—Dr. C. Chree, F.R.S., vice-president, in the chair.—Some simple questions on the images of microscopes and telescopes: W. B. **Croft**. It may have been noticed that when a microscope is focused visually, an image is formed on the focusing-glass of a camera, into which the microscopic eye-piece is inserted after removing the camera-lens. This image remains more or less in focus at variable positions of the camera-screen. Although it is not always perhaps true, yet it is surprising how often the pencil emerging from a microscope eye-piece behaves like a single concentrated line of light. Several photographs of microscopic details were exhibited to intimate how often the author had found, when projecting from an optical eye-piece, that no change can be detected in the definition of the image as the screen of the camera is moved. If a camera-lucida is placed on the eye-piece, the image of a stage-micrometer can be thrown on a scale at 10 inches distance or at 40 inches distance. The parallel rays emerging from the eye-piece give the image of a point along a direction, at no definite position. The image can be imagined at 40 inches distance as easily as 10 inches. Mr. Croft also showed some photographs taken from sections of the human eye; he indicated that a divergent pencil from a small aperture or from a convex reflecting surface of large curvature will give the Purkinje figures as bright radiating lines, whereas the usual method of sending light through the side of the sclerotic gives them as shadows. Several different specimens were shown of magnetic oxide of iron and magnetic sulphides of iron. The power of nickel and cobalt to receive permanent magnetism was illustrated with a compass-needle of nickel.—The lateral vibration of bars subjected to forces in the direction of their axes: J. **Morrow**. Three cases of unloaded bars are dealt with, namely, those under the following end-conditions:—"supported-supported," "clamped-clamped," and "clamped-supported." Expressions are obtained from which the frequencies may be calculated, and the results are stated in a form such that the determination of stresses, terminal couples, &c., may be easily made. The case of greatest interest is that of a stretched bar clamped at each end. Approximate solutions of this problem have been arrived at by both Seebeck and Donkin. These are on the assumption that the vibration is but slightly affected by the rigidity of the material. An assumption of a very different character, and one generally fulfilled in structural work, is made in this paper, namely, that the longitudinal force is not very great. Solutions are thus found for the period of the fundamental or any harmonic.

Mathematical Society, May 10.—Prof. A. R. Forsyth, president, in the chair.—The substitutional theory of classes and relations: Hon. B. **Russell**. The object of the paper is to explain a solution of the contradictions discovered by Burali-Forti and the author. The solution is sought in the substitutional theory, sketched in a previous paper by the author, according to which statements apparently about a class are significant only when they can be analysed into statements about all or some of the members of the class. The substitutional theory is extended to propositions and relations.—The expansion of polynomials in series of functions: Dr. L. N. G. **Filon**. The question is that of expanding a function $f(x)$ in a series of functions of the form $\phi(\kappa_n, x)$, where the numbers $\kappa_1, \kappa_2, \ldots$ are the roots of a transcendental equation. The method is analogous to Cauchy's method of expansion of functions in Fourier's series, and depends upon the calculus of residues. In Cauchy's method a subsidiary function $F(\kappa)$ is introduced through a knowledge of the form of the coefficients of Fourier's series; in the present paper a rule is given for determining this subsidiary function *a priori*, and the rule is shown to be applicable to many classes of functions $\phi(\kappa, x)$ when the function $f(x)$, of which the expansion is desired, is a polynomial. The subsidiary function $F(\kappa)$ being known, the coefficients in the expansion of $f(x)$ can be obtained explicitly.—The motion of a swarm of particles the centre of gravity of which describes an elliptic orbit of small eccentricity round the sun: Dr. E. J. **Routh**. It is proved that for a spherical swarm the period equation takes the Lagrangian determinantal form, and the conditions of stability can be completely exhibited. The problem of a swarm of unequal thicknesses in different directions is illustrated by a discussion of the case in which the boundary is ellipsoidal; and the changes of length of two diameters in the plane of motion, one of which passes through the sun, are investigated in detail.—The theory of integral equations: H. **Bateman**. The partial integral equation

$$\int_a^1 \kappa(s, x) f(x, t)\, dx = \int_a^b f(s, x)\, h(x, t)\, dx$$

is regarded as the characteristic equation of a transformation by which the properties of the function $h(s,t)$ are deducible from those of $\kappa(s,t)$. This transformation leaves unaltered the numbers λ_n for which the homogeneous equation

$$\phi_n(s) = \lambda_n \int_a^b \kappa(s, t)\, \phi_n(t) dt$$

possesses a solution different from zero. The numbers λ_n are important in the theory of the potential and in connection with a certain theory of the origin of spectral lines.—Linear differential equations of rank unity: E. **Cunningham**. The paper is concerned with an extension of Laplace's method of solution of linear differential equations by means of definite integrals. The proposed solution takes the form of a double integral involving a subsidiary function which satisfies a certain partial differential equation. Particular forms of this subsidiary function are developed, and the appropriate domains of integration determined.

PARIS.

Academy of Sciences, April 30.—M. H. Poincaré in the chair.—Diphenyl or alkylphenyl camphomethane and methylene: A. **Haller** and E. **Bauer**.—Simple relations between the "statical actions" of muscle with the energy which produces them: A. **Chauveau**.—The doubly infinite varieties of points of a quadric in space of four dimensions applicable to a plane: C. **Guichard**.—Contribution to the study of the infra-red spectrum: Milan **Stephanik**. In the study of the infra-red region of the spectrum three methods have hitherto been used, the thermometric method, the photographic method, and the utilisation of the phenomena of phosphorescence. In studying the eclipse of August 30, 1905, the author noticed that when a deep red screen was placed in front of the slit of the spectroscope a portion of the infra-red spectrum became visible. This method has been followed up at the Meudon Observatory, various screens being tried. It was found that the best results were obtained when the screen absorbed nearly the whole of the luminous spectrum, leaving only the extreme red and infra-red rays. The ultra-red spectrum has been mapped out in this way down to 1 μ, and, in certain circumstances, a little further with some difficulty.—A theorem of J. Clark: Maurice **d'Ocagne.**—The result of the experimental study of a centrifugal ventilator: Henri and Léon **Bochet.** A study of the Capell ventilator, for which an abnormal yield had been claimed by the inventor. The results generally support the inventor's views.—A galvanometer with a movable needle for alternating currents: Henri **Abraham.** The instrument is of the d'Arsonval type, the permanent magnet being replaced by an electromagnet excited by an alternating current of the same frequency. In delicate measurements the best results are obtained by exciting the electromagnet by a small auxiliary transformer. Details are given of the sensibility obtainable.—The spectra of alloys: J. **de Kowalski** and P. B. **Huber.** Copper-magnesium and copper-zinc alloys were studied. By interposing self-induction in the discharge circuit a larger number of lines disappear from the spectrum when the electrodes consist of the pure metal than when an alloy is used. The lines which have disappeared in the spectra of the alloys are the same for the copper-magnesium and the copper-zinc alloys, and belong to copper. The results can be explained by Prof. J. J. Thomson's views, or by supposing that the mean temperature in the oscillating discharge between the electrodes is higher in the case of the alloy than with the pure metal.—The synthesis of $\beta\beta$-dimethyl- and $\beta\beta$-trimethylpimelic acids: G. **Blanc.** The starting point of this synthesis is the anhydride of $\beta\beta$-dimethylglutaric acid. This is reduced by sodium and absolute alcohol to a lactone, and the latter, treated by phosphorus pentabromide and alcohol consecutively, gives the ethyl ester of δ-bromo-$\beta\beta$-dimethylvaleric acid. The condensation of this bromo-compound with the sodium derivative of malonic ester leads to the desired $\beta\beta$-dimethylpimelic acid. The substitution of the sodium derivative of methyl-malonic ester in this condensation gives the trimethylpimelic acid.—The chemical composition of glauconite: Léon W. **Collet** and Gabriel W. **Lee.** The analysis of a fresh sample of glauconite from the collection of Sir John Murray, of the *Challenger* Office, showed that it is a ferric and not a ferrous silicate.—Overlapping strata in Sicily: Maurice **Lugeon** and Émile **Argand.**—The existence of phenomena of drift earlier than the Stephanian in the region of Saint-Etienne: P. **Termier** and G. **Friedel.**

DIARY OF SOCIETIES.

THURSDAY, MAY 17.

ROYAL SOCIETY, at 4.30.—Determinations of Wave-Length from Spectra obtained at the Total Solar Eclipses of 1900, 1901 and 1905: Prof. F. W. Dyson, F.R.S.—Some Stars with Peculiar Spectra: Sir Norman Lockyer, K.C.B., F.R.S., and F. E. Baxandall.—An Apparent Periodicity in the Yield of Wheat for Eastern England, 1885–1905: Dr. W. N. Shaw, F.R.S.—Some Physical Constants of Ammonia: a Study of the Effect of Change of Temperature and Pressure on an Easily Condensible Gas: Dr. E. P. Perman and J. H. Davies.

CHEMICAL SOCIETY, at 8.30.—The Relation between Absorption Spectra and Chemical Constitution, part vi., The Phenyl Hydrazones of Simple Aldehydes and Ketones: E. C. C. Baly and W. B. Tuck.—Aromatic Compounds obtained from the Hydroaromatic Series, part ii., The Action of Phosphorus Pentachloride on Trimethyldihydroresorcin: A. W. Crossley and J. S. Hills.—Studies of Dynamic Isomerism, part v., Isomeric Sulphonic-derivatives of Camphor: T. M. Lowry and E. H. Magson.—Studies on Basic Carbonates, part i., Magnesium Carbonates: W. A. Davis.

ROYAL INSTITUTION, at 5.—The Influence of Ptolemaic Egypt on Græco-Roman Civilisation: Rev. J. P. Mahaffy.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Notes on Overhead Equipment of Tramways: R. N. Tweedy and H. Dudgeon.

FRIDAY, MAY 18.

ROYAL INSTITUTION, at 9.—International Science: Prof. A. Schuster, F.R.S.

SATURDAY, MAY 19.

ROYAL INSTITUTION, at 3.—The Old and New Chemistry: Sir James Dewar, F.R.S.

MONDAY, MAY 21.

ROYAL GEOGRAPHICAL SOCIETY, at 3.—Anniversary Meeting.—(1) Presentation of Medals and Awards; (2) Address by the President; (3) Annual Report and Election of President and Council.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Problem of the Electrochemical Fixation of Nitrogen. Prof. P. A. Guye.

VICTORIA INSTITUTE, at 4.30.—Biblical Astronomy, part ii., The Morning Star: Colonel George MacKinlay.

TUESDAY, MAY 22.

ROYAL INSTITUTION, at 5.—Glands and their Products: Prof. William Stirling.

ANTHROPOLOGICAL INSTITUTE, at 8.15.—(1) Exhibition of Slides of Stone Monuments from India; (2) The "Genna" in Assam: T. C. Hodson.

WEDNESDAY, MAY 23.

SOCIETY OF ARTS, at 8.—The General Supply of Electricity for Power and other Purposes: J. N. Shoolbred.

GEOLOGICAL SOCIETY, at 8.—On the Importance of Halimeda as a Reef-forming Organism, with a Description of the Halimeda-limestones of the New Hebrides: F. Chapman and Douglas Mawson.—Notes on the Genera Omospira, Lophospira, and Turritoma, with Descriptions of New Species: Miss Jane Donald.

THURSDAY, MAY 24.

ROYAL SOCIETY, at 4.30.—Croonian Lecture: On the Presence of Special Excitable Substances in Striated Muscle and in Tissue Cells: Prof. J. N. Langley, F.R.S.

ROYAL INSTITUTION, at 5.—Man and the Glacial Period: Prof. W. J. Sollas, F.R.S.

UNIVERSITY OF LONDON, at 5.—The Atmospheric Circulation and its Relation to Weather: Dr. W. N. Shaw, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Annual General Meeting.—Report of Council and Election of the New Council.

SOCIETY OF ARTS, at 4.30.—The Parsis of Persia: Major P. M. Sykes, C.M.G.

LINNEAN SOCIETY, at 3.—Anniversary Meeting.

FRIDAY, MAY 25.

ROYAL INSTITUTION, at 9.—Compressed Air and its Physiological Effects: Leonard Hill, F.R.S.

PHYSICAL SOCIETY, at 5.—Colour Phenomena in Photometry: J. S. Dow.—Exhibition of an Automatic Arc Lamp: H. Tomlinson and Rev. G. T. Johnston.—The Theory of Moving Coil and other Kinds of Ballistic Galvanometers: Prof. H. A. Wilson, F.R.S.—Exhibition of a Bifilar Galvanometer free from Zero Creep: A. Campbell.

SATURDAY, MAY 26.

ROYAL INSTITUTION, at 3.—The Old and the New Chemistry: Sir James Dewar, F.R.S.

CONTENTS.

PAGE

THURSDAY, MAY 24, 1906.

ADOLF VON BAEYER'S COLLECTED WORKS.

Adolf von Baeyer's gesammelte Werke. Herausgegeben zur Feier des siebzigsten Geburtstages des Autors von seinen Schülern und Freunden. Erster Band, pp. cxxxii+990. Zweiter Band, pp. 1194. (Brunswick: F. Vieweg und Sohn, 1905.)

AS we examine these two splendid volumes we cannot but feel that no better way of commemorating the seventieth birthday of Adolf von Baeyer could possibly have been found than that of collecting together his researches and publishing them so that they might be studied in their entirety by all students of chemistry.

The publication of the complete researches of an investigator who has had a profound influence on the scientific thought of his time has much to recommend it, since the collected works form not only a memorial to the investigator, but also enable others to gain an insight into the train of thought which preceded the gradual development of each important discovery.

The present volumes have, moreover, a special interest since they have been produced under the personal supervision of Baeyer himself, with the result that the vast amount of work which he has accumulated during the fifty years of his active life is arranged in the manner which he himself wished and thought most suitable.

These volumes contain as frontispiece a strikingly lifelike portrait of Baeyer. The introduction contains a most interesting sketch of Baeyer's life (1835–1905) from his own pen, which enables the reader to form a very vivid idea of the difficulties Baeyer had to encounter in the earlier days of his scientific career. Not only were the schools of chemistry which existed at that time few in number and the appliances even in the best of them only of a very elementary kind, but research in organic chemistry was still quite in its infancy, and therefore every new development was of the nature of pioneer work.

Although in his grandfather's house Baeyer was in his early years brought into contact with Paul Heyse, Geibel, Fontane, and other literary giants of the time, he showed no inclination towards literature, and soon began to develop a love for science by taking a keen interest in chemistry, botany, physics, and mathematics.

In 1856 he decided to devote himself seriously to chemistry, and became a student in Bunsen's laboratory at Heidelberg at a time when Roscoe, Pebal, Lieben, Beilstein, Lothar Meyer, and others were working in the laboratory, and when Bunsen's reputation as a teacher and investigator was at its highest. His first original investigation was a continuation of the work of Bunsen and Roscoe on the combination of hydrogen and chlorine, and this, as well as his next research, on methyl chloride, were suggested by Bunsen. After this Baeyer worked entirely on his own initiative, and gradually laid the foundations upon which the great edifice of his life-work was subsequently raised.

The papers collected together in the two volumes before us have been grouped by Baeyer under the following headings: (1) The organic arsenic compounds; (2) the uric acid group; (3) indigo; (4) papers arising from the researches on indigo; (5) pyrrol and pyridine bases; (6) experiments on the elimination of water and on condensation; (7) the phthaleins; (8) the chemistry of the hydroaromatic compounds; (9) the terpenes; (10) nitroso-compounds; (11) furfurol; (12) acetylene compounds and the "Spannung's Theorie"; (13) peroxides; (14) the basic properties of oxygen; (15) dibenzalacetone and triphenylmethane; (16) various researches in the aromatic series; (17) various researches in the aliphatic series; (18) nomenclature; (19) diversa.

The titles alone will serve to convey some idea of the immense range of subjects which have claimed the attention of Baeyer, and as we study each of these sections we meet always the same characteristics—great skill in overcoming experimental difficulties (often necessitating the working out of entirely new methods of attack), and great ability in deducing the correct theoretical explanation from the results of experiment.

Within the necessarily limited space of this review it is, of course, impossible to discuss in any detail even the most far-reaching of Baeyer's discoveries or to attempt to follow their historical development.

Attention may, however, be briefly directed to some characteristics of Baeyer's work which will probably strike the reader most as he studies the successive sections into which these researches are divided.

The researches on uric acid, which date from 1860, are marvels of experimental skill, including, as they do, the discovery and characterisation of barbituric acid, violuric acid, and many other new members of this important group, and this at a time when the structure and relationship of the more important members of this section of organic chemistry were little understood. Baeyer was naturally interested in the problem of the synthesis of uric acid, and in 1863 he endeavoured to accomplish this by combining uramil with potassium cyanate, when he obtained pseudo-uric acid, an acid which contains one molecule of water more than uric acid itself. The synthesis was completed in 1895, when E. Fischer and L. Ach showed that pseudo-uric acid is converted into uric acid when it is melted with anhydrous oxalic acid.

Of great interest, not only from a purely scientific, but also from the commercial point of view, are the sections on the phthaleins and on indigo. The researches on the phthaleins must have required exceptional skill, ingenuity and patience, because it must be remembered that this work was absolutely new, and, moreover, the substances belonging to this class are, at the present day, some of the most difficult to deal with experimentally.

The well-known papers on indigo should be read in connection with a most interesting sketch of their historical development (p. xxxviii) which Baeyer himself has contributed.

The labour entailed in carrying out these researches must have been very great, and it is instructive to read that, after a certain time, Baeyer became so wearied with indigo that he was quite unable to continue experimenting on the subject, and had to allow the various problems connected with the commercial development of his discoveries to pass into other hands. In search of fresh fields for investigation, Baeyer commenced an inquiry with the object of discovering whether carbon atoms, uncombined with hydrogen, are capable of uniting to form long chains, and, in order to determine this, he synthesised a number of poly-acetylene compounds, including tetracetylenedicarboxylic acid

$$CO_2H.C\equiv C-C\equiv C-C\equiv C-C\equiv C.CO_2H.$$

This remarkable acid is quite colourless, but is readily blackened by the action of light, and compounds of this type were found to be so explosive that their further investigation had to be abandoned. One of the fruits of the consideration of the properties of these compounds was the enunciation of the well-known "Spannung's Theorie," which has given rise to so much discussion, and proved to be of such value in suggesting new lines for experimental inquiry.

Section viii., which Baeyer has placed directly after the phthaleins, deals with the chemistry of the hydroaromatic compounds and the constitution of benzol. These researches date from the year 1866 when, in conjunction with Graebe, Born, Mohs and others, he first investigated the behaviour of phthalic acid and terephthalic acid towards sodium amalgam.

Baeyer repeatedly returned to this subject in later years, but it was not until 1888 that the epoch-making series of papers "Ueber die Constitution des Benzols" began with the exhaustive study of the products which are formed when terephthalic acid is reduced with sodium amalgam. These researches on the reduction products of the phthalic acids and of benzene itself are well known, but they have perhaps hardly received the close attention which they merit, owing partly, no doubt, to their difficult and intricate nature. The careful study of these papers will, however, more than repay the time spent, and to the young investigator they may well serve as an example of the patience and endurance which he must be prepared to face if he wishes to attempt the solution of a problem of really first-rate importance.

It is perhaps a consequence of the study of these artificially prepared reduction derivatives of benzene that Baeyer was led to investigate that wonderful series of naturally occurring reduced benzene derivatives—the terpenes the constitution of which has offered one of the most difficult problems to the modern organic chemist. During the course of his experiments on the oxidation of substances which, like the terpenes, contain unsaturated closed chains, Baeyer commenced to experiment with Caro's acid, and, among many other interesting results, showed that this acid was a most valuable reagent for the conversion of ketones into lactones. Further experiments resulted in the discovery of the remarkable series of peroxidised substances of which benzoylhyperoxide and diethylperoxide may be taken as types, and led to a development of Collie and Tickle's important work on the tetravalent nature of oxygen and the oxonium theory.

Baeyer's latest publications deal with the vexed question of the relation of colour to constitution, and are concerned especially with the reason for the coloured nature of certain salts derived from dibenzalacetone and from triphenylcarbinol. One of the most remarkable results of this investigation is the proof that the coloured salts of triphenylcarbinol are in reality esters possessing the properties of salts, and that they cannot be regarded as quinoid compounds.

Baeyer is, at the present time, occupied with the further development of this important matter.

It is impossible to close the volumes before us without marvelling at the immense amount of work which it is possible for one man to carry out, and without a deep impression of the enormous influence which the work of Baeyer has had on the development of modern chemistry. The list of papers published from Baeyer's laboratory occupies no less than sixty-three pages of closely-printed matter, and when we look at the names attached to these papers we are able to form some idea of the magnitude of the school which he has founded, and of the extent to which many of the greatest chemists of the day owe their training in research to Baeyer.

W. H. Perkin, Jun.

A STANDARD TREATISE ON ELASTICITY.

A Treatise on the Mathematical Theory of Elasticity. By A. E. H. Love. Second edition. Pp. xviii+552. (Cambridge: University Press, 1906.) Price 18s. net.

INSTEAD of merely revising his former treatise, Prof. Love has written a new one; the result is that we have two works by the same author, in some ways contrasting, in others complementary. And as in the similar cases of Maxwell's "Electricity," and Thomson and Tait's "Natural Philosophy," the prudent will buy the new book without parting with the old.

Naturally one feature in the new edition is the inclusion of important or interesting results obtained since the appearance of the earlier one. In some branches of mathematics the proportion of English workers is distressingly small; but in elasticity this is happily not the case, and the recent researches of Michell, Filon, Dougall, and others, besides those of veterans that need not be named, receive in these pages their due recognition. So also do those of their Continental *confrères*, more particularly Voigt; but it is hard to avoid the impression that the deaths of Kirchhoff and Hertz have left vacancies which have yet to be worthily filled.

It is interesting to compare the historical introduction in its old form with its successor. The former was in some places controversial, and the author seems to have thought some of the statements too dogmatic, at any rate in form. However this may be, the new introduction is strictly impersonal, and shows clearly enough how recent physical theories and discoveries affect the subject of elasticity. A great deal of the polemic about the number of elastic constants was as illogical as the quarrel about *vis viva*. As an abstract mathematical theory, the 21-constant hypothesis is as legitimate as its rival and conversely; the question that interests physicists is which of the two, if either, best corresponds to the properties of elastic bodies. Saint-Venant rightly argued that this could not be settled *a priori*, but only by experiment; and at the present day his justification on this point is complete, although he was led to adopt the rari-constant theory by relying upon inconclusive experiments. As Prof. Love points out (pp. 14, 15) our views of the ultimate structure of matter are being profoundly modified, and until they are cleared up it is premature to propose an "atomic" theory of elasticity. Meanwhile we can make a working hypothesis by assuming the existence of a strain-energy-function which is a quadratic function of the components of strain. In all probability the ultimate theory, if we could only reach it, is kinematical; the stresses set up in a strained body being an aspect of a new distribution of kinetic energy in space.

The results of the theory, as applied to the arts, are, of necessity, only approximate; and great care must be taken to see that, when an approximate solution has been obtained, it is really applicable to the concrete case. An excellent example is given on p. 140, relating to a sphere strained by its own gravitation. If we put in the numerical values of g, r_0, ρ, and any reasonable values for λ, μ, when the sphere in question is the earth, we find that the condition that U/r should be small for $r_0 > r > 0$ cannot be satisfied, although this is one of the assumptions on which U has been calculated. This point was brought out in the previous edition (i. 220); it is a pity that this warning has been suppressed, though another, equally instructive, has been given.

Again, take the condition (or conditions) for rupture taking place (pp. 117 *sqq.*). This cannot be given by the ordinary theory, which is only applicable when the elastic limit is not exceeded. Nevertheless, attempts have been made to express the condition in terms of the components of stress. This is entirely illogical, and hence, as usual, a contest between rival formulæ. It may, of course, happen that one formula, as against the other, may have a wider range of applicability; but it ought to be treated as purely empirical, and not rashly applied to untested cases. On this point the author might have been more dogmatic than he is.

A very interesting section is that on the deformation of plates. This is a famous problem, historically, and even lately gave rise to a controversy, now satisfactorily settled. To get a reasonably simple approximate solution some kinematical assumption must be made, and this must be compatible with the boundary conditions. Prof. Love pointed out that, strictly speaking, a vibrating plate with free edges cannot satisfy the condition that the middle surface is unstretched; Mr. Basset and Prof. Lamb showed that the boundary condition could be satisfied without supposing any considerable stretching except near the edge. An interesting statical illustration due to Lamb is given on p. 521. On p. 506 Prof. Love obtains, by a method of his own, second approximations for stress and strain in a curved shell, agreeing to that order with results of Mr. Basset's.

In this, as in other parts of the book, the analysis is very elegant, and is given in sufficient detail for really competent readers to follow. But the author follows the general tendency now in vogue, of suppressing details of calculation, and emphasising results of practical value, rather than examples of mainly æsthetic interest. In his preface he expresses a hope that his book will be useful to engineers; how far they do so depends, of course, upon them as well as upon him. They will find among the subjects treated the buckling of plates, the collapse of boiler-flues, the whirling of shafts, the stability of slender columns, and other such things; it is to be hoped that they will also appreciate the general theory, as the author presents it. Every student, not an expert, should follow the advice given in the preface of proceeding to chapter v. as soon as possible.

It is a great advantage that the author of this book is a mathematician of wide as well as accurate attainments. As an illustration, it will be enough to refer to p. 306, dealing with the torsion of a rectangular prism; it is at once clear that the author's knowledge of Fourier expansions is quite different from that of the average physicist. Similar examples of rigour free from pedantry may be found throughout the volume.

At the end of the introduction occurs the sentence: "Most of the men by whose researches it [the mathematical theory of elasticity] has been founded and shaped have been more interested in Natural Philosophy than in material progress, in trying to understand the world than in trying to make it more comfortable." It may be added that most of the comfort we enjoy, and most of our civilisation that is worthy of the name, is due to men who have endured discomfort, in pursuance of ideal ends. Apart from the poets and the philosophers, where should we be?

G. B. M.

PROTEID CHEMISTRY.

Chemistry of the Proteids. By Dr. Gustav Mann. Based on Prof. Otto Cohnheim's "Chemie der Eiweisskörper." Pp. xviii+606. (London: Macmillan and Co., Ltd.; New York: The Macmillan Co., 1906.) Price 15*s*. net.

DR. GUSTAV MANN started this work with the modest idea of producing an English translation of Prof. O. Cohnheim's well-known monograph on the chemistry of the albuminous substances. But it has developed into a volume of a much more ambitious nature, and has culminated in a book twice the size of that on which it is founded. The subject in many parts is treated much more fully, and a good deal of new matter introduced. In many places, moreover, Cohnheim's own views are adversely criticised, so that the present volume bears witness to the originality of the English author.

Those who know Dr. Mann best as a histologist may be surprised that he should have the necessary knowledge to write on a subject at first sight so far removed from the microscope. His previous book on Physiological Histology has, however, shown the connection between the two. The fixing action of preservatives on tissues, the staining reactions of cells and nuclei, are ultimately chemical in nature, and much of macro-chemistry can be learnt from micro-chemistry. Dr. Mann's sympathies are mainly physiological, not anatomical. Physical chemistry also is more than a hobby with him, and the sections relating to speculations of a physico-chemical nature form pleasant oases in what as a rule is rather solid reading. His histological proclivities have led him in some cases to devote a good deal of space to subjects which some might regard as of secondary importance —for instance, his lengthy description of the interactions of proteids with mercury compounds evidently springs from the extensive use he has made of corrosive sublimate as a fixative.

Cohnheim's book in the original state cannot be described as an ideal one. It lacks the imaginative faculty, and reflects the stolid, plodding German worker, anxious to omit no reference to literature that can possibly be dragged into a footnote. To some investigators this is of course advantageous; they will profit by the diligence of the author, and easily be able to consult the memoirs quoted in reference to any special point they are interested in. But to the student who desires to obtain a general insight and a wide outlook on the general relationships of the subject, this compression of material is a distinct hindrance; he will be apt to lose sight of the wood on account of the trees.

Dr. Mann follows on very much the same lines, and though it is impossible to restrain one's admiration for his labours in hunting up literature, quoting authorities as far back and as far forward as possible, one cannot but regret that the text does not as a consequence run easily, and most of it will form stiff reading even for advanced students. In some places the pages abound with chemical formulæ without a sufficient guidance in words. Here, again, anyone but an accomplished organic chemist will have difficulty in finding his way along.

Dr. Mann also has certain mannerisms of style, but one does not complain of these unduly, for they stamp the pages with the author's individuality; but there is one of these faults which many will find annoying and even confusing, and that is a looseness and inexactitude in the use of terms. For instance, on the title-page we find the word "proteid" used as a general expression for all the albuminous substances; within the pages of the book "proteid" is employed only for a certain group of these materials. Albumin also is sometimes used as a generic term, and at other times applied to a specific group; sometimes it is used as opposed to globulin, sometimes it includes the globulins, and sometimes it includes everything. In one place we read that lactalbumin is one of the few true albumins; on another page it is alluded to as a hypothetical substance. The author has dedicated his work to his father, and in the dedication tells us something of his father's life-work. It would be interesting to know something more about his ancestry—whether, for instance, he has any Irish blood in him. The use of the expressions "true pseudo-acid" and "true pseudo-base" is distinctly Hibernian.

The same kind of carelessness is shown in the spelling. Albumin is sometimes spelt with an *i*, sometimes with an *e*. The nomenclature committee of the Chemical Society tried to introduce uniformity into spelling, and assigned certain meanings to certain terminations. A word ending in *ine*, for instance, means an alkaloidal material; a word ending in *in* does not; similarly, the terminations *ol* and *ole* have a distinct chemical significance. But Dr. Mann has paid no attention to such rules. "Vitellin," for example, is sometimes spelt with, sometimes without, a final *e*. "Gelatine" and "cholin" are spelt as just printed in direct contravention of the rules of the Chemical Society. The names of investigators are also often mis-spelt; Waymouth Reid, Curtius, Claude Bernard, and Lane-Claypon are among the sufferers.

The whole question of nomenclature in chemistry is very difficult, especially in translations. It is hopeless to try to reconcile English with German usages, but there ought to be an attempt on the part of English writers to adopt some sort of uniformity. This difficulty is accentuated in relation to proteid nomenclature, and one can only hope that the joint committee of the Physiological and Chemical Societies now sitting on this very subject may put forward some practicable suggestions. Dr. Mann is therefore not wholly to blame for his misdeeds.

In spite of the blemishes to which I have devoted so much space, I believe the book will have a useful career in front of it. Its many excellences can be discovered by reading it and using it, and Dr. Mann is to be congratulated in having produced such a valuable addition to scientific literature.

W. D. H.

STATISTICAL SEISMOLOGY.

Les tremblements de terre. Géographie Séismologique. By Comte F. de Montessus de Ballore; with a preface by Prof. A. de Lapparent. Pp. v+475. (Paris: Armand Colin, 1906.) Price 12 francs.

WITH the growth of their science seismologists have become more and more specialised, and devoted themselves to the cultivation of a limited portion of their domain, but none have marked out for themselves a more clearly defined plot, or cultivated it with greater assiduity, than the Comte de Montessus de Ballore. Leaving to others the study of the nature and effect of earthquakes, he has confined himself to the consideration of their cause, and attacked the problem by the statistical way, believing that a detailed study of the distribution of earthquakes in time and space will most conclusively indicate their cause. By no means the first cataloguer of earthquakes in point of time, for the great lists of Mallet and Perrey are well known, to say nothing of the numerous local catalogues compiled by others, our author stands preeminent in the number of earthquakes which he has tabulated, and the work before us deals with the records of 171,434 distinct shocks. The labour involved in this compilation would have formed no light task for any man, and when we remember that, besides being a specialist in seismological statistics, the author is an officer on the active list of the French Army, the result seems almost miraculous.

In summing up the results of all this compilation the author holds that he has conclusively established the independence of earthquakes and volcanoes, and the greater prevalence of the former along those tracts where the surface relief shows the steepest and longest gradients. Both these conclusions had been reached by Prof. Milne while working in Japan, and the second of them is only an empirical, and not invariable, way of expressing the general principle that earthquakes are most abundant where the crust-movements have been greatest and most recent, while they become rarer as these movements are older and have more or less completely died out; but we must remark that earthquakes seem to be more particularly associated with the changes resulting from, or accompanied by, compression, for the dropped valleys of the Jordan, the Red Sea, and of Central Africa are not specially affected by earthquakes.

Comte de Montessus attempts to carry his conclusions still further, and finds that earthquakes are almost confined to certain bands which correspond with the secondary geosynclinals of Haug, and are said to lie along two great circles, making an angle of 67° with each other. We have had the curiosity to plot these bands, as shown on the map accompanying the book, upon a globe, and have failed to find any correspondence between them and the great circles as defined, or, indeed, with any other great circles; approximately, they seem to form a network of arcs of great circles, joining up in groups of three and four, an interpretation which is more probable than the other, though the departures in detail render the correctness of either view doubtful. However this may be, the fact remains that nine-tenths of the shocks recorded have originated in regions which cannot cover more than one or two per cent. of the globe and are almost all distributed along certain lines, of which the most important are the great girdle of the Pacific, the line which runs up from the Sunda Islands, through Arracan, the Himalayas, Caucasus, and Alps to the western Mediterranean, and another which runs up from the Caucasus through the mountains of Central Asia to Lake Baikal, possibly continuing to somewhere in the neighbourhood of the Bering Straits.

Though, in the main, the distribution of the more violently shaken regions shows no change from that drawn by Mallet in 1858, there is a radical difference in the character of the two maps. In Mallet's the frequency of earthquakes was indicated by the depth of tint, and the dark patches shaded off gradually into the white; de Montessus, believing that it is a mistake to treat an essentially discontinuous phenomenon as a continuous one, has made the limited areas, where destructive earthquakes are known to originate, black, and left the rest of the map blank. This abrupt boundary between the regions classed as seismic and the much more extensive ones classed as peneseismic or aseismic, is held to be a better representation of what is actually the case than any gradual shading of the one into the other. The difference between the two maps is, in fact, one of principle; Mallet's was meant to indicate the frequency with which earthquakes were felt, that of de Montessus the frequency with which they originate. Each of these facts is interesting in itself, but their delineation must necessarily differ, apart from any question of increasing perfection of the data.

We have indicated some of the conclusions drawn in this book, which do not seem to be so fully established as its author suggests, but this must not be taken in derogation of the value of his work in statistical seismology. We welcome this summary of his researches, and regret that he should have followed the custom, so common in France, of omitting a subject index.

OUR BOOK SHELF.

Notes on Shipbuilding and Nautical Terms of Old in the North. By E. Magnusson. Pp. 62. (London: A. Moring, Limited, 1906.) Price 1s. net.

THIS small volume reproduces a paper read before the Viking Club Society, and its appearance will be welcomed by all who are interested in the history and development of shipbuilding. Although it deals chiefly with Scandinavian records and discoveries, it contains an excellent summary of Greek and Latin references to ancient ships, and does not leave unnoticed much older Egyptian types. In short it is a scholarly performance, and the writer has a full appreciation of technical developments which have accompanied progress in shipbuilding. Wide reading and research must have been undertaken to provide the materials; they have been dealt with in a terse but clear style, and the result is of permanent value as a book of reference and a bibliography of the subject. An excellent glossarial index is appended. The only regret one feels is that there are no illustrations. The rock-carvings of ancient ships found in Egypt, Sweden, and Norway are described and compared; but simple illustrations would have emphasised the deductions made by the author. Again, the details of methods of construction which Mr. Magnusson gives are readily understood by experts in shipbuilding, but would be grasped by general readers also if diagrams of a simple nature had been given. The ancient ships found in Scandinavia and preserved in museums might also have been pictured with great advantage. Of course size and cost would be increased if this were done, but that action is well worth the consideration of both author and publisher, as the permanent value of the book would be greatly increased thereby, and its place in the libraries of all interested in shipbuilding would be assured.

A book so condensed in form and substance must be read to be understood. Mr. Magnusson does not claim originality in discovery or treatment. He starts with the log and raft of the stone age, passes to the canoe hollowed from a single log by the use of fire and flint implements; traces the development of the coracle and other hide-covered vessels, with internal framework; shows how these "skins" were replaced by wood planks, first fastened by thongs or withes, and later on by iron nails; and so he arrives at methods of building which persisted, with trifling variations, until wood gave place to iron in the last century. As regards propulsion a similar advance is traced from the single oar, to the rowing boat, and the galley with its banks of oars, coming at last to the use of masts and sails, as navigation took a wider and over-sea range. The special provisions made in vessels used for purposes of war are described, including that most ancient method of attack—the ram-bow. Altogether the book is an excellent piece of work.

W. H. W.

A First German Course for Science Students. By Prof. H. G. Fiedler and F. E. Sandbach. Pp. x+99. (London: A. Moring, Ltd., 1906.) Price 2*s.* 6*d.* net.

It is essential that students who intend to devote serious attention to science should be able to read scientific works in French and German, and, if possible, also in Italian. By the use of the present book a working knowledge of the German language can be obtained through lessons based upon work in elementary physics and chemistry. The book consists of a series of reading lessons describing simple experiments and principles such as are included in the rudimentary courses of schools. The words and phrases used in the various reading-passages are graded in such a way that the principal rules and grammatical forms are illustrated by the text. A short outline of grammar essential for the purpose in view follows the series of lessons, and there is a full vocabulary.

The book is printed in English characters, but the text and illustrations have a decidedly German appearance, as is appropriate in this case. Though the course covered by the lessons is similar in substance to that taken as introductory science in many schools, no doubt most teachers will prefer to follow English text-books for the actual work of the class-room and laboratory, and to use this book as an auxiliary aid or an incentive to the study of German. For pupils who are familiar with the experiments described, the book will be found very useful, and it will make them acquainted with the German equivalent of many technical terms not to be found in the ordinary reading books of the language. As an attempt to coordinate the teaching of modern languages and science, it will no doubt be appreciated, and for the finer feeling of literature pupils may still read extracts from the works of standard authors.

Personal Hygiene Designed for Undergraduates. By Dr. A. A. Woodhall. Pp. vii+221. (London: Chapman and Hall, Ltd., 1906; New York: John Wiley and Sons.) Price 4*s.* 6*d.* net.

Personal hygiene is an important branch of hygiene which does not receive its full measure of treatment in any text-book, but this small work does not pretend to offer to its readers more than a clear and elementary statement upon the hygienic needs of the body. It is intended for undergraduate students, and it consists of the substance of lectures upon personal hygiene delivered by the author during the past few years. Exercise, food, clothing, habits, and similar matters of daily individual concern, are here dealt with in language as free from technical terms as possible. We are told in the preface that the constant aim of the writer has been to present actual conditions in the simplest language, and it must be said that he has achieved this object. We may add that the work is free from "Americanisms"—either of wording or spelling.

Only such elementary facts of anatomy and physiology as are necessary to the reasonable understanding of the subject are introduced, and some hints as to "first aid" are here and there given in the text, but this subject is otherwise omitted.

The chapters on alcohol, tobacco, and exercise are particularly good. They are discussed in tolerant language and with much sound common-sense. After reading the following opinion (p. 157) the reader will think twice before he refuses an offer of confectionery. "Where the taste has not been vitiated, in a degree by tobacco but chiefly by alcohol, sugar is as acceptable to the normal civilised man as it is to savages, and his disposition toward candy is no bad test of his drinking habits."

The following criticism of our national game of cricket will scarcely meet with approval in this country:—"Cricket, an exotic that has never taken wide root on our soil, lacks many of the qualities of a good game, chiefly because of the long waits before going to the bat and the limited number actively engaged." But though the author does not write in his usually well-informed manner upon this particular item, the following statement (p. 88) will serve to acquit him of the charge of bias towards *every thing* American:—"The misnamed nasal twang with which some Americans are justly charged is due partly to chronic catarrh, blocking the nasal passages, and partly to that curious and unconscious imitation by which in youth we acquire the tone most commonly heard. Unfortunately, as a people all our voices are too sharp and rasping. . . . We are so accustomed to strident voices that we fail to recognise their inherent infirmity."

Life and Matter. A Criticism of Prof. Haeckel's "Riddle of the Universe." By Sir Oliver Lodge. Pp. ix+200. (London: Williams and Norgate, 1905.) Price 2*s.* 6*d.* net.

It is difficult to pardon Prof. Haeckel for his dogmatism and his over-statements, and no less for his having furnished the peg on which have been hung many dull books and reviews. Forgiveness becomes easier when his work evokes a first-rate criticism like that in the volume before us. Sir Oliver Lodge contests chiefly (*a*) the right by which the name of Monism is arrogated to the Haeckelian philosophy; (*b*) Haeckel's statement of the "Law of Substance," the true account of which, according to the critic, is that "anything which actually exists must be in some way or other perpetual"; (*c*) Haeckel's account of the development of life, and particularly the theory which endows the atoms of matter with life, will and consciousness.

The later chapters of the book state with great clearness Sir Oliver Lodge's own constructive views. He regards it as possible that life is a basal form of existence, as fundamental an entity as matter and energy. "It can neither generate nor directly exert force, yet it can cause matter to exert force on matter, and so can exercise guidance and control." His view occupies a middle position between the so-called monistic one and that, for example, of Prof. James Ward, who argues that the laws of physics are only approximate and untrustworthy.

The author, who understands well that effective illustration is half the difficulty, and that the "analogy of experience" is one of the soundest of philosophic principles, develops a fascinating comparison between life and magnetism. If we understand his views aright they imply that possibly mind can exist apart from terrestrial brains, and life apart from living creatures or plants as we know them—that is, that the phenomena of life and consciousness which surround us are due to the interaction of something material and something spiritual, or (to express it otherwise) to the fact that something spiritual uses the material as its instrument or organ. This seems to imply a dualism, but he also holds it possible that "there may be some intimate and necessary connection between a generalised form of matter and some lofty variety of mind."

The arrangement of the various topics is not always the best possible. This is partly caused by the inclusion of reprints from well-known journals—a practice which is open to criticism. But apart from these slight defects the book deserves hearty commendation.

The Fox. By T. F. Dale. (Fur, Feather, and Fin Series.) Pp. xiii+238; illustrated. (London: Longmans, Green and Co., 1906.) Price 5s.

"THE fox," writes the author in his opening paragraph, "is at home in Europe, Asia, including India, a great part of Africa, the whole of North America, and a distinct but allied species, *Canis virginianus*—known as the grey fox in the United States—is found in South America." If he had tried to compress as many errors as possible into a single sentence, he could scarcely have succeeded better. The fox is unknown in India proper, it inhabits only the northern fringe of Africa, and the grey fox (*Urocyon cinereo-argenteus*) is a native of North and not of South America. This is one of those numerous instances where authors of works on popular natural history will go out of their way to refer to subjects which they do not understand, and which do not concern them. Had Mr. Dale kept within his proper limits, we should have had nothing but commendation to bestow upon his work, in which the fox is discussed from the point of view of the sportsman and the farmer in a very thorough manner. The eight illustrations by Messrs. Thorburn and Giles are all that can be desired, although one of them follows somewhat closely on the lines of a well-known sketch by the late Mr. Wolf.

R. L.

Oologia universalis palæarctica. By Georg Kause. Part i. (Stuttgart: Fritz Lehmann, Verlag; London: Williams and Norgate.)

THIS is the first part of a beautiful egg book, printed entirely on separate sheets of cardboard, two sheets being devoted to each species—one of coloured figures of the eggs, the other of letterpress, backed with references to the specimens figured. The text is in German and English, and comprises a large number of synonyms and local names, and a short description of the range of the bird, its breeding habits, nest, eggs, &c. The four species treated of in the first part are the golden eagle, quail, song thrush, and raven, as many as sixteen (odd) eggs of the last-named bird (from different localities) being figured. In the case of the song thrush we have five "clutches," and in that of the golden eagle a clutch of two eggs and three single ones. The colour printing has been very successful, and admirers of eggs will welcome the excellent selection of varieties which has been figured, of each of which the "data" are given. We cannot extend the same praise to the English version of the letterpress, which is crude, too literal, and disfigured by unfamiliar words and expressions. However, it is possible to understand what is meant, although the remark on the quail that "the ♀ only breeds, the male is polygamons," reads strangely until we substitute broods for breeds and correct the misprint.

The work is to be complete in 150 parts, and Messrs. Williams and Norgate point out that on the publication of Part ii. the price per part will be raised from fifteen to eighteen pence.

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.]*

Osmotic Pressure.

IN the concluding sentence of his most interesting letter on this subject in your issue of May 17 (p. 54) Mr. Whetham states that "The theory of ionic dissociation rests upon electrical evidence, and by such evidence it must be tried." It is unnecessary to dwell on the importance of the pronouncement.

Will Mr. Whetham kindly tell us *how* we *know* all the things which—in the final paragraph of his letter—he so confidently asserts that we know; in fact, what *precisely* the *electrical evidence* is upon which the theory of ionic dissociation *now rests*. He is a recognised master of lucid exposition and will be able, I am sure, as counsel of the whilom advocates of the doctrine of molecular suicide in solution, to state the case fully and fairly on their behalf. When we have this statement it will perhaps be possible to consider the validity of his modest contention and whether electricians alone have the right to pronounce judgment. A plaintiff is usually sure of his case before his cross-examination takes place.

This request is preferred in no adverse i(r)onical spirit, simply because I feel that it really is necessary that we should be informed where we are exactly. Our friends the ionic dissociationists are incorrigible squatters and seem to think that they have acquired the right of preemption over their adversaries' property; it is difficult to know, as they object to stock-taking, whether they have given anything in exchange for that they have lifted and what they have jettisoned of their original property; and until the electricians' title-deeds are shown and submitted to careful scrutiny, chemists can scarcely be expected to admit that they are ousted from possession.

As a chemist and a friend of the poor molecules, I feel that the aspersion of immorality should not be allowed to rest upon them for ever unless the evidence be really condemnatory beyond question. In any case, it is important that we should discover the true nature of the crime committed in solution; to cloak the inquiry by restricting it to thermodynamic reasoning—a favourite manœuvre of the mathematically minded—is akin to using court influence in abrogation of full and complete investigation; such a course may satisfy the physicist but is repulsive to the chemist, who, although able, perhaps, to imagine the existence of a frictionless piston, yet desires, in the first place, to get nearer to a knowledge of what happens to the real tangible piston of practice.

HENRY E. ARMSTRONG.

MR. WHETHAM'S letter in NATURE of May 17 (p. 54) raises clearly the whole question of the applicability of thermodynamic reasoning to osmotic phenomena. As my views as to the value of thermodynamic reasoning appear to be somewhat heterodox, may I indicate some criticisms of his remarks?

All thermodynamic proofs assume the truth of the "second law." Now the machinations of Maxwell's demon have shown clearly that the meaning of this law, when interpreted in terms of the molecular theory, is merely that, in the processes considered, no differential treatment is applied to the molecules in virtue of their different velocities. The law may or may not be true in any particular case. It cannot be said that there is any *a priori* support for it, or that a proof of its validity for one small branch of phenomena would justify its application to a totally different branch.

In all treatises with which I am acquainted, when the law has been stated, the only reasons alleged for believing it to be true are those derived from our inability to construct a heat engine which will work without equalising temperature. A few pages, before or after, will be found the statement that we cannot construct a reversible heat engine; but it is not pointed out that the irreversibility of all actual engines would mask the effect of a violation of the second law, unless that violation were very complete and the separation of the molecules into high and low velocity groups very nearly perfect. A demon might be slaving with the most commendable energy, but all his exertions would be rendered inoperative by the imperfections of our apparatus. To my mind, the evidence for the second law, even applied to the best actual heat engines, is extremely slight.

But even if the evidence were overwhelming, there would be no justification for applying the law to a process of such an entirely different nature as osmosis, where, moreover, there is some presumption that it is not true. No actual membrane is perfectly semi-permeable; some molecules of the solute pass through; it is not wildly improbable that these molecules possess velocities within some narrow range. But if this is so, Maxwell's demon is at work, the second law is not applicable, and thermodynamic reasoning is absurd. Definite experimental proof must be offered before the validity of the law for osmosis can be considered even probable. Some progress might be made by examining the same membrane at different temperatures; if its "degree of imperfection" did not vary rapidly with the temperature, the existence of such a separation as has been suggested would be rendered less probable.

Mr. Whetham has offered some proof already. He points out that there are five assumptions involved, and asserts that the truth of all of them is proved by the agreement between theory and experiment. But he ignores the possibility that two or more of the assumptions may be incorrect and that the errors thus introduced may cancel each other. He offers a particular solution of an equation containing five variables, and assumes that it is the only solution possible.

It must be remembered that there is not perfect agreement between theory and experiment. The errors are larger than those involved in the direct measurement of the pressure and the other quantities involved; there is a systematic error. But this is due, say the thermodynamicists, to the imperfection of the membrane. Exactly so; but that imperfection may invalidate the whole proof; in order to support their proof they may be denying one of their fundamental assumptions.

Mr. Whetham says that to reject the theory because there is no perfect membrane would be as absurd as to reject all thermodynamics because there is no reversible engine. I agree; but then I am such a heretic that I reject both. Our inability to construct a perfectly reversible engine is connected with the impossibility of handling individual molecules; friction and the rest would vanish if we could replace the material cylinder by a swarm of trained demons. When we have constructed a perfectly reversible engine we shall be possessed of the powers of those demons, and we shall be no longer bound by the second law, which merely asserts that we do not possess those powers. So far as physicists are concerned, reversible thermodynamics *is* "a vain thing."

Neither am I convinced of the perfection of Mr. Whetham's two perfect membranes. They are doubtless perfect so far as the solute is concerned, but his assumption (2) may be violated by the molecules of the solvent. It is quite possible that it is the swifter molecules which escape in the vapour and the slower which escape into the solid, and that, if our experimental devices were sufficiently delicate, we could use the separation thus effected to perform useful work. At any rate, proof is required to the contrary before thermodynamic deductions can be made with accuracy.

So far as I can see, thermodynamic reasoning applied to osmotic phenomena, as to most others, proves nothing but that the sum of the errors introduced by the various rather doubtful assumptions is not very different from zero —a result that does not seem to me worth the labour that has been expended in obtaining it.

NORMAN R. CAMPBELL.

Trinity College, Cambridge, May 20.

The Oscillation of Flame Cones.

PROF. GALLOWAY (NATURE, April 19, p. 584) considers that my explanation of the phenomenon described by Mr. Temple in his letter (March 29, p. 512) is inadequate, and he offers a different explanation. With the view of deciding the question some experiments have been made here by Mr. C. E. Whiteley. I may perhaps repeat that the phenomenon in question is the continued descent and re-ascent of the inner cone of a coal-gas and air flame when a suitable mixture of the two is ignited at the end of a glass tube fixed so as to form a prolongation of the metal tube of a Bunsen burner.

The following results were obtained by Mr. Whiteley:—(1) The continued oscillation of the inner cone could not be established with a forced supply of both gas and air, but only when the air was sucked in by the injector action of a gas jet, as in the ordinary Bunsen burner. (Mr. Temple informs me that this was also his method of working.) (2) The continued oscillation of the inner cone could be maintained when the apparatus was tilted even to horizontality or beyond. (3) When the inner cone began to descend a back pressure was immediately produced in the ascending current of gas and air.

I think the determining influence is clear from these observations. When the cone begins to descend and causes a back pressure this will momentarily check the indraught of air without materially checking the supply of gas. A stratum of mixture containing less air is thus produced; its rate of inflammation is less than its upward velocity, and so the cone is carried to the top of the tube. Soon the normal air supply is re-established, a mixture with a higher rate of inflammation is restored, and the cone again descends.

A confirmation of this explanation is afforded by two further observations:—(4) a shortening of the glass tube increases the rapidity of oscillation in conformity with the shorter distance to be traversed by the altered stratum; (5) a "capacity" in the form of a globe at the bottom of the glass tube stops the oscillation. Such an arrangement would both damp the back-pressure impulse and obliterate stratification.

Observations (2) and (5) show, I think, that the chimney-like action suggested by Prof. Galloway cannot be the determining cause, and indeed this could hardly be expected, inasmuch as such action would increase the aspiration of air and produce a mixture having a higher rate of inflammation, a condition which would oppose the other effect, viz. the increased upward velocity of the mixture to which alone Prof. Galloway alludes.

My own previous explanation was inadequate to explain the continued oscillation, and only important in relation to the lighting back of Bunsen flames.

ARTHUR SMITHELLS.

The University, Leeds, May 19.

Ancient Fire Festivals.

IN reference to your series of articles which have recently appeared in NATURE on Stonehenge and the ancient festivals, I send you the following notes on a Wiltshire celebration of the August fire customs. Tan Hill Fair is held on August 6, and the coincidence of the name Tan (Celtic for fire) and the date point to a time long prior to our era, when the fire festivals were annually held.

This fair, the origin of which is lost in antiquity, is held in the very last place likely to be chosen for such a purpose, and must have had its beginning at a time when men assembled there for some purpose very different to what brings them there now, for neither roads nor waterways (conditions essential to most fairs) lead to Tan Hill.

Tan Hill is on the highest part of the downs (near Devizes, north Wiltshire), 958 feet above sea-level, looking down on Avebury and dominating the whole country, and crossed only by British trackways which lead to the fair.

Sacred fires lit of old on this Tan Hill would have been seen from Martinsell (near Marlborough), Hackpen, Oldbury, and for miles around, and were probably eagerly watched for by the people taught to expect the blessing on the crops of the ensuing year consequent on these fires; and it is on this bleak, desolate down that one of the largest fairs of the country is held.

Fairs in Ireland and in Wales carry on the same tradition of the ancient fire festival held in August, as well as this one at Tan Hill.

In ancient Ireland this August celebration was called "*the Lugnassad*," the feast of Lug (a sun god), and according to Prof. Rhys "this festival was the great event of the summer half of the Celtic year, marking the victorious close of the sun's contest with the powers of darkness . . . when the crops were fast coming to maturity," and he suggests that the great festival held on the first of August "at Lyons (ancient *Lugduna*) superseded an older feast held on that day in honour of Lug, and was the Gallo-Roman continuation of the Celtic custom of old days." Gwyl Awst (the Yule of August) is the name by which this same August festival was known in ancient Wales.

He remarks that "the Lugnassad was, so to speak, the Summer Solstice of the Celts, whereas the longest day was then of no special account" (Rhys, Hibbert lectures).

Very interesting accounts of an August festival are given by Mr. Frazer ("Golden Bough") as celebrated by the Creek Indians and also by the Natchez tribe on the Lower Mississippi, when fires were lighted to destroy what was old before the ceremonial renewal of new fire took place by the priests by the friction of two pieces of wood, on the appearance of the first ray of the rising sun.

Among the special marks distinguishing the primitive ritual of heathendom from later customs, Mr. Frazer remarks that there were no temples, but that the celebrations took place by brooks, in woods, barns, harvest-fields, &c.

This interesting fair is clearly a survival from pre-Celtic days, but the interest in the place has unfortunately been much obscured by the alteration of the old name Tan to St. Anne's Hill on all modern maps.

It was a very common and well-known custom of the Church in late times to alter the name of a place to that of a saint, where, finding large gatherings assembled for religious ceremonies, their object was to substitute Christian for heathen ideas. *Caer Anna* in Brittany became St. Anne d'Auray, and Tan Hill became St. Anne's Hill. St. Anne's Day was not fixed for the whole Latin Church until 1584, when Gregory XIII. appointed the feast to be held on July 26 (August 6); the name of St. Anne does not occur in the older church calendars, and her cult is a very late one.

THEREZA STORY-MASKELYNE.

Carbon Dioxide in the Breath.

THE presence of 0·06 per cent. of carbon dioxide in the atmosphere is held, I believe, to render the air unfit for breathing purposes, whereas 0·03 per cent. may be taken as normal. A consideration of the quantity of this gas which must be continually present in the lungs makes such sensitiveness on their part to appear rather extraordinary.

Taking an average expiration as 300 c.c. and the reserve "air" in the lungs as 2000 c.c., and assuming that the atmosphere contains 0·03 per cent. of carbon dioxide and expired air 4 per cent. of carbon dioxide, we have the following figures (a homogeneous mixture in the lungs is imagined for simplicity):—

Just before expiration		Just after expiration		Just after inspiration		
2208	...	1920	...	2219·91	...	c.c. air
92	...	80	...	80·09	...	,, CO_2
2300	...	2000	..	2300	..	,, in lungs.

Hence before the next expiration 11·91 c.c. of carbon dioxide must accumulate to make up the original 92 c.c., the corresponding oxygen being absorbed.

Now if conditions remain the same, excepting that the atmospheric carbon dioxide reaches 0·06 per cent., we have

Just before expiration		Just after expiration		Just after inspiration		
2208	...	1920	..	2219·82	...	c.c. air
92	...	80	...	80·18	...	,, CO_2
2300	...	2000	..	2300	...	,, in lungs.

Before the next expiration 11·82 c.c. of carbon dioxide are required to make up the original 92 c.c.

Comparing these numbers, 11·91 and 11·82, we find that in the case of a person breathing at the rate of sixteen times a minute, only one more respiration would be required every seven minutes to get rid of the extra carbon dioxide due to an increase of 0·03 per cent. in the atmosphere.

One is tempted to wonder, therefore, whether carbon dioxide *per se* in these small quantities can have any appreciable effect. Or, on the other hand, is it possible that this gas in the lungs is in some manner "vitalised," as questioned by Prof. Meldola some time ago (see NATURE, 1902, vol. lxvi., p. 492), and that on reaching the outer world it is in a short time changed into the ordinary and more poisonous form?

F. SOUTHERDEN.

Royal Albert Memorial College, Exeter, April 25.

AMERICAN PALÆOBOTANY.[1]

THESE two volumes form the second instalment, under the editorship and to some extent the authorship of Mr. Lester Ward, of a detailed report on the Mesozoic floras of the United States, the first part of which appeared in the twentieth annual report

FIG. 1.—Jurassic Ginkgo leaves from Oregon. (From "Status of the Mesozoic Floras of the United States.")

of the U.S. Geological Survey published in 1900. The second paper deals with Triassic, Jurassic, and Lower Cretaceous floras, and includes observations on the stratigraphical relations of the plant-bearing strata.

The excellent quality of the plates, many of which consist of photographic reproductions of specimens, is in welcome contrast to the unsatisfactory figures

[1] "Status of the Mesozoic Floras of the United States." Second Paper. By Lester F. Ward, with the collaboration of William M. Fontaine, Arthur Bibbins, and G. R. Wieland. Part i., Text. Part ii., Plates. Pp. 616; Plates i–cxix. Monographs of the U.S. Geological Survey, vol. xlviii. (Washington, 1905.)

in some of the earlier monographs on American fossil floras. Under the head of Triassic floras an account is given of the results of an expedition into Arizona in 1901, which seems to have been more successful in discovering fossil vertebrates than the remains of vegetation. Reference is made to the "inexhaustible quantity of silicified wood," some specimens of which are included in the genus Araucarites, a type widely distributed in Mesozoic strata in many parts of the world. By far the most important part of the report is that by Mr. Fontaine, which deals with the rich Jurassic flora of Oregon. An inspection of the photographs and drawings reveals the interesting but not unexpected fact that the general facies of the vegetation exhibits a striking agreement with that which has been described from the Oolite rocks of East Yorkshire, Siberia, and other Old-world localities. A few species occur which appear to be identical with Wealden plants, while others are reminiscent of the older Rhætic floras. We welcome this exceedingly valuable addition to palæobotanical literature, but it is unfortunate that the author has

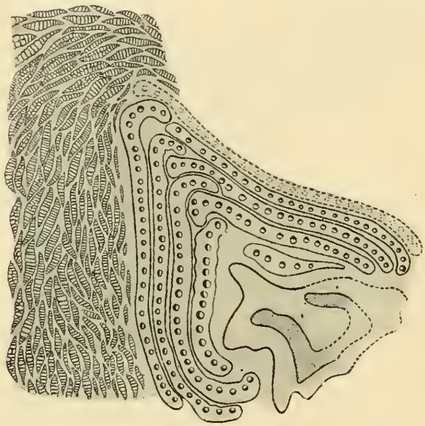


FIG. 2.—Unexpanded Frond of *Cycadella utopiensis*, Ward, showing the rachis with two rows of young pinnæ and a mass of ramental scales. (From "Status of the Mesozoic Floras of the United States.")

not exercised more self-restraint in his use of recent generic names in cases where there is no proof of close relationship between the Jurassic and existing plants. Fragments of fern fronds are designated species of Dicksonia and Thyrsopteris on wholly insufficient grounds. So long as palæobotanists continue the practice of labelling fossil species with the names of recent genera merely because of superficial resemblances presented by vegetative organs, their lists of species cannot be accepted as trustworthy contributions towards a fuller knowledge of the plant-distribution of former ages. Ferns and Cycads are well represented, and the abundance and variety of leaves referred to the genus Ginkgo—that striking embodiment of the "past in the present"—constitutes a notable feature of the Oregon flora (Fig. 1). The volume also contains an account of Lower Cretaceous floras, together with much information on the plants of the older Potomac formation, and descriptions of additional specimens of silicified Cycadean stems from the Jurassic rocks of Wyoming and the Potomac beds of Maryland. Mr. Wieland gives a particularly interesting figure of a young frond of a species of Cycadella in which the rachis is traversed by a U-shaped vascular band bearing a much closer resemblance to the meristele of a fern petiole than to the conducting strands in the rachis of a Cycad (Fig. 2). The notes which Mr. Wieland has already contributed on the morphology of Mesozoic Cycads have raised a keen desire for further information, and embolden us, who wait with envy and impatience, to urge him to publish with all speed an instalment of his promised monograph.

By the publication of these volumes Mr. Lester Ward has laid his fellow-workers in palæobotany under a further obligation. Although there are various matters of detail which we should venture to criticise if space permitted, there can be no doubt as to the value of this latest contribution from the veteran author and editor.

A. C. SEWARD.

RECREATIONS OF A NATURALIST.[1]

THE "naturalist" on the present occasion is Mr. J. E. Harting, from whose pen we have welcomed during the past forty years (*eheu! fugaces*) many volumes on many aspects of sport and natural history. Among his recreations are outings on the moor, the hill, and into the quiet byways of the

FIG. 1.—A Kingfisher hovering. From "Recreations of a Naturalist."

country, with gun or rifle (in their proper season), or with neither with equal enjoyment to him, and, as frequently as fortune favoured, with what it is easy to see he perhaps loves best of all, "a cast of hawks." Another form of "recreation" has been—metaphorically speaking—"finding a hare in the library and hunting it through the preserves of ancient authors until the hunt had a happy termination, or the literary hare escaped to give sport another day."

No doubt the writing of the essays that describe these recreations formed a supplementary one, not improbably combined with "business" as an enhancement to the diversion; for most of the forty essays in the present volume have previously appeared elsewhere, chiefly in the columns of *The Field*. Mr. Harting's library hunts are fewer in number and less engaging than those pursued by him out of doors. Of these one here and there might, perhaps, have been omitted, as somewhat belated, such as the account of "Swan-upping," in which the information is eleven years old, while the "Horse and its Historians" is a review of a work published in 1888.

[1] "Recreations of a Naturalist." By James Edmund Harting, author of a "Handbook of British Birds," &c. With 81 illustrations. Pp. xvi+433. (London: T. Fisher Unwin, 1906.) Price 15*s*. net.

though since then has not the "Thoroughbred Horse" been written by Prof. Ridgeway?

The majority of the other essays are, however, worth issuing in collected form. In reading them we recognise the spirit of the genuine sportsman naturalist the best combination in a human being for the full enjoyment of the external world—and follow with deep satisfaction his excellent companionship out into the open in his "Marsh Walk in May," "On the Hill," and "Bird Life on the Broads." An interesting chapter on "Small Birds on Migration carried by Large Ones" leaves the question as undecided as before. It may be worth recording, however, that many years ago the present writer listened with intense interest to his *vis-à-vis*, at a Lisbon hotel *table d'hôte*, relating how he had seen in Egypt small birds landing from the shoulders of an immigrant crane. The writer on inquiry learned that the name of his co-resident was "von Heuglin."

In his essay on the "Fascination of Light," Mr. Harting records some circumstantial evidence for believing that the powder-down patches of certain herons are phosphorescent, and probably provide a "living light" for alluring fishes to the surface of the water, and within sight of the foraging bird during the darkness. It is suggested also in regard to the common kingfisher that its orange-coloured breast may serve the same purpose when the bird is hovering (during daylight) over water "on the feed." While it would be very difficult to prove the latter suggestion experimentally, it seems that the former might be investigated with much chance of success by a couple of unprejudiced, enthusiastic and properly equipped ornithologists spending a few dark nights in a punt in the quiet haunts of the heron.

These "Recreations" may be cordially recommended to the lover of nature as a companion on his summer holidays. The book is full of delightful illustrations—those especially by Joseph Wolf and George Lodge—and, as a specimen, the beautiful hovering kingfisher, by the latter artist, is reproduced here. F.

FORTHCOMING VISIT OF REPRESENTATIVES OF UNIVERSITY EDUCATION IN FRANCE.

THE Senate of the University of London has invited representatives of the University of Paris (Faculty of Letters and Faculty of Sciences) and of the Collège de France to visit London at Whitsuntide. These representatives will be accompanied by the highest officials of the French Ministry of Public Instruction and by a number of representatives of the French provincial Universities. The Société des Professeurs de Langues vivantes and of the Guilde Internationale will be simultaneously entertained by the Modern Language Association, and the University has arranged for the representation of all these bodies at the various ceremonies. The French delegations will be headed by M. Liard, the Vice-Rector of the University of Paris.

The King has graciously expressed his desire to receive a number of the French visitors at Windsor on Thursday afternoon, June 7.

The general programme will include the following items:—Monday, June 4, an informal dinner at the Royal Palace Hotel, Kensington, at which the guests of the University will stay. Tuesday, June 5, a reception at the Foreign Office by Lord Fitzmaurice and by Mr. Lough, Parliamentary Secretary of the Board of Education, at noon; luncheon at the University; addresses at the University by Sir Edward Busk, Vice-Chancellor, M. Liard, Sir Arthur Rücker, and Prof. Sadler (on behalf of the Modern Language Association); informal receptions of French and English specialists. Wednesday, June 6, visits to Westminster Abbey, to Westminster School, and to some of the London County Council educational institutions, followed by a luncheon to be given by Mr. Evan Spicer, chairman of the County Council, at Belair, Dulwich; in the evening a dinner at University College, and various private dinners, followed by a reception by his Excellency the French Ambassador at the French Embassy. Thursday, June 7, addresses by the Deans of the Faculties of Arts and Science of the Universities of London and Paris, by Sir William Ramsay, K.C.B., and by representatives of the Collège de France, the French provincial Universities, and the French Modern Language Association; and in the evening a conversazione at the University. It is understood that a number of the French guests will, on Friday, June 8, visit the Universities of Oxford and Cambridge.

The guests will include the following representatives of science in France:—

University of Paris: M. Liard, Vice-Recteur de l'Université; Profs. Appell, G. Bertrand, Léon Bertrand, Vidal de la Blache, Borel, Boutroux, Bouty, Bouveault, Dastre, Delage, Fernbach, Hérouard, Houssay, Joannis, Lapicque, Leduc, Lippmann, Matignon, Matruchot, Painlevé, Pellat, Perrin, Pruvot, and Puiseux.

Collège de France: Profs. Henneguy and Pierre Janet.

University of Bordeaux: Prof. Lorin.

University of Caen: Prof. Guinchant.

University of Lille: Prof. Ponsot.

University of Nancy: Prof. Cuénot.

NOTES.

GREAT surprise and regret have been caused in German chemical circles by the announcement that Prof. W. Ostwald has requested the Saxony Minister of Education to allow him to give up the position which he has held in the University of Leipzig for so many years. German scientific journals and papers are unanimous in saying that of living chemists not one has exercised so great an influence on the progress of modern chemistry as Prof. Ostwald in his almost twenty years of academic teaching. But Prof. Ostwald finds the direction of a large university laboratory making so many calls on his time as to prevent his carrying out the amount of original and private work which he would like, with the result that he has decided to retire to his country house at Grossbothen (Saxony), where a small private laboratory has been arranged, and devote himself to literary and experimental work, dealing in the first instance with the technology of painting.

AT the invitation of the Anglo-German Friendship Committee a number of editors of German newspapers will visit London shortly. According to present arrangements, the visitors will arrive in London on June 20. Among the many entertainments provided is a visit to the Natural History Museum on Sunday, June 24, under the guidance of Lord Avebury and Prof. Ray Lankester. On Wednesday, June 27, the party will go to Cambridge to be entertained at one of the colleges and taken over the University.

THE President of the Board of Trade has appointed Major P. A. MacMahon, F.R.S., to be Deputy Warden of the Standards, to succeed the late superintendent of weights and measures, Mr. H. J. Chaney.

THE Friday evening discourse at the Royal Institution on June 1 will be delivered by Prof. H. Moissan, on "L'Ébullition des Métaux," and on June 8 by Sir James Dewar, on "Studies on Charcoal and Liquid Air."

The anniversary meeting of the Royal Geographical Society was held on Monday, May 21, when the medals and other awards announced in Nature of April 5 (p. 541) were presented.

A feature of the "Country in Town" Exhibition which will be held on July 5–19 in the Whitechapel Art Gallery will be photographs illustrating what can be done to beautify urban gardens, streets, and parks. Photographic prints for the exhibition will be gladly received by the honorary secretary, Mr. Wilfred Mark Webb, at Toynbee Hall, Whitechapel, E.

The death of Mr. Charles Eugene De Rance occurred on May 9, after eleven days' illness, the result of an unfortunate accident. Although Mr. De Rance began and ended his professional career as a civil engineer, he was for thirty years an officer of the Geological Survey of England and Wales. During this period he was engaged in the south of England and upon the Coal-measures of Flintshire and elsewhere, but most of his work was among the Triassic rocks of Lancashire and Cheshire, and the Glacial deposits of the same districts. He contributed to several memoirs of the Geological Survey, but his principal published work was the "Water Supply of England and Wales" (1882). For sixteen years he acted as secretary of a committee of the British Association on the circulation of underground waters; he was associated also with a committee on coast erosion. Problems of water supply always enlisted his attention; one of his last acts was an appeal for information as to the influence of the recent earthquakes on the flow of water in wells.

We notice with regret the announcement of the death on May 1 of Prof. I. C. Russell, head of the Department of Geology at the University of Michigan. He was for a short time assistant professor of geology at Columbia University, and became geologist in the U.S. Geological Survey in 1880. In 1892 he became professor of geology in the University of Michigan. Prof. Russell was vice-president of the American Association in 1904, and was president of the American Geological Association at the time of his death.

Messrs. C. Venkataraman and V. Apparan, of the Presidency College, Madras, write to describe a modification of Melde's experiment with a weighted string attached to the prong of a tuning-fork. When the string to which the pulley is attached is held so as to be neither parallel nor perpendicular to the vibration of the tuning-fork, then, if the tension is properly adjusted, the string takes up a stationary form of vibration capable of simple explanation.

Referring to the correspondence on "Sounding Stones" published in our issue for January 4 (vol. lxxii., p. 222), Mr. E. M. Buchanan, writing from Henzada, Burma, directs attention to the resonant properties of fossilised wood and a long established custom in Upper Burma, where such wood is common. The natives collect pieces of a kind with even grain, obtainable in lengths of 4 feet to 6 feet, and convert them into gongs by polishing them slightly. In the monasteries or shrines the monks accompany their recitations at matins and vespers with the music of their stone gongs, which are usually well attuned and give a pleasing effect.

We learn from the *Times* that the Government has given its sanction to a scheme for the organisation of the Archæological Department of India on a permanent and improved footing. Although much has been done since a Director-General of Archæology was appointed in 1902 for a period of five years, the experience gained has proved that the task of restoring and conserving the antiquities of India will always require trained ability for its adequate discharge. The present Director-General of Archæology is confirmed in his appointment. In lieu of the present Government epigraphist for Madras, the scheme provides for the appointment of a Government epigraphist for the whole of India, whose duty it will be to organise and collate the results of the epigraphical work of the provincial surveys. At the same time, the importance of Madras for this form of research and its special linguistic conditions necessitate the retention of a special epigraphical expert in that presidency.

The chief annual meeting of the Verein Deutscher Chemiker will be held this year at Nurnberg on June 6–9. Prof. C. Duisberg, of Elberfeld, will report on the work of the commission appointed by the Gesellschaft Deutscher Naturforscher und Aertze to consider the science teaching in German schools; Herr A. von Baeyer will lecture on the anilin dyes; Dr. Lehner, of Zürich, on artificial silk; Prof. Stockmeier, of Nurnberg, on explosions in the aluminium bronze colour industries; Prof. F. Haber, of Karlsruhe, on the optical analysis of coal gas; Prof. A. Werner, of Zürich, on valency; Dr. F. Raschig, of Ludwigshafen, on catalysis; Prof. M. Busch, of Erlangen, on new methods of determining the amount of nitrogen in nitrocellulose; Dr. Ed. Jordis, of Erlangen, on the chemistry of silicates; Dr. L. Eger, of Munich, on the examination and evaluation of railway materials; Dr. O. Röhm, on the manufacture of illuminating gas; and Dr. M. Neumann, of Cronberg, on the theory of the Glover process and the manufacture of sulphuric acid in towers. Visits will be paid to several chemical works and large engineering works in the neighbourhood, including Messrs. Siemens and Schuckert's, while excursions to Erlangen on June 8, to Rothenburg a.T. (Württemberg) on June 10, and to the Jubilee exhibition on June 9 are to be arranged.

The Connecticut Agricultural College has been authorised to accept the Edwin Gilbert bequest consisting of a farm of 350 acres at Georgetown, Conn., together with a fund of 12,000*l*. for the maintenance of the farm. The tract of land is, according to *Science*, to be used for experimental purposes in connection with the work of the agricultural college, but it is not intended to establish a branch of the college at Georgetown. From the same source we learn that the additional appropriation of 1000*l*. for the agricultural experiment stations, provided by the Adams Bill, has now been paid. This Bill increased the present appropriation of the agricultural stations under the Hatch and Morrill Acts by 1000*l*. for the year ending next June, and by an additional 400*l*. annually above the amount of the preceding year for the next five years. At the end of the five years this will amount to an increase of 3000*l*., bringing the total appropriation to each experiment station to 6000*l*. annually. The funds are to be applied only to original researches or experiments bearing directly on the agricultural industry of the United States, with due regard to the varying conditions and needs of the States in which the stations are located.

The contents of the May number of *Naturen* include articles on mosquitoes and gnats, on the Yangtse-kiang district and its products, and on dogs—prehistoric and modern—the last of these being by Dr. Reinhardt.

Owing to the advent of abnormally high temperatures at an unusually early period, which rendered collecting in the desert practically impossible, Dr. C. W. Andrews, of the Natural History Museum, has returned from his Egyptian trip. We understand that he has obtained some important specimens from the Fayum deposit, but that he was unable to visit the zeuglodon-beds of the Mokattum range.

The greater portion of the April issue of the *Museums Journal* is taken up by an illustrated article by Colonel Plunkett, director of the Dublin Museum, on the methods employed at that institution in circulating objects of art, or reproductions therefrom, among schools and other local establishments. A special endeavour has been made to reduce so far as possible the labour and expense connected with handling, packing, receiving, and dispatching the circulation sets, and although the scheme has only been in operation for a couple of years, it appears to be a conspicuous success.

An important paper by Mr. F. W. Thyng appears in the Proceedings of the Boston Society of Natural History (vol. xxxii., No. 11) on the squamosal bone of the skull in four-footed vertebrates. After maintaining, in opposition to the views of Gadow, Broom, and others, that the mammalian incus corresponds to the reptilian quadrate, the author proceeds to demonstrate that, of the two bones lying between the parietal and the quadrato-jugal in the labyrinthodont skull, the lower one, as not overlying the otic capsule, represents the squamosal of mammals, while the upper one should be called the supratemporal. According to the generally accepted scheme of cranial osteology, these names are transposed. The author's re-determination is largely based on the evidence afforded by the larval skull of the limbless amphibians, or cæcilians, which appear to come the nearest of all living groups to the labyrinthodonts.

The articles in the combined second and third parts of vol. lxxxi. of the *Zeitschrift für wissenschaftliche Zoologie* are only three in number, but each is of unusual length. In the first Mr. Hans Dunker discusses the homology of the cirri and the elytra in the "sea-mouse" (Aphrodite); the second is a continuation of Dr. L. Böhmig's studies of the planarian worms of the Tricladida group; while the third, by Mr. C. von Janicki, of Basle, is devoted to certain new or little-known cestode parasites infesting marsupials, bats, insectivores, rodents, and edentates. In the case of the last paper, especial interest, from a geographical point of view, attaches to the discovery in a Brazilian opossum of a new species of tape-worm belonging to the genus Linstowia, which was established by Zschokke in 1898 for the species *L. semoni* infesting one of the Australian bandicoots, but included another species found in the Echidna or spiny anteater of the same region. The new evidence is of the highest importance in confirming the opinion as to the close affinity of the South American to the Australasian marsupials, and also as to the relatively late date at which the two groups were sundered. Whether the common habitat of the ancestral type was, as has been suggested, in south-eastern Asia or in a sunken southern land remains to be determined.

Some cultural notes by Mr. H. Drion on hardy bamboos, continued from the previous number, are published in the April number of *Le Bambou*. Prof. E. de Wildeman contributes a note on the bamboo-hat industry in Java, that gives employment to a large number of natives. The hats are made double and in various qualities depending upon the degree of fineness of the woven strips. Their cost varies from four pence to eighteen pence; the chief defect is their tendency to become discoloured.

The Para rubber tree and its cultivation, also the cultivation of other American rubber trees, have attracted a great deal of attention lately, but *Ficus elastica*, the source of india-rubber, is seldom mentioned, and its cultivation is by no means fully understood. A small brochure written by Mr. C. Bald contains much information on the subject that will be useful to rubber planters in the north of India and elsewhere. Wild plants generally begin life as epiphytes, but the writer describes how seedlings can be readily germinated and transplanted, or a branch may be specially prepared for layering, whereas artificial attempts at epiphytic germination have mostly failed.

The third number of the Kew Bulletin for this year contains a series of identifications of new plants by workers in the herbarium. Dr. Stapf contributes a decade of African plants and a selection from various countries, including four species of Icacineæ from Borneo. Among the new orchids named by Mr. Rolfe are a Catasetum from Colombia and a Pteroglossaspis that is interesting as the first American record of a genus hitherto known only from Africa. Mr. G. Massee concludes an account of animal and plant parasites destructive to beets and mangolds by pointing out the risk of growing two root crops in succession.

In the Bulletin of the Department of Agriculture, Jamaica, vol. iv., part iii., an article by Mr. H. Q. Levy is published on the cultivation and marketing of oranges and grape fruit. Mr. Levy treats the subject from the point of view of the small grower, and gives advice on the laying out of the plantation, suitable catch crops, and the diseases of citrus fruits; the varieties of orange recommended are the seedless Petersfield navel and the seeded Pineapple. The hints on grading and packing the fruit are pertinent and practical. The part also contains a list compiled by Mr. Wm. Harris of the seasons and prices in Kingston for fruits, vegetables, and other products.

Mr. E. P. Stebbing writes a short note in the *Indian Forester* (March) on *Termes gestroi*, a termite that attacks Para rubber trees. This parasite has been reported previously from Borneo, Singapore, and the Straits Settlements, and now from the Mergui plantations in Burma. Little appears to be known of the habits of these white ants except that they hollow out their galleries in the crown of the root, where they collect and store the latex, and that they have increased greatly owing to the favourable conditions they find in the plantations of this exotic tree. Further information with regard to their life-history is required before satisfactory methods of treatment can be suggested.

Although an exhaustive investigation into the methods of cultivating and manufacturing natural indigo in India was carried out by Mr. Rawson a few years ago, and valuable suggestions were made by him for effecting improvements, the importance of the subject warranted further experiments that have been undertaken by Mr. C. Bergtheil, the agricultural bacteriologist to the Government of India. In the recent report of the Indigo Research Station at Sirsiah the superiority of the Natal plant, *Indigofera arrecta*, as improved by cultivation in Java, over the ordinary Bengal plant, *Indigofera sumatrana*, is clearly established, except under certain conditions. Mr. Bergtheil also emphasises the importance of seed selection. In the manufacturing processes the chief point inculcated is the necessity for maintaining the steeping vats at a temperature of 90° F.

Mr. E. R. Pratt, of Ryston Hall, Norfolk, writes an interesting article on the East Anglian timber willow in the recently published Journal of the Royal Agricultural Society. The supply of timber suitable for their trade has in recent years caused manufacturers of cricket-bats some anxiety. In East Anglia, and apparently in other parts of England, all large willows have been felled, except those kept by landowners for ornamental purposes, and the price of timber good enough for bat-making has risen to 5*s.* per foot. Two varieties of willow are purchased, the "close-bark," which is considered much the best, and the "open-bark." Growers of willows have found it a difficult matter to ascertain what variety the bat-maker wants, as his descriptions of the tree have been very vague. Mr. Pratt has gone carefully into the question of variety, and has examined a great many willows in the eastern counties. On the authority of a botanist who has given special attention to the genus (Rev. E. F. Linton, of Edmondsham, Salisbury), he states that the "close-bark willow" is not *Salix alba*, but *S. viridis*, a variable hybrid between *S. alba* and *S. fragilis*. Many of Mr. Pratt's specimens closely approached the former species, but could always be distinguished by the bronze-red winter shoots. He believes that the genuine *S. alba*, of which he has cultivated specimens obtained from Kew, is very rare in the eastern counties. Mr. Pratt further states that the "open-bark willow" of the bat-maker is *S. fragilis*, the crack willow, or its variety, *S. Russelliana*, the Bedford willow. In his experience *S. viridis* is much more common in East Anglia than *S. fragilis*.

In the *Engineering Review* (vol. xiv., No. 5) illustrations are given of the works at Notodden where the synthesis of nitrates from the air has been found commercially practicable.

Some very useful hints for horseback travel and transport are given in an article by Mr. F. L. Waldo on outfitting for the prospecting trail in northern Mexico in the *Engineering Magazine* (vol. xxxi., No. 1). During a ten years' residence in Mexico the author's attention has many times been directed to the incongruity of the outfits prepared and brought into that country by those whose business or pleasure call them into the Sierras. While the suggestions given refer specifically to a certain region, many of them will be of value elsewhere.

A Bulletin (vol. iii., No. 54) has been issued by the Department of Agriculture, Madras, describing experiments on well irrigation made by Prof. A. Chatterton at Metrosapuram in 1902–5. The results show that with adequate pumping power it is possible to improve the water supply and to cultivate a very considerable tract of land from a single well. If in the future oil engines and pumps are extensively used for well irrigation in India, it appears certain that the 3-inch centrifugal pump will be most largely employed, and that such a pump will water six acres per day of twelve hours, and will be suitable for areas ranging from thirty to fifty acres.

The annual progress report of the Geological Survey of Western Australia for 1905 (Perth, 1906) shows that much valuable work has been done. The Wodgina tinfield has been carefully examined, and it is believed that it will prove an important tin and tantalite producer. About 1 cwt. of tantalite specimens have been presented to the Survey museum. During the year there was a sudden demand for tantalum ores which had hitherto been considered useless. Considerable interest has been taken locally in deposits of graphite, and those on the Donnelly River have been worked to a slight extent. A sample of laterite iron ore from Comet Vale, North Coolgardie, proved of great interest on account of the occurrence in it of a notable proportion of chromium, mostly in the form of a hydrate. A large portion of the report is devoted to the results of examinations of the various goldfields, full reports of which will be published in due course.

The weather report of the Meteorological Office for the week ending Saturday, May 19, shows that the recent rains were excessive in places, while in other parts of the United Kingdom the rainfall was below the average. In the east of Scotland and in the north-east of England the aggregate fall was at least four times the average. The measurements due to the exceptionally heavy rains of Saturday, May 19, were:—2·53 inches at North Shields, 2·40 inches at Alnwick Castle, and 2·23 inches at Seaham. Both France and the Spanish Peninsula participated in the heavy rains of Saturday, the measurement for the twenty-four hours at Lyons being 2·25 inches, and at Corunna 2·40 inches.

We have received copies of the *Boletim mensal* of the Observatory of Rio de Janeiro, issued under the auspices of the Ministry of Industry. Anyone wishing to study the climate of that part of the Atlantic shore lying between the mouth of the Amazons and Rio de Janeiro will find trustworthy statistics for several of the coastal stations. The data are chiefly for ten-day means, with monthly means and extremes, but for Rio de Janeiro the actual observations for three-hourly periods are given in addition, and furnish most valuable details for all meteorological elements.

The Republic of Uruguay has recently established a National Institute for Weather Prediction, with its central observatory at Monte Video; the meteorological observatory at that place was founded by the municipal authorities in 1895. Observations have been made at several stations for some years, and the new institution has commenced its operations by the collation and discussion of the means and extremes already available, and by the investigation of the characteristics of the severe storms which affect the navigation of the estuary of the Rio de La Plata. The most dangerous storms are those from the south-east, as they usually occur with a rising barometer, in connection with anticyclonic conditions over the Atlantic, and are frequently accompanied by thick fog on the coast. The first number of the bulletin of the institute contains an exposition of the hydrography of the estuary, and tables showing, *inter alia*, the effect of the various winds upon the tides of the river.

Two reports have recently been issued on rates of deck watches and of box and pocket chronometers on trial for purchase by the Board of Admiralty at the Royal Observatory, Greenwich, in the latter half of last year. The number of deck watches on trial from August 5 to November 25, 1905, was 125, and the makers of the first five in the list, in which the watches are arranged in order of merit, are:—(1) W. Potts and Son, Leeds; (2) L. Hall, Louth, Lincs; (3) S. D. Neill, Belfast; (4) and (5) J. Player and Son, Coventry. The makers of the first five box chronometers of those on trial from June 17, 1905, to January 6, 1906, are:—(1) Kullberg, London; (2) and (3) Johannsen, London; (4) Lilley and Son, London; (5) M. F. Dent, London. In the same period the makers of the leading five pocket chronometers are:—(1) Newsome and Co., Coventry; (2) and (3) Kullberg, London; (4) Lindqvist, London; (5) Newsome and Co., Coventry.

Prof. B. Walter states in a brief note published in the *Annalen der Physik* (vol. xix., p. 874) that the ultra-violet portion of the spectrum of a high-tension arc in air shows a series of bands identical with those observed by Eder in 1892 as characterising the combustion of ammonia, and considered by him as ammonia bands. It would appear probable that these bands are to be attributed rather to an oxide of nitrogen, produced in both cases, than to the cause suggested by Eder.

Some successful attempts, made in the geophysical laboratory of the Carnegie Institution, to prepare small plates of quartz glass suitable for the construction of lenses, mirrors, or other optical apparatus, are described by Messrs. Arthur L. Day and E. S. Shepherd in *Science* (vol. xxiii., No. 591). The glass obtained was nearly free from air bubbles, and was only slightly discoloured by the presence of silicon. The conditions for obtaining such a material by the fusion, in a small graphite box, of pure crystallised quartz or tridymite, are summarised as follows:—an initial temperature of 2000° or more without pressure, so as to allow of the production of sufficient vapour to drive out the air between the grains, followed by pressure (at least 500 lb.) and a reduced temperature of about 1800°, with time for the quartz to flow compactly together without being attacked by the graphite.

An interesting contribution to the study of fluorescence is contained in a paper published by Mr. Harry W. Morse in the Proceedings of the American Academy of Arts and Sciences (vol. xli., No. 27) under the title "Studies of Fluorite." The fluorescence and thermoluminescence of fluorite and the nature of the gaseous and liquid inclusions in fluorspar are dealt with under different headings. The fluorescence spectra shown by fluorite when excited by the light of the condensed electric spark between electrodes of certain metals contain sharp lines and narrow bands; the lines of these fluorescence spectra do not appear to belong to any known substance, and are remarkable inasmuch as different lines are obtained with different exciting sources. The spectrum also varies sharply from crystal to crystal with the same means of excitement. The cause of fluorescence, whatever be its nature, is removed or destroyed by heating at a temperature of about 300° C. At the same temperature the colouring matter of the different varieties of fluorite is destroyed; the nature of this colouring matter is discussed by reference to the gaseous products liberated at higher temperatures. As these consist of hydrogen, carbon monoxide, and carbon dioxide, the colouring matter would appear to be organic in its origin; the gases are probably produced by its undergoing a process of destructive distillation

No. 3, vol. xxiii., of the *Astrophysical Journal* contains an important paper by Mr. Theodore Lyman on the extreme ultra-violet spectrum of hydrogen. Part of this spectrum was previously photographed and investigated by Dr. Schumann, whose work was briefly described in vol. lxix. (p. 262) of Nature. Unfortunately Dr. Schumann, although he photographed the spectrum down to λ 1270, was unable to give the wave-lengths beyond λ 1850, but this omission has now been rectified by Mr. Lyman, who has not only determined the missing wave-lengths, but has also extended the known spectrum down to λ 1030 (see Nature, p. 465, vol. lxix., and p. 110, vol. lxx.). In the present paper the author describes the apparatus and methods employed in great detail, "in the hope that an exact knowledge of the conditions necessary to success may prove of value to investigators who work in this field"; he also gives reproductions of his spectrograms, with wave-length scales, for the region between λ 1670 and λ 1270.

The Watkins Meter Co., Hereford, has published a third edition of "The Watkins Manual of Exposure and Development," by Mr. Alfred Watkins.

The report for the year 1905 of the council of the Hampstead Scientific Society has been received. The Christmas juvenile lectures, and those on nature-study, intended to encourage the teaching of this subject to children, proved very successful. Among lectures delivered at the general meetings of the society may be mentioned those by Prof. Marcus Hartog, on the end and beginning of individuality as shown in the living cell; Dr. R. S. Clay, on the peculiarities and paradoxes of fluid pressure; Sir Samuel Wilks, F.R.S., on spirals; Dr. C. W. Andrews, F.R.S., on fossil hunting in the Libyan Desert; and Mr. F. W. Rudler, on the geology and scenery of the British Isles.

The seventy-second annual report of Bootham School (York) Natural History, Literary, and Polytechnic Society shows that the pupils of this school continue to receive every encouragement to devote their leisure hours to the outdoor study of natural phenomena. During 1905 the boys were particularly successful in discovering rare plants, and though we have been unable to find a specific caution in the report, we trust that all observers are urged not to uproot plants or in any other way to assist the disappearance of rare species. It is satisfactory to find that attention is given to many branches of natural science so that the predilections of as many boys as possible may be satisfied.

OUR ASTRONOMICAL COLUMN.

Spectrum of Nova Aquilæ No. 2.—A visual observation of the spectrum of Nova Aquilæ No. 2, made at the Lick Observatory on September 5, 1905, showed a number of bands, the brightest of which was recognised as Hβ. Hγ and a band near λ 4600 were distinguished with difficulty owing to their extreme faintness.

Photographs obtained with the one-prism spectrograph on September 6 and 10 (exposures three and four hours respectively) confirmed the visual observation, the intensities of the bands at λ 4600 and Hγ being respectively one-fifth and one-tenth that of Hβ. Hδ was also seen, but was very faint.

A faint continuous spectrum was seen to extend from about λ 4500 to the region of the Hγ band. Hε and the so-called nebular lines were not visible.

Visual and photographic observations made on October 11, 1905, agreed in showing a marked diminution in the brightness of Hβ, which was then no brighter than Hγ (*Astrophysical Journal*, vol. xxiii., No. 3).

A number of magnitude observations of this Nova, made on various dates between September 20 and November 24 at the Utrecht Observatory, are recorded in No. 4089 of the *Astronomische Nachrichten* by Dr. A. A. Nijland.

Stereo-comparator Discoveries of Proper Motions.—At a meeting of the Paris Academy of Sciences, held on May 7, Prof. Loewy announced that Prof. Max Wolf had met with considerable success in discovering and measuring stellar proper motions by means of his stereo-comparator.

In one instance a star of known proper motion was seen to be obviously displaced after the very short interval of four years. When the two photographs, taken at this interval, were placed in the stereoscope, the star in question was seen to stand out in a plane considerably different from that in which the neighbouring stars appeared to be set.

Prof. Wolf has also been able to show that a ninth-magnitude star in the constellation Leo has a proper motion hitherto unsuspected, and he has obtained a value for the motion which he believes to be more correct than could be determined by ordinary micrometric measures. In this case a period of fourteen years separated the times of taking the photographs (*Comptes rendus*, No. 19, 1906).

MEASURES OF DOUBLE AND MULTIPLE STARS.—The measures of 1066 double and multiple stars are published in vol. ii., part iii. (astronomical series), of the Publications of the University of Pennsylvania by Prof. Doolittle.

The measures were made with a wire micrometer attached to the 18-inch refractor of the Flower Observatory, and include, among others, 733 Burnham stars, 109 OΣ, and 102 Σ stars. Four hundred and ninety-two stars from Prof. Hough's catalogue have also been re-measured but are not included; it is Prof. Doolittle's intention to re-measure all the stars discovered by this observer.

The micrometer, the corrections of the instrument, and the method of observing are all fully discussed in the present publication, which is a continuation of part iii., vol. i.

Part ii., vol. ii., of the same publications gives the results of the observations made with the zenith telescope of the Flower Observatory from October 1, 1901, to December 28, 1903, and also contains a re-discussion of the 1896–1898 series, of which the details appeared in part ii., vol. i., in 1899.

OBSERVATIONS OF COMET 1905*c*.—Numerous observations of comet 1905*c* are recorded in No. 4090 of the *Astronomische Nachrichten*.

This object was observed at Vienna from December 17, 1905, to January 14, 1906, and during that time its apparent diameter increased from 2′ to 4′–5′, the length of its tail from 5′ to 40′, and its total magnitude from 9·5 to 4·0. On December 30 a nucleus of magnitude 6·0 was observed.

Heliometer observations at the Cape Observatory showed the comet as a faint nebulous mass with no visible nucleus. Observations of position were recorded from February 5 to February 20, 1906.

The observations at Strassburg Observatory extended over the period December 10 to March 21, and the apparent position, the total magnitude, and the diameter were recorded on eleven different dates.

A LUNAR TIDE ON LAKE HURON.—Whilst examining the curves showing the periodical oscillations of the *seiches* on Lake Huron, Prof. W. J. Loudon, of Toronto University, was struck by the regularity of their general outline, which seemed more marked in calm weather. Further investigation of the matter showed a well-marked and regular rise and fall twice a day, and also showed that no oscillation of the lake could have a period of more than four hours.

From these facts Prof. Loudon concluded that a true lunar tide occurs on Lake Huron, a conclusion which his further experiments seemed to verify.

THE HAUNTS OF THE OKAPI.

ACCORDING to a report in Monday's *Times* (May 21) the expedition to the Congo Free State under the charge of Captains Boyd Alexander and C. B. Gosling has been successful, not only in procuring a fine skin (and it may be hoped a skeleton) of the okapi, but likewise in obtaining some important particulars with regard to the habits of this animal. The specimen, which it is stated will ultimately find a home in the Natural History Branch of the British Museum, was obtained at Bima, on the River Welle, in the northern territory of the Congo State. It is mentioned in the letter that the animal was seen alive by the expedition, but further particulars on this point are desirable, as it is not stated whether anyone but the Portuguese collector by whom it was trapped had this good fortune. The animal was caught in a pit according to native fashion, previous attempts to shoot it having proved ineffectual.

Hitherto the only definite account of the kind of country inhabited by the okapi and the probable nature of its food is one given by Mr. J. David under the title of "Weitere Mitteilungen über das Okapi," and published in vol. lxxxvi. of *Globus* (1904). Captain Alexander's notes, which differ in some respects from the former, are therefore of great value and interest, and may be quoted in full.

"The okapi here is generally found singly or in pairs, but Mobatti hunters state that sometimes three may be found together. An essential to the life of the okapi is a small stream of water with some muddy and swampy ground on either side. In this grows a certain large leaf that on its single stalk attains a height of 10 feet. It is the young leaf of this plant that is the favourite food of the okapi, and I venture to say that where the plant is not to be found the animal will not exist. During the night he will wander along in the mud and water in search of it. Here he may be found feeding as late as 8 a.m. in the morning, after which he retires to the seclusion of the forest, where he remains until nearly dusk. On the three occasions that I was at close quarters with the beast, he was perfectly concealed in this swamp leaf. Near the River Welle I found his spoor on ground frequented by buffalo and waterbuck, but this is unusual, and his companions in the forest are the elephant, the greater bushbuck, the yellow-backed and small red duikers. The okapi is very quick of hearing, and in that respect is classed by the Mobatti with the bushbuck (local name 'bungana'). In the forest here I consider this latter beast to be more difficult to obtain than the former. On the hunting ground of the first village that I visited I estimated the number of okapi as five or six, at the second and third nil; and twenty miles south in the forest, on very likely ground where my guide said they were formerly numerous, there was one only, probably owing to rubber-collectors who had been there."

Several specimens had been speared, shot, or trapped by natives shortly before the date of Captain Alexander's visit, but time did not admit of further investigation. The sex of the new specimen is not stated, but it is to be hoped that it will prove to be a male, as Sir Harry Johnston's example, now exhibited in the Natural History Museum, is a female. A pair of okapis are exhibited in the Congo Free State Museum at Tervueren, near Brussels, which also possesses other skins; and there are likewise a few other examples in Europe, notably one in Italy and another in Mr. Rothschild's museum at Tring. It is a great pity that the Belgian Government does not take immediate steps to publish coloured figures of its specimens in order to aid in solving the question as to whether there is more than one species (or race) of okapi. Important information on this point will, however, doubtless be afforded by the Alexander-Gosling specimen, which, it may be hoped, will also indicate (if a male) whether the tips of the horns always protrude through the skin, and thus foreshadow the antlers of deer.

THE TARAWERA VOLCANIC RIFT, NEW ZEALAND.

MR. JAMES MACKINTOSH BELL, director of the New Zealand Geological Survey, contributes a paper to the April number of the *Geographical Journal* describing the present topography of the great volcanic rift of Tarawera, in the north island of New Zealand, and the changes which have taken place in the configuration of the region since the great eruption of Mount Tarawera on June 10, 1886, which is memorable for the destruction of the famous pink and white terraces, and their submergence in Lake Rotomahana.

Mount Tarawera lies near the centre of the Taupo volcanic zone, and about 135 miles south-east of Auckland. This zone, which has a breadth of some twenty-five miles, extends from near the great volcanic cones of Ruapehu, Tongariro, and Ngaurahoe north-eastwards to White Island, on the Bay of Plenty, a distance of nearly 160 miles. A great rift, which was the scene of greatest intensity of the 1886 eruption, stretches from near Lake Okaro along the Tarawera range to Mount Wahanga, in the most north-easterly part. This rift, really a line of craters, forms a huge fissure about nine miles in length, cutting the summit of the range, and appearing on its south-western slope. It is divided into several somewhat distinct craters by low partitions, and on the south-west side a long narrow rift extends to the base of the hill, so far as the edge of Lake

Rotomahana. Lake Rotomahana is a sheet of dirty, muddy green water, some three and a half miles long by less than two miles in the opposite direction, and with a maximum depth of 427 feet. In continuation along the same line, beyond Lake Rotomahana, are the deep holes forming the Black, Fourth, Waimangu, Inferno, Echo Lake, and Southern craters. Hot water and steam issue in larger or smaller quantities from these craters, the water finding its way to Lake Rotomahana.

The most remarkable feature of the region during the last few years has been the great geyser of Waimangu. This geyser was discovered in January, 1900, and is believed to have become active only a short time before that date. While playing, outbursts occurred nearly every day, and sometimes more frequently. Mud, sand, and immense boulders were shot up in huge columns of dirty black water. At some hundreds of feet above the water the column broke, showering boulders, mud, and sand back into the pool, and even high up on the walls surrounding it.

In July, 1904, the great geyser suddenly ceased, and remained dormant for seven weeks and five days; then it again burst into action, and until November 1 following outbursts occurred almost daily. Then it stopped, and since then there has been no further explosive activity. We reproduce a photograph of the highest known eruption of Waimangu, from the illustrations accompanying Mr. Bell's paper. It is estimated that this "shot" ascended 1500 feet above the water, and carried a volume of 800 tons.

FIG. 1.—Highest known eruption of Waimangu.

HYDROLOGY IN THE UNITED STATES.

THE papers relating to the hydrological work in the United States which are issued by the department of the Geological Survey have from time to time been noticed in NATURE. We have now to acknowledge twenty-six of the papers last issued. The greater part of these relate to the progress of stream measurements in the different States, and to other matters which are of local interest. There are, however, some of the papers that deserve the attention of those engaged in works of water supply.

On a previous occasion, in NATURE of December 21, 1905, we gave a short account of the investigations that are being made as to the movement of underground water. A further paper on this subject has now been issued as the result of investigations made by Prof. Slichter, No. 140, on field measurements.

This paper presents an amplified exposition of the method of measuring underground water as described in his former paper of 1902. It contains descriptions of the apparatus used for the laboratory study of wells controlling horizontal and vertical movements, and the result of these studies confirms the conclusions described in the former paper as to the possibility of measuring the flow of subsurface water with trustworthy accuracy. Some improvements that have been made in the apparatus as the result of experience are described.

The author shows that the flow of water in a given direction through a column of sand is proportional to the difference in pressure at the ends of the column, and inversely proportional to the length of the column, and is also dependent upon a factor which he terms the transmission constant of the sand.

Experiment shows that the resistance to the flow of water through sand is very great, the water having to pass through pores, usually capillary in character, and the diameter of which varies from one-fourth to one-seventh of the diameter of the sand particles. When the sand is not of uniform size, and is mixed with grains slightly larger, the effect is to increase the capacity of the sand to transmit the water. Where particles seven to ten times the diameter of the original sand grains are added, each of these tends to block the course of the water. For example, a boulder placed in a mass of fine sand checks the passage of the water, and the rate of flow decreases in proportion to the number of such boulders until the amount of the large particles is equal to about 30 per cent. of the total mass. After this the flow increases until the mass of fine particles becomes negligible, and the capacity to transmit approaches that of the mass of large particles alone.

These facts are shown to have an important bearing upon the capacity of gravels to furnish water to wells, or to transmit it in the underflow to rivers.

Tables are given showing the transmission constant for sands and gravels of different sizes and different degrees of porosity.

It is also shown that the rate of flow is affected by temperature, a change from freezing point to 75° nearly doubling the power of the soil to transmit water. This paper contains a great deal of information as to the discharge from wells used for irrigation or other purposes.

Paper No. 144, by Mr. Daniel D. Jackson, deals with the normal distribution of chlorine in the natural waters of New York and New England. The author shows that, with the exception of local deposits, the normal chlorine in natural waters is derived from the salt of the ocean, blown over the land by storms, and that it diminishes in amount as the distance from the ocean increases. This decrease is so definite that equal amounts of chlorine are found along lines generally parallel to the sea coast, thus affording a basis for the establishment of *isochlors*. Charts and tables are given showing the proportion of chlorine at different distances from the coast. The samples were taken from ponds or open water basins as far removed from human habitation as possible. The charts show that the quantity of chlorine near the coast amounts to 6 parts in a million, at 4 miles away to 5 parts, at 20 miles to 3 parts, at 40 miles to 1 part, and at 100 miles to 0·4 part.

The fact that chlorine exists in rain water to a large extent near the sea coast was stated in the report on domestic water supply of the Rivers Pollution Commission in 1874. It was there shown that on the coast of Devonshire, where with south-west winds sea spray is blown over the land, the amount of chlorine varies from 1·20 to 2·10 parts in 100,000, and at the Land's End, with a strong south-west wind blowing, it amounts to as much as 21·8 parts. Inland the average quantity of chlorine diminishes to 0·39 part; increases to 0·99 part at Liverpool and 0·79 part at Newcastle.

Paper No. 151, by Mr. Marshall O. Leighton, deals with the field assay of water, and describes the methods which have for some time been used in connection with the investigations into the quality of water in various parts of the United States. The methods described relate, not to laboratory experiments, but to simple tests to ascertain the general character of the water by methods which can be carried out on the spot. These field determinations give the turbidity and colour of the water, the presence of chlorine, carbonates, calcium, and iron, and the amount of hardness; also the amount of suspended matter. The former are more particularly required in water for domestic supply, and the latter for that used for irrigation purposes. The amount of gradient to be given to a canal for conveying water for irrigation is governed to a great extent by the solid matter in suspension, and this also affects the capacity of the storage reservoirs. The method for determining turbidity, accompanied by an illustration of the gauge used for this purpose, was given in NATURE of January 7, 1904. A description and illustration of the Geological Survey field case is given in the paper.

Paper No. 143, by Mr. J. H. Quinton, details the experiments made under the direction of the Reclamation Department on steel concrete pipes for the purpose of determining the durability and permanence of these structures in connection with the supply of water for irrigation purposes. The pipes experimented on were 5 feet in diameter, 20 feet long, and 6 inches thick, of concrete, enclosing an armour of steel rods sufficient to resist a head of 150 feet of water with a factor of safety of 4. The experiments showed the difficulty, even with the closest attention to the construction, of making pipes of this kind that would stand a head of 100 feet.

Paper No. 150, by Mr. Robert E. Horton, gives the results of an investigation of the theory of weir measurements, and the discharge over different forms of weirs. The various coefficients of Bazin, Fteley, Stearns, and Hamilton Smith are analysed. A further description is given of the experiments performed at the Cornell University laboratory, where a closely regulated volume of water was passed over weirs of different forms placed across an experimental canal, and the results obtained compared with the different formulæ for obtaining the discharge. Tables are also given for calculating the discharge over weirs.

GREENWICH OBSERVATIONS.[1]

IN the introduction to the first work mentioned below, an opinion is expressed that the revision of an old catalogue must always be a source of anxiety to those who advise and undertake the revision, and that only the final result can justify the expenditure of the time and labour. Those who are responsible for this work need be under no apprehension that their efforts have been misspent. It would rather seem that in this case they have fulfilled a necessary duty, and discharged an honoured trust. It has always seemed to the writer that the ancient authorities at Greenwich were a little wanting in patriotism and enterprise in entrusting to a foreigner, however eminent, the reduction and discussion of Bradley's observations. Groombridge's observations, in a sense, may not be so completely a national possession as those of Bradley, but certainly it is not unfitting that at the Royal Observatory, almost within the shadow of which Groombridge erected his transit circle, his observations should be examined and discussed.

There are several circumstances which tend to give distinction to Groombridge's work. At the beginning of the last century his instrumental equipment was equal to, if not more powerful than, that of any other observer in Europe. The fact that, as an amateur, he gave his time and leisure to the repetition of the same mechanical performance shows that he was a lover of order and accuracy. Pond, the Astronomer Royal, whatever his failings may have been, appreciated the necessity for certainty and accuracy, and he must have impressed these qualities upon Groombridge. Further, the lapse of time, that factor which has increased the value of so much astronomical work and enhanced the reputation of so many worthies, has fought on the side of the retired West Indian merchant.

The method to be pursued in the reductions, how far the observations are to be treated as independent, how far they are to be regarded as differential, are points which must be left to the decision of the computers. They must accept the entire responsibility, since the knowledge and experience is theirs. In this case it is not impossible but that they have had the assistance of tradition. The interesting remarks of Colonel Colby and Dr. Firminger quoted by the revisers, probably do not exhaust the information at their disposal. It would be an impertinence for anyone who has not even seen the originals to offer any criticism on the methods employed by those who have gained familiarity and experience by long contact with Groombridge's figures. These methods are described with clearness and in sufficient detail, but the revisers must know so much more than they can set down.

The result is to obtain a catalogue for the equinox of 1810 of 4239 stars. The number in the original Groombridge catalogue was 4243, but of these nine have been rejected on various grounds, and five have been added as separate stars. The places of a few more stars have been considered discordant, and have not been used in the subsequent discussion of proper motion. The accuracy of the catalogue and the care of the observer can both be estimated in some measure from the fact that a discrepancy of four seconds of arc in either right ascension or polar distance has been considered a proper limit to warrant the exclusion of the observation. The number excluded is 75 in right ascension and 214 in polar distance, slightly more than 1 per cent. of the total number of observations.

The peculiar value of this catalogue lies in the fact that its epoch is 1810. Therefore, by comparison with modern observations, it offers the means for a new determination of the precessional constant, while the new proper motions which it makes available should give greater certainty to researches into the amount and direction of the solar motion. The length of time elapsed since Groombridge's day is not much less than that available in the case of Auwers-Bradley, and the accuracy of the observations would seem to be of the same order; but Bradley's optical means were smaller, and the average of his stars considerably brighter. Groombridge's stars include many of the ninth magnitude, and fill a gap between those to which Bradley's observations refer and the results that will be derived from photography. On the other hand, Bradley's stars were better distributed over the whole sky. Groombridge limited his observations to the circumpolar regions. Against this drawback, as against many others, the Greenwich authorities have struggled with apparent success, and a few of their final results may be given.

We have, in the first place, the proper motions of more than four thousand stars determined by comparison of places at intervals of approximately ninety years. These proper motions have been derived for the most part by a

[1] "New Reduction of Groombridge's Circumpolar Catalogue for the Epoch 1810–0." By F. W. Dyson, F.R.S., and W. G. Thackeray. Under the direction of Sir William H. M. Christie, K.C.B., F.R.S., Astronomer-Royal. (Published by order of the Board of Admiralty in obedience to His Majesty's command. Edinburgh: Neill and Co., Ltd., 1905.) Price 24s.

"Telegraphic Determinations of Longitude made in the Years 1888–1902, under the direction of Sir W. H. M. Christie, K.C.B., F.R.S., Astronomer-Royal. (Published by the Board of Admiralty in obedience to His Majesty's command. Edinburgh: Neill and Co., Ltd., 1906.) Price 15s.

simple comparison of positions at the extreme limits of time. It is not made clear why observations at intermediate dates, such as those of the Radcliffe Observatory, have not been used. The plan adopted seems the more strange, since the precessional variation has been applied and a comparison has been instituted. Considering the important part these proper motions were to play in the subsequent discussion, it would seem that too much care could not be exercised in their determination. These proper motions have been arranged in tables according to their amount, or the magnitude of the stars, or the character of spectrum, and, indeed, in every way that ingenuity could suggest as likely to be useful. This method of distribution cannot but be of essential service to those who wish to make further use of the material.

Next we have a determination of the precessional constants. The final result may not possess more than an academic interest, but the research is thorough and valuable. It would serve no useful purpose to enter into details, since those who are interested in such recondite questions must refer to the original sources for information, but the numerical results may be quoted, since they differ from Newcomb's values by a greater amount than would have been anticipated. For the centennial values of m and n we have:—

	m	n
Newcomb	$4607''\cdot11$ ...	$2005''\cdot11$
Dyson and Thackeray ...	$4607''\cdot57$ ...	$2005''\cdot31$

Another result which follows incidentally from the method of discussion is to show that, so far as this material is available, there is no reason to suspect any rotation of the brighter stars, as a whole, relatively to the fainter stars.

Lastly, the authors assign a direction to the solar motion, or rather many directions, for the material is discussed in many ways, all interesting. Here, again, we must content ourselves with the final result, which places the apex of the sun's motion in right ascension 275° and north declination 37°, referred, presumably, to the equinox of 1850.

In tendering our congratulations to Messrs. Dyson and Thackeray, and all who have been engaged in this work, we cannot help remarking that, as in the past, the Royal Observatory has distinguished itself by its energy in laboriously piling up observations, so in this instance, it demonstrates equally happily its power to make the accumulated material available for the advance of philosophical astronomy.

The title of the second book reminds us how loyally the Greenwich Observatory has served the purposes of its foundation. To determine, or to supply the means for determining, the longitude has constantly figured in its programme of work. The times have altered, the conditions of the problem have changed, and, above all, accuracy has increased, but, steadfast to its original design, the Royal Observatory has always been willing to assist in such inquiries, whether in the interests of navigation or for the purposes of geodesy. The Paris meridian seems to have been a constant source of anxiety to Greenwich, and the present volume gives the history of no less than three attempts to grapple with the difficulty. The two earlier results, 9m. 20·85s. and 9m. 20·79s. west of Greenwich, seem fairly accordant to the lay mind, but since they both differed in the same direction from the results of the French observers, the small discrepancy led to a third attempt in 1902, from which it appeared that Paris was west of Greenwich 9m. 20·932s., with a probable error of only 0·006s. Since this probable error is equivalent to about the length of an ordinary writing table, it would seem to possess the necessary accuracy, and the problem of the distance between the meridians of Greenwich and Paris may be considered as laid aside for some time to come. The remaining portion of the book is concerned with the longitudes of Montreal, Waterville, and Canso, and of stations incidentally connected with the scheme of operations. The result is to place Montreal in west longitude 4h. 54m. 18·62s., with an uncertainty of about 20 feet. Doubtless the day will come when this error will be felt to be intolerable, but if a demand is made for a fresh inquiry, we may be sure that the best traditions of Greenwich will respond to the appeal. W. E. P.

ANTI-TYPHOID VACCINE.

A MEMOIR "On the Standardisation of Anti-typhoid Vaccine," by Captain George Lamb and Captain W. B. C. Forster, has just appeared (Scientific Memoirs of the Government of India, No. 21. Calcutta: The Government Printing Office, 1906. Pp. 15. Price 7*d*.). After reviewing the various methods which have been proposed for the standardisation of Wright's anti-typhoid vaccine, Captains Lamb and Forster come to the conclusion that the virulence of the organisms used in the preparation of the vaccines must be taken into account. Since it appears that virulence is in direct proportion to the number, or avidity for immune body, of the receptors, an estimation of these latter in any vaccine will take cognisance of the virulence of the organism from which it was prepared. Admitting this as a basis, the method of standardisation suggested by Captains Lamb and Forster is to estimate what dilution of the various vaccines when mixed in equal parts with serum is able to remove completely the bactericidal power of that serum; in other words, to determine in what dilution of vaccine the receptors completely neutralise the amboceptor content of the serum. This is carried out by preparing a number of different dilutions of the vaccine, which are each mixed with the same amount (100 c.cm.) of fresh goat serum, and left in contact for an hour at 37° C. At the end of this period a small quantum of living typhoid culture is added to each tube, the several tubes are incubated for about twenty-four hours, and then sterile broth is added to each tube in order to ascertain whether the bacilli have been killed or no, and in this way various vaccines may be compared. The memoir must be consulted for the details of the method. R. T. HEWLETT.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The thirteenth "Robert Boyle" lecture of the Junior Scientific Club will be delivered by Prof. J. H. Poynting, F.R.S., on Wednesday, May 30, upon the subject of "The Pressure of Light."

Mr. J. S. C. Douglas, Christ Church, has been elected to the Radcliffe travelling fellowship for 1906.

Prof. Ritchie, fellow of New College, has been nominated as an examiner in preventive medicine for 1906, 1907, and 1908.

The 284th meeting of the Junior Scientific Club was held on May 16, when Mr. P. W. Robertson read a paper on "A New Method of Estimating Quinine," and Prof. E. G. Hill one on "Chemistry in India."

CAMBRIDGE.—The museums and lecture rooms syndicate has reported that the chemical laboratory of Gonville and Caius College will be closed at the end of the academic year 1906–7. It will therefore be necessary to provide further accommodation in the University for the students who have hitherto found places in the chemical laboratory. The museums and lecture rooms syndicate recommends that a site in the museums' grounds contiguous to the buildings of medicine should be set apart for this purpose. It is also recommended that the proposed extension of the Cavendish Laboratory should take place on a site with a frontage to Free School Lane to the north of the existing building. Lord Rayleigh's gift of 5000*l*. of the Nobel prize will, it is hoped, enable this building shortly to be begun.

The Vice-Chancellor has been authorised to convey to the Worshipful Company of Goldsmiths the thanks of the University for its munificent gift of 5000*l*., to be applied to the present needs of the University library.

The well-known authority on coral reefs and oceanography, Mr. J. Stanley Gardiner, has been nominated by the master and fellows of Gonville and Caius College to be pro-proctor for the ensuing year.

Dr. Bonney will lecture at 5 p.m. on Thursday, May 31, in the Sedgwick Museum, on "Volcanoes and Man's Experience of them."

Steps are being taken for the provision of a permanent endowment to place the Balfour library in a secure position. The library owes its origin to the generosity of the family of the late Prof. F. M. Balfour, who after his death in 1882 presented his scientific books to the University for the use of the zoological laboratory. The library so constituted was housed in a room adjacent to the laboratory, and has ever since been freely open to all members of the University and to others qualified to make use of it. The library has been maintained hitherto out of the fees paid by students attending the classes; and the burden which it thus places upon the resources of the laboratory is undesirable. A committee has therefore been formed for the purpose of collecting subscriptions, and of establishing a fund to be called the Balfour Library Endowment Fund, with the object of putting the library on a secure and satisfactory basis. The committee at its first meeting agreed that the fund, when established, "be offered to the University at such time and under such conditions as the subscribers shall hereafter determine, provided that the management be closely connected with the zoological laboratory, and that the library be freely open to students." Subscriptions may be paid to the Balfour Library Endowment Fund, at Messrs. Barclay's Bank, or to the treasurer, Mr. Adam Sedgwick, Zoological Laboratory, New Museums, Cambridge. The sum already received or promised amounts to about 500*l*.

The King and Queen will visit Newcastle on July 11 to open the new wing that completes the Armstrong College. The King will also open the new university buildings at Aberdeen on September 24.

It has been resolved by the Corporation of McGill University, Montreal, to confer the honorary degree of LL.D. on Dr. D. Macalister, president of the General Medical Council of the United Kingdom.

It is announced from the Agricultural Department of the University of Edinburgh that Mr. E. Thompstone has been appointed assistant deputy director of agriculture for Bombay Presidency, and Mr. Roger Prosser will go to La Germania, Argentina, to investigate salt soils.

There is a vacancy for a junior assistant secretary, holding a science degree or possessing equivalent qualifications, in the office of the department of technology of the City and Guilds of London Institute. Applicants for the appointment should communicate with the superintendent, Exhibition Road, London, S.W.

According to the *Chemiker Zeitung*, the University of Basle has fallen into line with the German universities, and now requires from all German doctor candidates the leaving certificate of a nine-year gymnasium or of a corresponding Swiss institution. The German Government had threatened not to recognise the doctor's degree if the University continued to grant it on the old conditions.

A general meeting of old students of the Technical College, Finsbury, was held on May 8 to discuss the proposal to form an Old Students' Association. In a short opening speech Sir Owen Roberts, who occupied the chair, expressed his approval of such associations, and said that it gave him great pleasure to preside at the organisation meeting of such a one as this promises to be. Dr. M. O. Forster, F.R.S., was elected president of the association.

It is announced in *Science* that Mr. Andrew Carnegie has made a donation of 20,000*l*. to Lehigh University; and that the movement to increase the endowment of Victoria University, Toronto, by 60,000*l*. is now practically completed. The amount has been raised all but 2400*l*., counting the 10,000*l*. given by Mr. Carnegie. The latter gift was conditional upon the raising of an additional 10,000*l*., but no trouble in fulfilling the condition is expected. According to the N.Y. *Evening Post* Sir William McDonald, of Montreal, has given 11,000*l*. for the purpose of erecting an extension to Prince of Wales College, Charlottetown, P.E.I. Additional facilities will be provided for teaching nature-study, domestic science and kindred subjects, and for training teachers.

The commission appointed by the German Association of Naturalists and Physicians at Breslau in 1904 to consider the mathematical and scientific instruction in German schools held a general meeting in Elberfeld on April 9–11, and discussed the following questions at length:—the syllabus of the mathematical and scientific teaching in the girls' high schools, in the six-class Realschulen and in the Reformschulen; the science teaching of the elementary and continuation schools, as well as that of the commercial and special schools; certain hygienic and sexual questions in connection with school life; the chemical instruction given in the training colleges. While the results and reports of these discussions will be laid before the society at the Stuttgart meeting in the autumn, it has been decided to issue a report on the form of instruction recommended for the girls' high schools as early as possible.

An addition to the many proofs which have reached us of the active interest taken on the Continent in the reform of mathematical teaching is afforded by the publication of a German translation of the address delivered to the *Mathesis* Society by Prof. Gino Loria on April 22, 1905, at Milan. The translation, which is literal, has been made by Dr. H. Wieleitner, and is published by G. J. Göschen, of Leipzig, under the title of "Vergangene und künftige Lehrpläne." The address affords evidence of a general tendency on the Continent to attach less importance in school curricula to the performance of gymnastic exercises of little educational value, and to introduce the wider ideas of higher mathematics at an earlier stage in the curricula. The object of mathematical teaching should be to give the pupils as wide an insight into mathematical methods, especially higher methods, as is consistent with thoroughness. It is impossible to study a paper like this without seeing how much better off in this respect our Continental rivals are than we are. This difference is due partly to the fact that under our university systems a large proportion of the mathematical teachers of our schools never learn any higher mathematics whatever, whereas in Germany or Italy every student has the opportunity of studying under specialists. A second cause of difference is due to the lesser importance attached on the Continent to examinations and syllabuses. In illustration of the spirit of the paper, Prof. Gino Loria considers that "elementary conics" is of little value as usually studied, as the subject contains no new ideas, and the pupils are only wearied with complicated exercises. This is certainly true of the subject as commonly taught, but, at the same time, a course of elementary mathematics ought to contain some introduction, however small, to the study of common curves, their tangents, and their other simpler properties treated geometrically and not as graphs.

The conditions of admission of students to college not only vary in different countries, but also often in the colleges and universities of the same country. This subject is receiving interested attention among educationists in the United States. *Science* for April 27 prints an address by President G. E. MacLean, of the State University of Iowa, which discusses the question: Can there be a coordination of the examining, certificate, and accrediting (including school inspection) systems for admission to college, looking toward a common or national administration in the interests of students, colleges, and the preservation of standards? The American procedure in this matter is not uniform. The western plan may be said to be the admission of students to colleges and universities by certificates from duly inspected secondary schools, while in eastern States the method is to admit only by examinations conducted by representative boards or otherwise. Some valuable opinions are collected in the address as to the relative value of the two courses. President MacLean says that the accrediting system has raised the standard of the work done. It has linked the secondary school into one system with the college. It has given an increase of students entering college, and with better average preparation. It is sometimes alleged that the scholarship of students admitted on certificate is lower than that of students who are required to pass examinations, but President Schurman, of Cornell, says the experience at his university does not support the contention. On the other hand, Prof. Hadley, of Yale, believes that the examination method is fairer to boys who come from a distance to the university. Yet, with the exception of Harvard, Yale, and Princeton, practically a coordination of the examining, certificate, and accrediting system has been reached inasmuch as testimonials issued by the college authorities are interchangeable. President MacLean concludes by urging the need for liberty to each institution, and records his belief that it is a question of evolution—the best system or combination of systems will survive.

SOCIETIES AND ACADEMIES.

LONDON.

Zoological Society, May 1.—Dr. Henry Woodward, F.R.S., vice-president, in the chair.—Skin of a remarkable new duiker from Nyasaland, presented to the British Museum by Mr. S. W. Frank: Oldfield **Thomas.** The animal was named *Cephalophus walkeri*, sp.n.—Further notes on anthropoid apes: Hon. W. **Rothschild.** The author exhibited five mounted specimens, one skeleton, six skulls, and a photograph of the following races:—*Gorilla gorilla*, dark-headed race, *G. gorilla*, red-headed race, *G. gorilla matschiei*, *G. gorilla diehli*, *Simia vellerosus*, and *S. vellerosus fuliginosus*.—Mammals collected in South-West Australia for Mr. W. E. Balston: Oldfield **Thomas.** Thirty-two species and subspecies were enumerated, of which the following were described as new:—*Scoteinus balstoni*, sp.n., *Tachyglossus aculeatus ineptus*, subsp.n.—A series of papers on the Lepidoptera collected in South Tibet by the officers during the recent expedition to that country under Colonel Sir Frank Younghusband. Mr. H. J. **Elwes** gave an account of the butterflies contained in the collection, which comprised thirty-three species and varieties, four of which were described as new. The moths, exclusive of the Tineidæ, have been worked out by Sir George **Hampson,** Bart., who enumerated the sixty-three species of which specimens were obtained. Of these, examples of thirty-six species were taken at moderate elevations in Sikhim, and belonged to the Indian fauna, two being described as new; twenty-seven species belonged to the Palæarctic fauna, of which nine were widespread and eighteen Tibetan; ten of these were described as new. An account of the Tineidæ was supplied by Mr. J. Hartley **Durrant**; they were referred to four species, two of which were new. Contributions to the knowledge of the vascular and respiratory systems in the Ophidia and to the anatomy of the genera Boa and Corallus: F. E. **Beddard.**

Chemical Society, May 3.—Prof. H. E. Armstrong, F.R.S., past-president, in the chair. The chairman gave expression to the sense of loss sustained by the Chemical Society in the death of Prof. Pierre Curie. The meeting endorsed the letter of condolence addressed by the president to Mme. Marie Curie, an honorary and foreign member of the society.—The relation between absorption spectra and chemical constitution, part v., the *iso*nitroso-compounds: E. C. C. **Baly,** Miss E. G. **Marsden,** and A. W. **Stewart.** From observations of the absorption spectra of several *iso*nitroso-compounds in neutral and alkaline solution it is found that the free substances most probably have the

$$\text{constitution}\quad \begin{matrix} R.C:O \\ \cdot\ * \\ R.CH.NO \end{matrix}\quad \text{but in presence of sodium hydroxide}$$

the starred hydrogen atom is replaced by sodium and becomes labile. *Isorropesis* then takes place between the >C:O and >C:N groups, a tautomeric process being the actuating mechanism.—The residual affinity of coumarin as shown by the formation of oxonium salts: G. T. **Morgan** and Miss F. M. G. **Micklethwait.** Platinichlorides of coumarin, 6-aminocoumarin, ethyl-6-aminocoumarin, dimethyl-6-aminocoumarin, acetyl-6-aminocoumarin, and a coumarin hydriodide periodide were described. The formation of these salt-like additive compounds of coumarin agrees with the results of earlier investigators. Coumarin also exhibits an amphoteric character in combining with metallic oxides and hydroxides.—Brazilin and hæmatoxylin, part vii., some derivatives of brazilein: P. **Engels** and W. H. **Perkin,** jun. Brazilein is the colouring matter produced when brazilin is oxidised in alkaline solution by means of air. Trimethylbrazilein, trimethylbrazilein formic acid, trimethyl*iso*brazilein sulphate, and trimethylbrazilein hydroxylamine were described.—The action of tribromopropane on the sodium derivative of ethyl malonate: W. H. **Perkin,** jun., and J. L. **Simonsen.**—Pipitzahoic acid: J. McConnell **Sanders.** The author considers that the composition is best represented by the formula $C_{10}H_{11}O_2$, it being thus isomeric with camphorquinone, and similar to, although not identical with, the *iso*camphorquinone discovered by Manasse. The acid seems to behave as a hydroxy-ketone, forming a resinous acetyl compound and a greenish-brown copper derivative.—The constitution of the hydroxides and cyanides obtained from acridine, methyl-acridine, and phenanthridine methiodides: C. K. **Tinkler.** The constitution of ammonium amalgam: Miss E. M. **Rich** and M. W. **Travers.** The results of determinations of the freezing points of a series of samples of ammonium amalgam have led the authors to the conclusion that it is a true solution of ammonium in mercury.—Action of light on potassium ferrocyanide: G. W. A. **Foster.** When a neutral or alkaline solution of potassium ferrocyanide is exposed to light, a purely photochemical action ensues, and ferric hydroxide is slowly precipitated. A mercury vapour lamp was used as a source of light.—Note on the constitution of cellulose: A. G. **Green** and A. G. **Perkin.** The supposed tetra-acetate of cellulose has been re-investigated and found to be in reality a triacetate. This affords further evidence of the correctness of Green's formula for the nucleus of the carbohydrate.—Some new derivatives of pinene: F. P. **Leach.** When pinene nitrosochloride is treated with potassium cyanate in alcohol at 50° to 60°, a compound, $C_{12}H_{17}O_2N_3$, separates. When heated with concentrated sulphuric acid it yields a *base*, $C_{10}H_{18}ON_2$. This is amphoteric, and appears to be an amino-oxime; it is also obtainable from pinene nitrosochloride by the action of ammonia.—Glutaconic and aconitic acids: S. **Ruhemann.** A criticism of Rogerson and Thorpe's work on these acids.

Anthropological Institute, May 8.—Mr. H. Balfour, ex-president, in the chair.—Phonograph records of native songs from the Congo, collected by Dr. J. L. **Todd,** were exhibited. The songs were all collected in the upper waters of the Congo, and were of great interest as specimens of native African music.—Notes on the ethnography of the Ba-Mbala: E. **Torday** and T. A. **Joyce.** The data on which the paper was based were collected by Mr. Torday. The Ba-Mbala are a Bantu tribe inhabiting the district between the Kwilu and the Inzai, tributaries of the Kasai, in the Congo Free State. The country had not previously been visited by a white man, at least for many years. The most interesting feature connected with these people is perhaps the fact that they are cannibals, men, women, and children all indulging, with the exception of a particular class known as *Muri*, who are distinguished by wearing a particular kind of bracelet. Another interesting feature of these people is that they appear to have borrowed all their knowledge of crafts from the neighbouring tribes. The paper was illustrated by a collection of specimens sent home by Mr. Torday, and also by lantern-slides.

Physical Society, May 11.—Dr. C. Chree, F.R.S., vice-president, in the chair.—The dead points of a galvanometer needle for transient currents: A. **Russell.** When many types of needle galvanometer are connected with a condenser and a battery in the ordinary manner by a charge and discharge key the following phenomena can easily be observed. When the needle is initially at right angles to the axis of the galvanometer coil, and the spot of light is in the centre, X, of the scale, the throws on charge and discharge are equal. If the controlling magnet be turned through a small angle, or if the suspending fibre be twisted slightly so that the spot of light is not in the centre of the scale initially, the throws on charge and discharge are not equal. The algebraic difference between them, however, is constant. Hence, for an initial position P_1 of the spot of light there is no throw on charge, and similarly for another initial position P_2 there is no throw on discharge. The author shows that these effects can be explained with considerable accuracy by supposing that the magnetism of the needle consists of two parts, one permanent and the other proportional to the magnetising force. He finds that it is easy to arrange with a low-resistance galvanometer so that a, relatively speaking, gigantic charge can be passed through the coil without producing any throw at all. He also finds that all the galvanometers he has tested, whether needle or moving coil, will produce throws when certain transient currents pass through them, even although the integral value of these currents is zero. It also appears that the effective internal resistance of ordinary condensers is appreciable in certain cases.

Royal Meteorological Society, May 16.—Mr. Richard Bentley, president, in the chair.—An instrument for testing and adjusting the Campbell-Stokes sunshine recorder: Dr. W. N. **Shaw** and G. C. **Simpson.** Experience has shown the necessity of an instrument for testing the shape and dimensions of recorders, and for verifying their adjustment when installed. But it is not at all easy by mere inspection or simple measurements with ordinary measuring instruments to check the adjustment, nor is it possible on a sunless day, without some special instrument, to check the orientation, and so the time-scale of the sunshine recorder. The authors have devised an instrument for this purpose, which they fully described in the paper.—The development and progress of the thunder-squall of February 8, 1906: R. G. K. **Lempfert.** This squall was first noted at Stornoway soon after midnight, and the last station in England to feel its effects was Hastings, over which it passed at about 4 p.m. The rate of progress was nearly uniform, though it increased somewhat in the south-east of the country, where the thunder and hail storms were most intense. The average speed of advance of the line of squall was about thirty-eight miles per hour. The most marked feature of this squall was the sudden shift of the wind in the course of a few minutes from south-west to north-west, and it was during this period that the thunderstorm occurred, accompanied by a rise of barometric pressure and a fall of temperature.

Society of Chemical Industry (London Section), May 7.—Mr. A. Gordon Salamon in the chair.—Notes on the Gutzeit test for arsenic: J. A. **Goode** and Dr. F. Mollwo **Perkin.** Owing to the difficulty of obtaining zinc free from arsenic, the authors used an ammonium salt—preferably the chloride—and metallic magnesium. Numbers are given showing the solution potential of magnesium in ammonium chloride and sulphuric and hydrochloric acids, also the difference produced by the addition of cadmium salts. The potential found was always lowered by the addition of the cadmium salt. Attempts to obtain a permanent stain were unsuccessful. The authors, however, do not consider that this is a matter of great importance, because as the test is so readily carried out it is easy to conduct several experiments simultaneously, one to produce a standard stain, one a blank, and the other with the substance under examination. The authors found that mercuric bromide is more delicate than mercuric chloride, and the stain is more intense. With mercuric bromide it is possible to detect 1/2000 mg. of arsenic. Although magnesium and ammonium chloride were employed by the authors, they also used zinc and acids, and obtained results equally as good. In fact, they consider that zinc and acid is fractionally more sensitive than magnesium and an ammonium salt.—The separation of brucine and strychnine by nitric acid; influence of nitrous acid: W. C. **Reynolds** and R. **Sutcliffe.** The authors have examined the processes proposed by Keller (*Zeit. Oesterr. Apoth, Ver.*, 1893, 542), Stoeder (*Ned. Tydschr. Pharm.*, 1899, xi., 1–5), and Gorden (*Arch. Pharm.*, 1902, ccxl., 641–4), and show under what conditions brucine can be completely oxidised with the minimum loss of strychnine. They have also investigated the part played by nitrous acid in the oxidation, and the action of alkalis on the products.—Absorption of gallic acid by organic colloids: W. P. **Dreaper** and A. **Wilson.** The absorption of gallic acid by silk and hide powder is shown to be of a similar nature to its absorption by gelatin or albumin. The influence of general reagents and the curves obtained indicate that the reactions are due to absorption. The precipitation of these colloids by tannic and gallic acids indicates, when studied in detail, that the solution state is a determining factor in the production of these coagula. The influence of gallic acid on the nature of a tannic acid gelatin coagulum is also observed. The results confirm the pseudo solution theory of dyeing, and indicate the nature of tanning.

CAMBRIDGE.

Philosophical Society, April 30.—Mr. J. J. Lister in the chair.—Demonstration of new apparatus for psychological tests: W. H. R. **Rivers.**—The measurement of the earth air current and the origin of atmospheric electricity: C. T. R. **Wilson.** The experiments, so far as they go, yield no support to theories which attribute the positive electrification of the air to effects of its contact with bodies at the earth's surface, *e.g.* to friction, or to greater loss of negative than of positive ions on account of their greater mobility. In an article in NATURE in June, 1903, it was suggested that the precipitation theory of the origin of the electrical field might have to be abandoned on account of the difficulty of explaining how positively charged air could be carried from wet-weather regions for any considerable distance without losing practically all its charge, and another possible origin of the electrical field was suggested, *i.e.* the arrival at the earth's surface, from external sources, of negatively-charged particles of the nature of extremely penetrating kathode rays. This hypothesis has been made less unlikely by the recent experiments of Campbell and Wood, which suggest the existence at the earth's surface of rays from cosmical sources. On the other hand, the difficulty in the way of the precipitation theory is removed if the current from the wet- to the fine-weather regions is regarded as due to conduction in the upper atmosphere, and not merely to convection of the positive charge by winds.—A class of integral equations: H. **Bateman.**—A suggestion as to the nature of the horny teeth of the Marsipobranchii: H. W. Marett **Tims.** It is difficult to accept the homologies which have been proposed between the horny teeth of the Marsipobranchii and the teeth of higher vertebrates. The published accounts of the development of the former appear to the writer to harmonise more closely with the development of the teleostean scale, from which it is suggested in the present paper that the horny teeth may have been derived.

EDINBURGH.

Royal Society, May 7.—Dr. R. H. Traquair, vice-president, in the chair.—Vibrating systems which are not subject to the Boltzmann-Maxwell law: Dr. W. **Peddie.** In this paper the question of the partitioning of energy in a system of mutually influencing masses is considered, the law of action assumed being the generalised Hooke's law. It is shown that equipartition of energy is in general impossible. An infinity of cases with a given number of degrees of freedom in which equipartition holds is possible, but the order of the infinity of cases in which it does not hold is greater. A method of time averages for a single system is used. When equipartition cannot hold in the case of any one system, the same result must be true for the space averages of a large number. In the course of the work a very symmetrical condition for the reality of the roots of an n-ic is found.—The superposition of mechanical vibrations upon magnetisation, and conversely in iron, steel, and nickel: James **Russell.** The wire under examination was, when required, set into mechanical vibration by means of an electric bell, to the sounding part of which the one end of the wire was fixed. The investigation was a systematic comparison of the temporary and residual magnetisations of these materials in various cyclic fields, according as the material was or was not in a state of vibration. The influence also of the condition of the wire, according as it was annealed or "quenched," was carefully studied. Of the many results obtained the following may be mentioned:—With permanently acting vibrations hysteresis loss is increased when the limiting fields are low, increased when they are high, but always decreased when the comparison is made with the limits given inductions instead of fields. In the annealed condition of all three metals, vibrations greatly increase the effects of "field on" and "field off." When the vibrations are not maintained permanently, but are superposed upon the magnetised condition at different stages of the cycle, the results are very different. Thus with continuous vibration the slope of the curve decreasing from the same maximum is always greater with vibration than without. On the other hand, when the vibration is superposed an increase of induction always occurs on the down curve as the cyclic extreme is departed from, and this increase passes into decrease in the opposite sense as the other cyclic extreme is reached.—*Neobythites brucei*, Poisson abyssal nouveau recueilli par l'Expédition Antarctique Nationale Ecossaise: Louis **Dollo.** This is a unique specimen of a new fish (family Brotulidæ) which Mr. W. S. Bruce found in the Weddell Sea at a depth of 2500 fathoms, 800 feet deeper than the deepest sounding obtained by the *Challenger* in the same region.—The Nematoda of the Scottish National Antarctic Expedition: Dr. v. **Linstow.** Seven species were described, five of the parasitic genus Ascaris, of which two were new species, and one undetermined. The others were a new species of Monorygma and a free-living Thoreostoma. Mr. Bruce exhibited the specimens, the *Monorygma dentatus* found in the stomach of the Weddell's seal being specially interesting.—A Pfaffian identity and related vanishing aggregates of determinant minors: Dr. Thomas **Muir.**

PARIS.

Academy of Sciences, May 7.—M. H. Poincaré in the chair.—The discovery of the proper motions of the stars by the aid of the stereoscopic method of Dr. Max Wolf: M. **Lœwy.** The method consists of a comparison in a stereoscope of two photographs of a given portion of the sky taken at several years' interval. Among the photographs shown was one bringing out the proper motion of a star of the ninth magnitude in the constellation of Leo. The proper motion can be evaluated stereoscopically with a greater precision than by the ordinary micrometric methods.—Remarks on the twelfth volume of the "Annales de l'Observatoire de Bordeaux": M. **Lœwy.**—The methods for the detection of aggregations of luminous particles, mixed with the gases and vapours in the lower part of the solar atmosphere, at other times than during eclipses: H. **Deslandres.** Very little has been done on the composition and distribution of the non-gaseous portion of the solar atmosphere. The author reviews the difficulties of the subject, and gives suggestions as to the best mode of attacking the problem.—The nidification of bees in the open air: E. L. **Bouvier.** An account of two cases in which domesticated bees have built hives in the open air on the branches of trees, and of the modifications in the structure necessitated by the exposure to wind and rain. Owing to the neighbouring buildings, one side of the hive was more exposed than the other. This fact was appreciated by the bees, and the exposed side was strengthened accordingly.—The conglomerates from the explosions of Vesuvius, their minerals, and their comparison with the trachytic conglomerates of Mont Dore: A. **Lacroix.**—Remarks by M. Albert Gaudry on the forthcoming International Congress of Anthropology and Prehistoric Archæology at Monaco.—The synthesis of penta-methyl-ethanol: Louis **Henry.** The substance $(CH_3)_3—C—C(OH)—(CH_3)_2$ was obtained in an attempt to prepare

$$(CH_3)_2—CCl—C(OH)—(CH_3)_2,$$

by the interaction of magnesium methyl-bromide and ethyl chlorisobutyrate or the corresponding bromo-compound. The method described is the most advantageous one for the preparation of this alcohol.—Researches on the whitening of fur and feathers in winter: El. **Metchnikoff.** Observations are given showing the probability of the view that the blanching of the hair and feathers, in animals periodically and in man through old age, is due to the activity of living amœboid cells, chromophages, sensible to external influences, and capable of moving and attacking the pigment grains.—The generalisation of trigonometrical series: A. **Buhl.**—Certain asymptotic series: L. **Schlesinger.**—The acceleration of spherical waves of shock: M. **Jouguet.**—The application of the principle of superposition to the transmission of alternating currents over a long line. Its graphical representation: A. **Blondel.**—The interference effects produced by a grating limiting a thin plate: Georges **Meslin.** The theory of interference rings which appear when a grating is placed on the convex surface of a lens of small curvature, and are distinct from Newton's rings. These fringes can be applied practically to the verification of a surface without the use of monochromatic light, and this testing can be carried out without interrupting the working of the surface, owing to the fact that the diffraction grating may be placed at a distance of some millimetres from the surface without interfering with the production of the fringes.—The action of ammonia gas on anhydrous neodymium chloride: C. **Matignon** and R. **Trannoy.** Neodymium chloride forms seven different combinations with ammonia, containing respectively one, two, four, five, eight, eleven, and twelve molecules of ammonia to one of $NdCl_3$. These compounds form a further confirmation of the trivalency of neodymium, as the assumption of divalency for this metal would lead to improbable formulæ for these addition products.—The existence of sulphides of phosphorus; mixtures of phosphorus and phosphorus sesquisulphide: R. **Boulouch.** A criticism of a paper on the same subject by H. Giran, and a discussion of the nature of the eutectic mixture formed by phosphorus and the sulphide P_4S_3.—Some special brasses: Léon **Guillet.** The addition of an element such as aluminium to a brass containing copper and zinc only yields an alloy possessing mechanical properties and a micrographic structure corresponding to a pure copper-zinc brass of quite different composition. From numerous experiments on the addition of various elements, a quantitative expression is developed referring the properties of the alloys thus formed to the pure copper-zinc brasses of corresponding properties.—A method for the detection and estimation of small quantities of iron: A. **Mouneyrat.** The method is based on the production of a green colour in dilute solutions of iron salts by the action of sulphuretted hydrogen in ammoniacal solution. It is shown that the reaction is specific to iron and is of extreme delicacy, serving to estimate this metal between the limits of 1/1000 and 1/1,000,000.—The production of aromatic sulphamates by the reduction of nitro-compounds with sodium hydrosulphite: A. **Seyewetz** and M. **Bloch.** Nitrobenzene is reduced by sodium hydrosulphite in presence of sodium phosphate to the sodium salt of phenylsulphamic acid. The reaction is general for aromatic compounds, and has been extended to the three nitrotoluenes, metanitroxylene, and α-nitronaphthalene.—A seismic disturbance recorded at the Observatory of Ebro on April 18: P. **Circra.**

NEW SOUTH WALES.

Linnean Society, March 28.—Annual General Meeting.—Mr. T. Steel, president, in the chair.—Annual address: the **President.** The question of rabbit destruction was dealt with, the proposal to introduce disease for the purpose being condemned, on the grounds that not only would it not affect the desired extermination, but also that it was extremely undesirable to introduce a foreign pathogenic microbe of unknown potency under changed conditions, to be broadcasted over the land. Attention was directed to the indiscriminate destruction, wilful as well as inadvertent, of useful and harmless indigenous animals, and the deplorable results in loss of crops through attacks of insects which are sure to follow the killing off of insectivorous birds. Taking as the special subject of his address that of oceanic physics, the president briefly sketched the formation of the primary ocean, showing that it was in all probability highly saline and that calculations of the age of the earth, based on the present rate of transport of salt from the land to the sea, are misleading. Regarding the observed rate of increase in temperature downwards in the earth's crust, which has been found to be about 1° F. for each 51 feet of descent, reasons were given for considering that this rate is not maintained, and that a maximum temperature of about 7000° F. is reached at a depth of some 800,000 feet, after which the temperature to the earth's centre remains practically unaltered. Dealing with the phenomenon of wind-raised waves, it was shown that these have well-defined properties, waves of any given size having all their other functions in unison, the height, length, frequency, velocity, &c., being fixed and invariable, relative to one another. Allusion was made to the enormous amount of energy involved in the evaporation which takes place daily from the ocean surface, and to the profound effect on climate caused by the transference of heat absorbed in vapourising water from the sea and again liberated at the places where this vapour condenses to form clouds and rain. The address concluded with an examination of the possibilities in regard to the withdrawal of water from the ocean to be stored as ice at the poles, and the result on the relation of land and water levels, also on the adequacy of change of land level at the poles to account for the known former existence there of a comparatively mild climate.—The first recorded occurrence of Blastoidea in New South Wales: T. G. **Taylor.** The Australian Blastoids at present known comprise three species from the Gympie beds (permo-Carboniferous) of the Rockhampton district, and provisionally referred to the genera Metablastus, Granatocrinus, and Tricœlocrinus. The two specimens now recorded are different from the Queensland forms, and were obtained from the Glenwilliam (permo-Carboniferous) series at Clarence Town, New South Wales. They are provisionally classed as species of Metablastus.—A collection of Crustacea from the Port Curtis district, Queensland: F. E. **Grant** and Allan R. **McCulloch.** The paper deals with a collection of more than 100 species of Brachyura and Macrura taken in Port Curtis and at the extreme south of the Great Barrier Reef, in October, 1904. Five species are described as new. Twenty-one species are recorded as new for Australia.

CALCUTTA.

Asiatic Society of Bengal, April 4.—Notes on the tank fauna of India: Dr. N. **Annandale.** A cockroach of the genus Epilampra is recorded as being aquatic in Chota Nagpur, and a peculiarity in its spiracles and in those of some other members of its family is noted. A general account is given of the respiratory system of an aquatic glow-worm, probably the larva of a Luciola. Some further diagnostic characters (distinction of the sexes, structure of the eggs, relative proportion of body and tentacles) of *Hydra orientalis* are put on record. Two protozoa are noted as having been found associated with it, and the part played in its migrations by Paludina is pointed out. An account is given of a chironomid larva which binds both the polyp and certain Vorticellids and rotifers to a temporary protective case, and then devours them at leisure. The character of the food commonly eaten in the Calcutta tanks by Hydra is indicated.—Silver dioxide and silver peroxynitrate: E. R. **Watson.** If the crystalline substance formed during electrolysis at the anode from aqueous solutions of silver nitrate be washed and dried with sufficient care, it may be isolated pure, and proved to have the formula Ag_7NO_{11}, which Sûlc gave to it. On heating this silver peroxynitrate, the decomposition proceeds in two stages; for at first oxygen is given off, but later NO_2 as well as O, white silver being left. This behaviour suggested to Sûlc the structural formula $AgNO_3 3Ag_2O_2.O_2$; Mulder and Haringa suggested later the formula $AgNO_5.3Ag_2O_2$. To both suggestions there are considerable objections. Alternatives still under investigation are $Ag_7(NO_3)O_8$ and $Ag_7(NO_4)O_7$.—The Hindu method of manufacturing spirit from rice, and its scientific explanation: J. C. **Ray.** The fungus used in Orissa is prepared in small balls by the hill-people; it is mixed in a basket with wet steamed rice in the proportion of one to one hundred parts of dry rice. The mixture heats during the next twenty-four hours, after which it is made into circular cakes and exposed upon an earthen platform for three or four days, during which the mycelium so spreads as to make the grains in the cakes cohere. The cakes are now piled up, and in four or five days become black. Next the cakes are put with water into vats sunk in the floor of a shed, and an equal quantity of fresh, well-steamed rice is added. The vats before being charged are fumigated by burning straw. Fermentation is allowed to go on for eight to ten days, until bubbles cease to rise. Distillation follows. The average yield of spirit in a good distillery is 4 gallons, proof, from 82 lb. of rice. The maximum yield of 4·5 gallons is obtained in January, the minimum of 3·66 gallons in October. Experiments show that the caking is very essential to the process. The essential mould is believed to be *Mucor racemosus*; other moulds get mixed with it.

DIARY OF SOCIETIES.

THURSDAY, MAY 24.

ROYAL SOCIETY, at 4.30.—Croonian Lecture: On Nerve Endings and on Special Excitable Substances in Cells: Prof. J. N. Langley, F.R.S.
ROYAL INSTITUTION, at 5.—Man and the Glacial Period: Prof. W. J. Sollas, F.R.S.
UNIVERSITY OF LONDON, at 5.—The Atmospheric Circulation and its Relation to Weather: Dr. W. N. Shaw, F.R.S.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Annual General Meeting.—Report of Council and Election of the New Council.
SOCIETY OF ARTS, at 4.30.—The Parsis of Persia: Major P. M. Sykes C.M.G.
LINNEAN SOCIETY, at 3.—Anniversary Meeti

FRIDAY, MAY 25.

ROYAL INSTITUTION, at 9.—Compressed Air and its Physiological Effects: Leonard Hill, F.R.S.
PHYSICAL SOCIETY, at 5.—Colour Phenomena in Photometry: J. S. Dow.—Exhibition of an Automatic Arc Lamp: H. Tomlinson and Rev. G. T. Johnston.—The Theory of Moving Coil and other Kinds of Ballistic Galvanometers: Prof. H. A. Wilson, F.R.S.—Exhibition of a Bifilar Galvanometer free from Zero Creep: A. Campbell.

SATURDAY, MAY 26.

ROYAL INSTITUTION, at 3.—The Old and the New Chemistry: Sir James Dewar, F.R.S.

TUESDAY, MAY 29.

ROYAL INSTITUTION, at 5.—Northern Winter Sports: Colonel V. Bulck.
ZOOLOGICAL SOCIETY, at 8.30.
SOCIETY OF ARTS, at 8.—Glass Cutting: Harry Powell. (Paper to be read at the Whitefriars Glassworks.)

THURSDAY, MAY 31.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* On the Main Source of "Precipitable" Substances and on the *Rôle* of the Homologous Proteid in Precipitin Reactions: D. A. Welsh and H. G. Chapman.—The Viscosity of the Blood: A. du Pre Denning and J. H. Watson.—The Affinity Constants of Amphoteric Electrolytes, part i., Methyl Derivatives of Para-Aminobenzoic Acid and of Glycine: J. Johnston.—Part ii., Methyl Derivatives of Ortho- and Meta-Aminobenzoic Acids: Dr. A. C. Cumming.—Part iii., Methylated Amino-Acids: Prof. James Walker, F.R.S.
ROYAL INSTITUTION, at 5.—Man and the Glacial Period: Prof. W. J. Sollas, F.R.S.

FRIDAY, JUNE 1.

ROYAL INSTITUTION, at 9.—L'Ébullition des Métaux: Prof. H. Moissan, For. Mem. R.S.

CONTENTS.

THURSDAY, MAY 31, 1906.

FAMILY ABILITY.

(1) *Noteworthy Families (Modern Science).* By Francis Galton, F.R.S., and Edgar Schuster. Pp. xlii+96. (London: John Murray, 1906.) Price 6s. net.

(2) *Mental and Moral Heredity in Royalty.* By Frederick Adams Woods, M.D. Pp. viii+312. (New York: Henry Holt and Co., 1906.)

(1) IN the spring of 1904 a circular was issued to all Fellows of the Royal Society whose names appeared in the year-book for 1904 in which they were asked to give particulars of the achievements of their relatives. A statistical examination of the information thus furnished is made by Dr. Galton in the preface to the volume before us, while Mr. Schuster has selected from the returns particulars of sixty-six families containing at least three noteworthy kinsmen. The prominence given to the latter part of the work suggests that the primary object of the inquiry was not statistical, but was to form an index of those families now represented by men of science among what might be described as "the intellectual aristocracy."

When applying statistical methods to the information furnished Dr. Galton was confronted by several difficulties; only 207 of the 467 persons addressed sent serviceable replies, and of these only about one-half gave complete returns, so Dr. Galton found he had only 100 families to consider. In order to make any comparison between the kinsfolk of Fellows of the Royal Society and the generality it was therefore necessary not only to form a conjecture of the proportion of noteworthy persons in the community, but also to consider the reasons which prompted the large proportion of Fellows who abstained from replying—if, as Dr. Galton suggests, they were of a poorer class than those who replied, weight must be given to this consideration in the comparisons. The much debated question of environment is also referred to, and Dr. Galton gives two tables from which he concludes that if ability and environment are positively correlated, the association between success and ability becomes closer. We are not quite convinced by the tables, as it is hard to see the reason for splitting the nine possible combinations of ability (high, medium, and low) and environment (high, medium, and low) into three grades of success in Table II., which gives "ability independent of environment," while in Table III., showing "ability correlated with environment," the nine groups are distributed into five grades. The average number of relations which each individual has in a stationary community had to be considered, and this affords Dr. Galton the opportunity of giving the interesting note which appeared in NATURE for September 29, 1904 (vol. lxx., p. 529). The conclusion reached after making allowance for the various points mentioned is that able fathers produce able children in a much larger proportion than the generality, but as the statistics cannot be thrown into a form suitable for obtaining the usual coefficients of correlation, it is impossible to compare the results with recent statistical work on heredity.

The book is the first volume issued by the Eugenics Record Office of the University of London, a fact that gives it an additional interest, and encourages us to look forward to further work on the interesting subject which the office has—as the result of Dr. Galton's generosity—been established to investigate.

(2) This book gives us the result of an attempt to study some of the problems of heredity with the help of statistics drawn from the Royal Families of Europe. Dr. Woods has collected information from various sources, and whenever possible he has considered the view taken by more than one authority in the hope of eliminating the personal element which most people connect closely with historical work. The method adopted was to record every individual in every degree of relationship and also everything which could assist an estimate of the mental or moral status of any historical character considered. Dr. Woods then decided into which of ten groups showing grades of intelligence each person in his royal population should be put, and in order to give readers the opportunity of verifying his particulars he has given a list of the persons in their grades of intelligence. A similar plan was followed for morality.

The various Royal Houses are then examined in turn; a genealogical table of each is given showing the grades assigned to each person whose name occurs, and Dr. Woods points out the recurrence of marked characteristics in successive generations such as the Bourbon insanity or the Hapsburg "lip," though the latter is the only physical characteristic examined at any length. Throughout this, the main part of the work, an attempt is made to show that heredity can account for the total or partial recurrence of the type of mind exhibited by an ancestor, and although at times Dr. Woods seems to try to explain too much, he has certainly succeeded in giving a clear impression of his opinion of the statistics he has collected. He frequently suggests when discussing family traits, that inheritance seems alternative rather than blended, but if this leads the reader to expect an illustration of Mendel's laws in the statistical part of the volume he will be disappointed by Dr. Woods's footnote to p. 274, in which he says that he has not been able to detect the existence of "dominant" and "recessive" types, and adds:—

"Although the mind seems in its inheritance to roughly obey the principle of alternative inheritance and thus indicate segregation in the germ-cells, I do not feel that this is sufficiently clearly defined to enable one to classify according to hard and fast types, as is possible in dealing with the features of certain plants and animals like the colours of mice, whether albino or gray; or the shapes of peas, whether round or angular."

Dr. Woods points out that the large amount of inbreeding which has taken place in some of the Royal Families has certainly not led to sterility, though it is, we think, probable that it has helped to accentuate in offspring some of the noticeable characteristics on which the author dwells.

In the statistical treatment Dr. Woods first examines the interesting question of whether there is any connection between mental and moral qualities, and by means of Pearson's "fourfold-table" method finds the high value of $0{\cdot}3403 \pm 0{\cdot}0419$ for the coefficient of correlation, and he then proceeds to show that the average number of adult children increases with the higher grade of morality of the parent. It is a pity that no correlation table is given in this last case, as the result is interesting. It is, of course, a conclusion that would be expected from general considerations; for the dissolute members of any community tend to die at an early age, which leads one to expect them to have few children, while the fact of their being dissolute generally means that the children born are less healthy and therefore more often die in childhood. The other statistical results can be conveniently summarised as follows:—

	Coefficients of correlation between		
	Offspring and fathers	Offspring and grandfathers	Offspring and great-grandfathers
Mental qualities ...	0·301 ...	0·161 ...	0·153
Moral qualities ...	0·298 ...	0·175 ...	not calculated

The first four of these agree closely with the 0·3 and 0·15 expected by the Law of Ancestral Heredity. In comparing the figures given with those obtained from other sources it should be borne in mind that assortative mating is probably very slight among members of Royal Families, while elsewhere it plays an important part. We think it would have been well to give some information about the correlation between brothers, and also between offspring and mothers; the maternal lines have in fact been neglected almost entirely in the statistical work.

Dr. Woods states as his reason for using the "fourfold-table" method for finding coefficients of correlation, that his grades do not necessarily represent quantitative measurements, "for we do not know that grade (4) is twice as intellectual as grade (2), &c." This is incorrect; the ordinary method merely requires the groups to be equidistant, and the remarks on pp. 19 and 20 on the distributions of the people in their grades of intelligence or morality leave the impression that Dr. Woods attempted to make them so. In his correlation tables he always divides the offspring and parents into "below the mean" and "above the mean," instead of saying "grades (1) to (5)" and "grades (6) to (10)." The latter represents the real division, as the mean cannot be fixed without knowing the relative distances between the grades.

The book would be the better for a good index, and one or two misprints such as Frederic*k* Harrison and homogomy and father for brother on p. 235 have been allowed to pass, while we think the description of the condition of Portugal during the reign of Alfonso IV. as "progress, especially against the infidels," an unhappy one.

The conclusions reached in the two books are much alike, as the authors find a few centres about which the intelligence seems to collect rather than a chance-distribution of highly intelligent individuals through the population. We cannot help feeling, however, that there is some doubt as to whether the collection of information among special groups is as satisfactory as the investigation of random samples of the population. This objection can be urged against the "Noteworthy Families" rather than against the "Royalty," because in the former work we do not know for certain how many very able persons spring from the general public, but a similar question does not arise in dealing with Royalty, and the only point is how far we may apply results obtained from one class to persons in another.

We are inclined to think that both books may find readers among those who have not made a special study of the statistics bearing on heredity, for both give information in a clear and interesting manner, and the lists of families in the one case and the discussion of Royal personages in the other will attract many who would never look at a work containing nothing but statistical investigation. Is it too much to hope that some of these readers may be led to appreciate that the ultimate proof of historical or biological theories must have a statistical basis? That they will appreciate the painstaking energy of the authors is beyond doubt. I.

TOPOGRAPHICAL SURVEYING.

Text-book of Topographical and Geographical Surveying. By Major C. F. Close, C.M.G., R.E. Pp. iv+288. Printed for H.M. Stationery Office. Price 3*s.* 6*d.*

THE art of topographical surveying was almost invariably known in this country until recent years as "military topography," a phrase which may be taken to mean not that the topography of a region presented special features to the soldier, but that little attention was paid to topographical surveying of any sort until military necessity arose. The fact that interest in and knowledge of surveying of this kind is no longer confined to the Army is largely due to the active influence of the Royal Geographical Society in London and in the Universities of Oxford and Cambridge, as a result of which an increasing number of intending travellers, explorers, naturalists, and colonists go through some training in surveying before setting out for distant parts, but it is scarcely less due to the work of the Royal Engineers in constantly developing and testing new instruments and methods in the field, and in making the results of trial and experiment generally accessible.

That the extent of the field before the topographer is great is abundantly evident from Major Close's statement in an introductory paragraph that "excluding Canada, Australia, New Zealand, and India, the total unmapped area of the British Empire amounts to about 3,700,000 square miles." Now we cannot expect that the whole of this area will be mapped for purely military purposes. It is to be hoped that sooner or later Government surveyors will lay down a primary triangulation over it for the benefit of the topographer who may follow, but we can scarcely expect more. The topographic map must in the end be made by the civilian who is to use it; the most he can look for from outside is a number of fixed points upon which to "hang" his own surveys.

Thus we arrive at the conclusion that more provision must be made for the training of civilian topographers in this country, and we are at once confronted by great difficulties. Students learning surveying are usually studying other subjects at the same time, and in the more open parts of these islands where alone it is easy to do small-scale work extending over any considerable area, opportunities of studying other subjects are necessarily limited. The question of time also becomes troublesome, much of what is available being soon spent in getting to and from the scene of operations; and the climate, difficulties connected with trespass, setting up marks, getting unskilled assistance, and so on, are all against the student. Work with ordinary "classes" is for the most part restricted to mapping on a scale of at least three inches to a mile, with "demonstrations" of the nature of secondary triangulation, and bicycle expeditions for practice in rapid sketching over larger areas; beyond this it is necessary to depend on "vacation courses" extending over a week or ten days in the summer. The expedients, however, are more or less of the nature of makeshift, and the student cannot hope to acquire the eye for country, and the facility in representing it, which is characteristic of skilled surveyors in constant practice, like the native topographers in the survey of India.

But the difficulty does not end here, for it affects the civilian teacher as well as the student. However great the skill and experience of the latter may be, it is scarcely possible for him to keep "up to date" without direct contact with actual modern survey work, and this is difficult to achieve. The importance of this is clearly shown in Major Close's book, in which, as he says, "the field methods described are, for the most part, those in use by the Survey of India; but advantage has been taken of recent experience in mapping and exploring various territories in Africa and elsewhere to include useful methods which are not commonly employed in India."

Hence, for many reasons, it is to the advantage of all topographers in this country to keep up as close acquaintance as possible with the service work in all its branches, and amongst the many efforts which military surveyors have always made to render this easy, few have been more entirely adequate than the publication of this book. There are few subjects in which books by themselves are of less assistance than topographical surveying, but Major Close has succeeded fully in doing what can be done by this means.

The body of the book consists of seventeen chapters on instruments and methods, sketching, map projections, the reproduction of maps in the field, field astronomy and the determination of positions, and the theory of errors as applied to topographical work. Some of these chapters have been partly written by officers who have given special attention to the subjects treated of, others are drawn from published papers, and the sections on field astronomy have been revised by Mr. A. R. Hinks, of Cambridge Observatory. The eighteen tables giving the quantities usually required for plotting graticules, computing astronomical results, and so on have been specially revised, and in some cases recalculated. Ten appendices give various useful lists, explanations, and formulæ. The thirty-four plates, which include admirable examples of sketch maps of different kinds, specimen sheets of British and foreign topographical maps on different scales, and four new star charts, are almost the best features of the book. It would be difficult to suggest a better exercise in map reading for the student than a study of the reproductions of maps executed by the Ordnance Survey.

Taking the book for what it is, we find, as might be expected, little or nothing to criticise; it would be easy to criticise it for what it is not, and does not profess to be. As a text-book, experience has proved its excellence, but it must be fully realised that it is true to its name, and that while it supplies the text, the teacher must preach the sermon. Many chapters are distinctly of the "pemmican" order, and would prove extremely difficult to a reader altogether unacquainted with the subject. The difficulty is no doubt got over to some extent by the excellent lists of references given. These lists might perhaps be made more complete, but in some cases satisfactory books are still to be written. We may take as an example the chapter on map projections—largely reprinted from Major Close's "sketch" of the subject—and venture to express the hope that the author will one day give us an authoritative text-book on this alone. Another chapter about which the same remark might be made—indeed the author himself makes it—is that on the adjustment of errors, a subject we have always found of great value and interest even to elementary students dealing with comparatively rough observations. It is true that a good deal of help can be obtained here from the methods ordinarily employed by engineers, but for topographical purposes many useful results can be got by graphic extensions of these methods.

H. N. D.

GARDEN SHRIMPS.

The British Woodlice, being a Monograph of the Terrestrial Isopod Crustacea occurring in the British Islands. By Wilfred Mark Webb and Charles Sillem. Pp. x+54; with 25 plates and 59 figures in the text. (London: Duckworth and Co., 1906.) Price 6s. net.

AT present in England there are only two dozen species of these little land crustaceans on record. The number, combined with their love of obscurity, may remind us of the regal feast at which four-and-twenty blackbirds were served up concealed in a pasty. When the pie was opened, the birds began to sing. In correspondence with the daintiness of such a dish, the apostles of œcology are now earnestly trying to persuade society that all nature is tuneful. Those who are afflicted with toneless ears may assume a haughty indifference towards the resounding harmony, while they are themselves the objects of pity rather than of pride. The bright little volume under review is an excellent example of what can be done under the new impulse given to the old practice of "nature-study." It shows how members of our fauna, that have long suffered from negligent and contemptuous treatment, may in friendly hands receive their proper meed of appreciation. Though, out of deference to tradition, the book goes by the unprepossessing name of "The British Woodlice," its subtitle redeems the subject from prejudice by assigning it to its true place in classification. The many scurrilous colloquial terms that have been applied to these terrestrial isopods have, to the ordinary observer, obscured the fact that they are really made of one flesh and blood with the epicure's cherished treasures, the lobster and the prawn. Their use medicinally in old times would probably have been robbed of half its charm had this been understood, since in those days curative agencies seem to have been valued in proportion to the pain and disgust they inflicted on the patient. So lately as 1883, W. G. Black, in his "Folk Medicine," writes:—

"A relation of mine was in the cottage of a wise woman at Penzance about two years ago, and found that she was still in the habit of prescribing in scrofulous cases grammar sows, sow-pigs, millepedes or woodlice, to be swallowed as a pill. According to the Penzance woman, the sufferer must himself secure his medicine, but she had a corner in her little garden where nothing was grown but mint and thyme, and there the sow-pigs were reared. As a concession to modern feelings, patients are now allowed to wear this disagreeable medicine in a little bag round the neck, if they shrink from the heroic remedy of swallowing it."

One may wonder whether the man who first ate a shrimp thought himself a hero! It will be noticed that the wise woman of Penzance had to foster her colony of animated pills. Mr. Webb also recounts the efforts of industrious research on the part of himself and others by which the present small total of British species has been slowly ascertained. Some of the species, indeed, are known to be widely distributed, and in places to be very abundant. But there is little proof that even those which have the worst repute for depredation do any serious amount of harm in our gardens. They are chiefly to be found in rubbish heaps or nests of garden pots, or under flat, neglected stones. Many of the species are the rare prizes of diligent collectors. Mr. Webb has given a very full and faithful record of published captures, the only work of importance which he does not appear to have thoroughly examined being the Transactions of the Devonshire Association. Ireland, with a list of species not quite equal to that of England, still in *Trichoniscus vividus* (Koch) keeps one form exclusively to herself. In the very large number of European species all of ours are included, and twenty of them have been described by Prof. G. O. Sars in his admirable work on the Crustacea of Norway.

The authors of the present volume are most scrupulous in acknowledgment of assistance they have received from various sources. They are to be congratulated on their own accuracy and diligence. The results of their good work in the field, with the microscope, and in the study of the available literature on the subject are presented in a compendious and excellently illustrated treatise. Marine isopods are sometimes found with the front half of the body much narrower than the after part. Light is thrown upon this odd appearance by one of the incidents of exuviation. The animal sheds the hind part of its skin first, while the more dilatory front remains still incapable of expansion in its old armour. Messrs. Webb and Sillem explain that this is just what happens with our garden shrimps, there being an interval of three days or so between the two strippings. Their authority on this point, Mr. J. B. Casserley, has also observed that the thrifty creature eats the skin which it has shed. What fortunes there are to be made out of waste products! The habit is no doubt widely diffused among crustaceans, otherwise their innumerable cast skins would be more frequently met with.

The well-drawn plates of this commendable volume are not coloured, but the student whom it inspires to take up the subject may find exceptional attraction in the specific names of *Armadillidium pulchellum*, the beautiful little Armadillo, *Porcellio pictus*, the painted Porcellio, and above all *Trichoniscus roseus*, the rose-tinted Trichoniscus. T. R. R. S.

AUSTRALIAN ETHNOLOGY.

Ethnological Notes on the Aboriginal Tribes of New South Wales and Victoria. By R. H. Mathews. Pp. xiv+183. (Sydney: F. W. White, 1905.)

THE author of this work has published numerous articles on Australian anthropological subjects during the past ten years, but they have either been ignored or dismissed in a footnote by experts such as Dr. Howitt and Prof. Baldwin Spencer. A careful examination of his contributions does not give a high opinion of the author's qualifications for his task. The present volume contains a bibliography of the author's articles and some assertions as to the importance of this new contribution, of which the following sentences are specimens:—"Those portions of my book dealing with sociology," at pp. 5–15 and 84–103, will completely revolutionise all the old school notions respecting the organisation of Australian tribes "which have been published up to this date" (p. 4). "I have adopted none of the opinions nor followed any of the methods of other Australian authors, but have struck out on my own lines" (p. 2). "Since the time of Mr. Ridley and Mr. Bridgeman down to the present day, nothing important has been added to our knowledge of the Kamilaroi organisation" (p. 13).

It requires self-assurance to make the last of these three assertions, for Mr. Mathews can hardly expect his readers to be so ignorant as never to have heard of Dr. Howitt, whose "Native Tribes," published the year before last, contains much information on the subject, even if we neglect "Kamilaroi and Kurnai," published by him nearly five-and-twenty years ago in collaboration with Dr. Fison. In the work before us the main novelty in the way of sociological information appears to be the statement that the Ngeumba tribe is divided into "castes" and "bloods" as well as kins and phratries. The Ngeumba, whom another writer seems to have termed Nyamba, are near neighbours of the Euahlayi on the Narran River, and the names for the "blood" divisions in the Ngeumba tribe are virtually identical with those given as phratry names by Mrs. Langloh Parker for the Euahlayi. That being so, we have the choice of three theories:—(1) that both authors are correct; (2) that Mr. Mathews has confused two tribes; or (3) that Mrs. Parker's information is incomplete. In view of the fact that she resided twenty years among them and gained the full confidence of the Euahlayi, the latter seems improbable; we are therefore left to choose between a superposition of organisations or a confusion created by Mr. Mathews. He does not work out how the "blood" organisation affects the ordinary social organisation.

The "castes" are stated to have reference to the manner of camping and to denote the shade of various parts of a tree; our confidence in this explanation is not increased by the discovery that one of the words, *nurai*, is the ordinary name for the black snake totem in two or three adjoining tribes. It is to be hoped that some anthropologist of reputation will turn his attention to the tribe. If Mr. Mathews's information turns out to be correct, he will have done something towards establishing his reputation.

N. W. T.

THE BREEDING INDUSTRY.

The Breeding Industry. By Walter Heape, F.R.S. Pp. xii + 154. (Cambridge: University Press, 1906.) Price 2*s.* 6*d.* net.

THE author of the present volume has long been distinguished for his investigations in vertebrate embryology and the physiology of vertebrate reproduction. He has also paid considerable attention to the practical aspects of the subject, in so far as they concern the methods adopted by the animal breeder and the needs of the breeding industry. In the light of the special knowledge and experience which he has thus gained, Mr. Heape has become firmly convinced that the breeder will derive "inestimable advantage from the right application of science to the industry with which he is concerned," while it is no less his strong belief "that the field of scientific biology will be broadened, the number of workers therein increased, and the means available for their work augmented, as the result of . . . . more intimate relations between scientific and practical biologists." Those who read this volume, and all others who are familiar with the nature of the questions discussed therein, can have little difficulty in realising that Mr. Heape is right.

The first chapter, which is introductory in character, deals with the present position of the breeding industry in our own country. The scientific man and the breeder are too frequently antagonistic, and tend to distrust one another. This antagonism, which is quite unnecessary, is as much the fault of the man of science as of the practical man, and it is to be partly ascribed to the unsympathetic attitude of the former towards many of the facts and problems of practical breeding, as well as to the general neglect by professed biologists of that wide field of investigation comprised within the physiology of reproduction. All this is pointed out in somewhat different language by the author, who lays great stress on the enormous advantages to be gained by the introduction of scientific method into the industry of breeding, just as it has proved invaluable to other industries.

The second chapter consists of a concise, clear, and eminently business-like calculation of the value of the breeding industry to the country. As a result of this calculation Mr. Heape arrives at the truly remarkable conclusion that the total sum invested in live-stock in the British Islands is scarcely less than 450,000,000*l.*—an estimate which does not appear to err on the side of excess. Added to this the capital invested in various accessories—vehicles, machinery, housing, &c.—the total becomes still more gigantic. And yet, in the words quoted from Mr. Bateson, the breeding industry is one "to which science has never yet been applied."

In a further chapter the author deals with the nature of the work required for the advancement of the breeding industry. This is comprised under three heads—(1) the keeping of records, (2) the carrying on of research, and (3) the work of administration—all of which are shown to be of the utmost importance. Under the heading of research the author alludes to the special nature of certain of the problems which require elucidation, and particularly those relating to the physiology of the generative system. He might have added that proper facilities for carrying out this kind of research are at present practically non-existent. Such as do exist are due almost entirely to private enterprise and generosity. In order to conduct on any considerable scale investigations upon questions involving the maintenance of animals under reasonably natural conditions and for prolonged periods of time, as well as for the study of the phenomena of inheritance and variation, the creation of some sort of experiment station or biological farm has become a matter of urgent necessity. For carrying on the work of administration Mr. Heape advocates the institution of a State department of animal industry, which would form a section of a new Board of Agriculture.

In the final chapter the management and work of the present Board of Agriculture are discussed, and it is pointed out that there is a want of confidence in its methods and an inadequacy about its organisation which compare unfavourably with those of the corresponding American department.

Mr. Heape's book is well calculated to arouse public interest, for the problem with which it deals is the concern, not only of the man of science, but of all who have regard for the welfare of one of the greatest industries of the nation.

FRANCIS H. A. MARSHALL.

OUR BOOK SHELF.

The Elements of Geology. By Prof. W. H. Norton. Pp. x+461. (Boston, New York, and London: Ginn and Co., n.d.) Price 6*s.* 6*d.*

THIS is a further addition to the well written and well printed introductions to physical geography and geology which have been produced of late years for American schools. We do not quite agree with the author as to the novelty of the arrangement of his material, but it is certainly effective, and the questions attached to many of the illustrations are such as will draw out the reasoning powers of the pupil. Chemical and mineralogical considerations are kept in the background, and rocks are very broadly dealt with, as when syenite is defined (p. 274) as consisting of "feldspar and mica," and diorite as being "still less siliceous, composed of hornblende and feldspar—the latter mineral being of different variety from the feldspar of granite and syenite."

The book, however, hardly suffers from this, as explanations are brought in at the proper points, and a certain chemical knowledge seems to be presupposed. Zoological definitions are given from time to time in the stratigraphical portion, but we still think that the study of geology is held in too light estimation when it is thus regarded as elementary and independent, and not to be preceded by an outline of other branches of natural history. The geographical study of surface-features may, of course, be linked with geological considerations quite early in the curriculum of a school, and the portion of Prof. Norton's book that deals with the shaping of the earth's surface strikes us as especially admirable. It is confessedly and worthily based on the methods of Prof. W. M. Davis, who contributes a note of introduction.

The illustrations, moreover, are well selected throughout, and, where they have been borrowed, acknowledgment is made in most cases of the source. Mr. Welch's famous pot-hole in Glenariff, which was introduced to geologists in an English work in 1895, does duty here for the fourth or fifth time; but the numerous photographs of American scenery will prove of special interest to readers on this side of the Atlantic. The book is modern and very carefully thought out. On p. 246 volcanic phenomena are "extra illustrated" by the ruins of St. Pierre; on p. 306 the latest views are expressed on the gneisses of the "fundamental" Archæan complex; the Mesozoic reptiles receive attractive treatment on pp. 385–392; while on p. 446 a "restored" head of Pithecanthropus finds a place among relics of primitive man. This last instance errs, however, in showing much that is prophetic of future discoveries. Prof. Norton still translates *roches moutonnées* as "sheep backs," but the mention of this detail is only a tribute to his general accuracy. G. A. J. C.

Letters from the Dead to the Dead. By Oliver Lector. Pp. 101. (London: Bernard Quaritch, 1905.) Price 6*s.* net.

THE fact that the letters attributed to Bacon, Shakespeare, Napier, Henry Briggs, and Guy Fawkes have dates attached to them about the years 1904 and 1905 should convince most readers that the book ought to be regarded in the light of a practical joke, in fact, a "take off" of the antique. As another example we may take the "Notes to Henry Briggs's letter," in particular the supposed proof (p. 75) that Napier's true base is the reciprocal of e and not e itself. As the difference depends entirely on whether $\log \sin 45^{\circ}$ has a plus or minus sign attached to it, it is interesting to speculate on how many readers will be deceived by what is, after all, a somewhat clever hoax.

Atlas colorié des Plantes et des Animaux des Côtes de France. By Dr. M. Langeron. Translated and adapted from P. Kuckuck's work. Pp. vii+67; with 24 coloured plates. (Paris: J. B. Baillière et Fils, 1906.) Price 7.50 francs.

THIS attractive publication is an adaptation, so far as the marine flora and fauna of France are concerned, of the well-known work of M. Kuckuck. It consists of three parts, dealing respectively with the phanerogams living in the neighbourhood of the sea, marine algæ, and marine fauna. The book is intended for the use of young students with a love of natural history, and should prove a useful companion during seaside holidays. The plates are instructive and well produced.

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.*]

Osmotic Pressure.

AT Prof. Armstrong's request, published in NATURE of May 24 (p. 79), I willingly summarise the electrical evidence on which the theory of ionic dissociation seems to me to rest, though a full discussion of that evidence would, I fear, be too long for a letter in this place. Perhaps Prof. Armstrong will allow me to refer him to two papers in which I have written more fully what follows; one paper is in the *Philosophical Magazine* for February, 1903, and the other in the *Electro-Chemist* for July of the same year.

It will, I think, be admitted that we must accept the general view of electrolysis which we owe to Faraday and Kohlrausch, and imagine that opposite parts of the electrolyte move in opposite directions through the liquid. Such a view seems necessary to explain the appearance of the products of chemical change at the electrodes only, and may be verified by direct visual observation, as in the experimental measurements of the velocity with which those parts travel. It need involve no further assumption if, for convenience, we agree to call the moving parts ions. Controversy begins when we attempt to explain how and by what mechanism the ions move. The dissociation theory represents the ions as free from each other (though probably combined with the solvent) during that fraction of their lives in which they are concerned actively in conveying the current. Prof. Armstrong, on the other hand, rejects the idea of any kind of permanent or semi-permanent dissociation, and holds that the electrolyte exists in solution as combined molecules of, let us say, potassium chloride. On the latter theory the mobility of the ions must be secured by some mechanism which involves a series of interchanges between the opposite parts of the molecules. Grotthus pictured the molecules arranged as the links of a chain extending all the distance from one electrode to the other. This particular hypothesis would be exempt from the following criticism, but I suppose it would not be upheld by anyone at the present day. It conflicts too clearly with our knowledge of other phenomena. From our modern kinetic point of view, we should regard the molecules as in continual irregular motion, and suppose the ionic interchanges to occur at the instants when two molecules come within each others' sphere of influence.

Such, I imagine, is the alternative to the theory of ionic dissociation; let us trace its consequences. The greater the frequency with which molecular collisions occur, the more often can ionic interchanges take place, and the faster will the ions work their way through the liquid. Thus the ionic velocities will depend upon and increase with the frequency of collision—a frequency which, on the kinetic theory, varies as the square of the concentration. Thus, on the hypothesis we are considering, the velocities of the ions will increase with the concentration, and be proportional, approximately at any rate, to the square of the concentration. The conductivity, which is measured by the product of the number of ions and their mutual velocity, will then vary approximately as the cube of the concentration. But the facts are quite at variance with these conclusions. The velocities of the ions are found to be constant in dilute solutions, and to decrease slowly with increasing concentration when the solutions are stronger, while the conductivity of a dilute solution is proportional at most to the first power of the concentration.

We must, therefore, it seems to me, abandon the theory of ionic interchanges at the instants of molecular collision, and turn to the rival hypothesis. There are several pieces of positive evidence in favour of the view that the ions migrate independently of each other through the solution. Of these pieces of evidence I may mention three:—(1) the calculated velocity of an ion, as calculated from the conductivity and the migration constant, is independent of the nature of the other ion present when the solution is dilute—the velocity of chlorine is the same whether the other ion be potassium, or lithium, or sodium; (2) the difference of potential observed between two solutions of different concentrations can be calculated numerically on the assumption that the ions migrate independently of each other until the electrostatic forces of attraction prevent further separation; (3) it is possible to explain satisfactorily the curious relation between the valency of the metallic ion of a salt and its specific coagulative power on certain colloid solutions on the assumption that coagulation is due to the effect on the surface conditions produced by a certain minimum electric charge brought together by the chance conjunctions of isolated ions (*Phil. Mag.*, 1899).

The evidence sketched above has been obtained by observations on aqueous solutions. It remains a further question whether similar relations hold for solutions in other solvents and for such electrolytes as fused salts. In the latter case, at any rate, the conditions may be fundamentally different, and it seems necessary to wait for further investigation.

Such, it seems to me, is the present case for the theory of ionic dissociation when put in brief form and restricted to direct evidence. The indirect evidence, based on the success of similar ideas in coordinating and explaining the conduction of electricity through gases, however, must now be taken into account in any full discussion of the subject. I confess that to me the cumulative evidence seems overwhelming. But I hold no brief for the theory, as Prof. Armstrong seems to imagine, and if ever it ceases to be the best hypothesis in the field I shall willingly abandon it. Consistency always seems to me to be the meanest of the virtues, and in matters scientific it may become the most deadly of the vices.

I have endeavoured, as well as the exigencies of space admit, to comply with Prof. Armstrong's request. May I ask him in return to state his own view of the mechanism of electrolysis, to explain, in effect, what is the alternative he proposes to the theory of ionic dissociation?

I am glad to have given an opportunity for Mr. Norman Campbell to explain in public his interesting views on the subject of thermodynamics—views which we have discussed more than once in private without coming to an agreement, though, for my part, I have learnt much by Mr. Campbell's clear-sighted criticism. He will know what my answer to his letter must be, though I have no hope that he will be convinced thereby.

I do not wish to discuss the whole question of the theory of thermodynamics; I am not entitled to do so. But Mr. Campbell holds that, even if general thermodynamics be sound, its application to osmotics is not justified. Now it is here that we do not agree, and I should like to explain the grounds of my belief that not only is the application of thermodynamics to osmotics successful, but that the success is one of the strongest arguments we possess for the general validity of reversible thermodynamics as an ideal towards which practical arrangements may approximate.

Referring to the concordance between the theoretical value of the osmotic pressure of dilute solutions and that observed experimentally, Mr. Campbell says:—"It must be remembered that there is not perfect agreement. . . . The errors are larger than those involved in the direct measurement of the pressure and the other quantities involved; there is a systematic error. But this is due, say the thermodynamicists, to the imperfection of the membrane." I am not sure that I like to be called such a bad name, even by Mr. Campbell, but may I point out that Mr. Campbell has not put forward the whole of the evidence?

The direct measurement of osmotic pressure may not be a very accurate performance, though experience shows that as our membranes become more and more perfect the observed values more nearly approach that indicated by theory as the ideal case. But let us pass that by for a moment, and consider the relation between the osmotic pressure of a solution as defined theoretically and its freezing point. To do so we must use again thermodynamical reasoning, and introduce its necessary assumptions. But most of the assumptions will be the same as we made in deducing the theoretical value for the osmotic pressure, and they, at any rate, do not really add to the total number. Having obtained the well-known relation between osmotic pressure and freezing point, let us calculate numerically what the freezing point of the solution would be if the osmotic pressure possessed the theoretical value. With the most probable number for the latent heat of fusion, the molecular depression of the freezing point of water by the solution in it of a small quantity of any substance should be 1°·857 C. Mr. Griffith's experiments, made with all the refinements of platinum thermometry, gave for the molecular depression of solutions of cane-sugar (from a concentration of 0·0005 to 0·02 gram-molecules per litre) the number 1°·858. The limiting number for solutions of potassium chloride was 3°·720, half of which is 1°·860. Now these numbers agree with astonishing closeness; the opposite errors on Mr. Campbell's hypothesis must balance each other to within very little more than one part in a thousand. I cannot disprove his contention, but I think the balance of probability is against him, and, after all, any evidence which involves experiment must be merely a question of less or greater probability.

Now it seems to me that in this concordance we have a very strong piece of evidence in favour of the existence of an effectively reversible operation in the process of freezing—an operation much more nearly truly reversible than any it is possible to obtain with the rough and crude arrangements of even the best practical heat engines. Hence my present opinion is that, not only is the application of thermodynamics to osmotic phenomena in their theoretical aspect justified, but that it gives one of the most valuable confirmations we possess of the general validity of thermodynamic reasoning as a means of discovering an ideal limit towards which practical processes may tend.

In conclusion, may I point out the great interest of Mr. Campbell's argument that it may be "the swifter molecules which escape into the vapour and the slower which escape into the solid." The contention seems reasonable; and, though I feel that the strength of the case I have stated above is so great as to indicate that such a sifting of molecules cannot affect appreciably the thermodynamic result, it is clear that Mr. Campbell's point should be considered. Has Mr. Campbell really caught a Maxwellian demon? If so, all the world will crowd to study the specimen. But this letter is too long already, and I must leave the discussion to some one more learned than I am in this particular branch of demonology.

W. C. D. WHETHAM.

Trinity College, Cambridge, May 26.

A New Vesuvian Mineral.

AMONG the ejected masses that strew the flanks of Vesuvius many minerals of known species are to be recognised, and will be referred to in a publication now in preparation.

Perhaps the most interesting among a large number of blocks that I broke open after the eruption were two containing fine crystals of halite associated in spots with a canary-yellow mineral. This latter occurs in crystals up to several millimetres in diameter, and, so far as I have yet examined it, appears to be in rather flat rhombohedra. It is somewhat deliquescent, and therefore requires special attention for its preservation. This is, no doubt, due to the small proportion of magnesium chloride.

A preliminary analysis affords the following result :—

Moisture	0·12	$MgCl_2+6H_2O$	0·22
Insoluble matter ..	0 65	$Na_2SO_4+10H_2O$ ...	1·95
$MnCl_2+4H_2O$	38·97	Fe_2O_3	traces
KCl	57·71		
NaCl	0·32	Total	99 94

From this analysis it appears that we have to do with a double chloride of manganese and potassium for which I propose the name of *chlormanganokalite*, at any rate provisionally until more complete studies can be made of this undescribed species and proper proportions attributed to the combined molecules.

The associated minerals have been deposited as sublimates in the interspaces of scoriaceous masses forming the upper part of the great cone.

The halite probably is rich in potash, but I have not yet had time to make an analysis.

H. J. JOHNSTON-LAVIS.

THE PHOTOGRAPHY OF THE FUNDUS OCULI.

IT is not surprising that the idea of photographing the fundus of the eye followed quickly upon the discovery of the ophthalmoscope by von Helmholtz in 1851. The many attempts made by Noyes (1862), Rosebrugh, Dor, Howe, Bagneris, and others on animals met with only partial success, whilst Gerloff, Thorner and others, who attacked the more difficult problem of the human eye, obtained very inferior results. The best photographs of the human fundus have been taken by Prof. Dimmer, of Graz, who records his experiments in the *Sitzungsberichte der kaiserlichen Akademie der Wissenschaften zu Wien, Math.-Naturwissensch. Klasse* (Bd. cxiv., Heft ix., 1905).

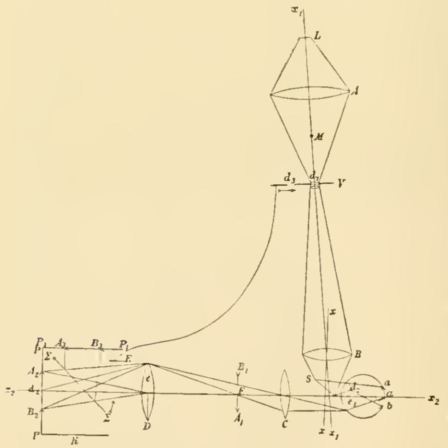


FIG. 1.—Diagram of apparatus.

The chief difficulties which have to be contended with are (1) that of keeping the eye immobile; (2) the necessity for very powerful illumination, which may have a deleterious effect upon the eye; (3) the reflexes formed by the surfaces of the dioptric media—corneal, lenticular, and fundal. Of these the complete abolition of reflexes has as yet proved insuperable. Prof. Dimmer has succeeded in reducing the corneal and lenticular reflexes to a minimum, but the shimmering reflexes at the fundus, which vary so much in different eyes, have resisted all efforts. Nevertheless, an encouraging degree of success has been attained.

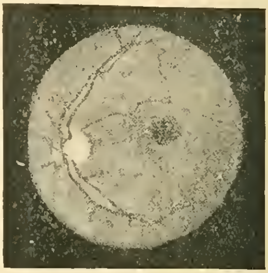


FIG. 2.—The normal fundus.

The method adopted was as follows:— The source of light was a 20–30-ampere arc lamp (L). The light was concentrated on a small diaphragm (d_1), which may be regarded as the immediate source of illumination. A second condenser system (B) formed an image of the diaphragm at the level of the pupil of the eye (d_2). The light and condenser systems were centred on an axis at right angles to the optic axis, the cone of rays being reflected into one half of the pupil by an oblique mirror (S) immediately in front of the eye. This arrangement has the advantages of illuminating a maximum field of the fundus, of reducing the corneal and lenticular reflexes to a minimum, and of leaving the other half of the pupil free for the emergent rays. The last device is that adopted by Bagneris, and by Wolff in his electric-light ophthalmoscope.

The image of the fundus is that of the ordinary indirect method of ophthalmoscopic examination. A convex lens (C) forms a real inverted image at or near its principal focus (F), according to the refraction of the eye. A second convex lens (D) is used to form an erect image upon the sensitive plate (PP). An oblique mirror (ΣΣ) in the camera reflects the image on to a ground glass screen (P_1P_1) at right angles to the position of the plate until the moment of exposure; this facilitates focusing, &c.

Fixation is maintained by an object (M) in the axis of illumination, the diaphragm being covered by a smoked glass. At the moment of exposure, which is instantaneous, a blank diaphragm (d_3) is shot into position by a simple electromagnetic arrangement. Orthochromatic plates are, of course, used to minimise the inopportune colour of the image.

Prof. Dimmer has photographed several normal and pathological eyes. No evil effects have apparently ensued, owing to the shortness of the exposure required. The results are better than any previously obtained, but they are far from perfect. Those who saw the original photographs at the International Ophthalmological Congress at Lucerne in 1904 will, however, condole with the author for the inferior halftone reproductions of the Imperial Academy.

We are forced to admire Prof. Dimmer's pertinacity in this research, at which he has been occupied since 1899. Considering the well-known dangers of very bright illumination upon the retina, the mediocre results obtained, and the doubtful utility in ophthalmic surgery, we cannot but hope that future experiments will be confined for the present to animals.

J. HERBERT PARSONS.

THE BIRDS OF THE ISLE OF MAN.[1]

THE present volume forms an addition to the now considerable list of those well-known and trustworthy "Faunas" of counties or special areas which have from time to time issued from the publishing house of David Douglas in Edinburgh. It is not an unworthy companion to them. The majority of its predecessors, however, have included the complete vertebrate fauna of the region dealt with, and, remembering the limited area of the Isle of Man, the present volume might well have done the same without increasing very seriously the labours of the author or the size of the book. It would then have been a useful complement to the "Vertebrate Fauna of Lakeland," by the late Rev. H. A. Macpherson, in the same series, and would have filled a blank.

It is rather surprising that, amid the numberless local faunas that have been published, we have as yet no complete work on the natural history of the Isle of Man, considering the numerous contributions, scattered, no doubt, through many periodicals, to its botany, zoology, geology, and antiquities that have been made by excellent and systematic observers from the days of Sir William Jardine and Edward Forbes onward. The present very complete volume on the birds is, however, heartily welcome. Its author, Mr. Ralfe, is well known in ornithological literature as one who has devoted much time to the study of the feathered fauna of his native Mona, "in the intervals of daily occupation and in more than usual isolation from the resources of science." He fully acknowledges his indebtedness to Mr. Kermode, whose name also, as he indicates, might well be bracketed with his own on the title-page, so intimately have they been associated together in bird-observation and record.

The detailed account of the species frequenting the island is prefaced by an introductory chapter containing sections on, among others, the topography of Man; on the history of Manx ornithology, in which the chief writers and their contributions are referred to; on Manx bird-names, so often expressive and musical; and on migration in Man. The latter is very disappointing. From so competent an ornithologist as Mr. Ralfe, with his residence on the island, which is a special rest-place on the main west coast fly-line, we might have looked for that chapter on the autumn and spring movements of the migratory stream which has yet to be written.

Nestling in the large north-western bight between England and Scotland, the Isle of Man has relationships with Lancashire, Lakeland, the three southernmost Scottish counties on its northern side, as well as with Ireland. Mr. Ralfe has carefully noted this relationship, where possible, by reference to the work of Service, of Gray and Anderson, of Macpherson and Mitchell, of Aplin, Coward and Oldham, and of Ussher and Warren. If we compare the number of species of birds recorded from Lancashire, as a neighbouring, accurately defined and well-worked area, with that from Man, we have 269 species from the several-times-larger county, against 183 from the smaller isle, indicating a fairly rich avifauna, notwithstanding its disadvantageous isolation, its bare heights, and its poverty in woodland and shrubberies. There are 75 residents and 18 summer visitors among the 93 nesting species of Man, against the 93 residents and 43 summer visitors comprising the 136 breeding birds of Lancashire. "Almost all birds generally distributed through the British Isles, at least as far as our latitude, are present. . . . Man agrees with Ireland and differs from the opposite counties of England in the absence or rarity of various small summer migrants," such as the garden warbler, redstart, tree-pipit, woodpecker, and others. The island, however, "is rich in rock-breeding coast birds, but rather lacking in shore-frequenting waders." Such is a summarised account.

The author has narrated concisely all that is worthy of record about the commoner species, reserving his space for fuller details in the history of others of special interest to the island. We find in regard to the carrion crow that it is the grey-headed form which is resident in Man, while the black race is practically absent, and, therefore, the island follows Scotland and Ireland and differs from England in the distribution of this bird. The following problem has often presented itself to us:—When the dimorphic forms (*cornix* and *corone*) of this species interbreed in considerable numbers on the border-line (*i.e.* along the line from the Firth of Clyde to the Adriatic) of their defined areas, and rear families of, say, three individuals of the *cornix* and three of the *corone* race in each nest, what induces the "greynecks" on the approach of the breeding season to hurry off to their proper side of the line, while their black nest-fellows feel constrained to reside to the southward of it? Ornithologists will be gratified to have Mr. Ralfe's assurance that the chough is not diminishing in numbers, but displays its scarlet beak and legs "abundantly on the steep brows which fall from the rocky hill-tops to the . . . . luxuriantly

Photo F. S. Graves.

FIG. 1.—Nesting-place and eggs of Arctic Tern (amid drift of highest tides). From "The Birds of the Isle of Man."

[1] "The Birds of the Isle of Man." By P. G. Ralfe. Pp. lv+321 Edinburgh: David Douglas, 1905.) Price 18s. net

foliaged sea-cliffs"; and that the peregrine falcons still occupy the ancient eyries in which they were protected for 300 years, although now their names are, strangely enough, not among those scheduled in the Wild Birds Protection Act. On the other hand, they will note with regret the extinction of the rock-dove and of the shearwater (which derives its name from the island), which were once so abundant among its cliffs.

This volume, if not perhaps quite up to the standard of some others of the series, is a conscientious and careful contribution to the natural history of Man. It is beautifully illustrated by two maps, as to the excellence of which no more need be said than that they are by Bartholomew, of Edinburgh, and by fifty full-page blocks of Manx scenery (most of them of favourite nesting-places of different species), a specimen of which, by the publisher's courtesy, is here reproduced. F.

THE BEAUFORT SCALE.[1]

ABOUT a hundred years ago, Admiral Beaufort, having felt the want of some scheme by which the winds could be classified according to their force, devised a plan which has been in uninterrupted use ever since. In the absence of mechanical anemometers he had to trust to personal experience and the observed effects of wind on the objects moved by it. As a sailor, he naturally selected ships as the objects moved. Calling a calm zero, and representing a hurricane, or a wind in which no ship could carry any canvas, by 12, he endeavoured to assign the intermediate numbers to winds the force of which could be gauged by the amount of sail that a well-conditioned ship of specified rig could carry. In the lapse of time sailing ships altered their rigging or disappeared altogether, with the result that the gallant Admiral's nomenclature became obsolete or unmeaning. Anemometers depending upon the application of some mechanical principle came into general use, and from the fact that these instruments gave a continual record, right or wrong, their register tended to supersede a plan, which relied simply on tradition and probably varied in individual observers. But it has always been felt that there existed some relation between the records of the anemometer and the Beaufort Scale, and various authorities have attempted from time to time to bring the two into accord, or to supply the means of expressing any given number in the Beaufort Scale as velocity reckoned in miles per hour. These well-meaning attempts have not enjoyed the unquestioned confidence of meteorologists, nor have they ensured uniformity in practice. Of late the Meteorological Office has instituted a rigorous inquiry into the estimates of wind force as made in the Beaufort plan and as recorded by anemometers, and have now issued their report.

A preliminary question presents itself to which it is difficult to give a completely satisfactory answer. Is the Beaufort Scale worth preserving? or, in other words, relying as the scale does on personal experience, is it capable of being reproduced with sufficient accuracy to ensure the maintenance of constancy in all circumstances and in all localities? This question must have presented itself to the Meteorological Office and been answered in the affirmative. The decision taken is probably justified. In many positions at sea it is not possible to use mechanical anemometers. In lawsuits and Board of Trade inquiries the vocabulary of the Beaufort Scale is in frequent use, and nautical assessors have to attach a definite meaning to it. On the other hand, are we sure that the automatic registration by anemometers has been correctly interpreted? Dr W. N. Shaw himself raises the question whether the hourly velocity is a suitable element for comparison. It is probably the best that can be done, but it may be that we are trying to compare a scale of doubtful utility with a record that is only imperfectly understood.

The anemometers in use in this country are of two kinds, that known as the Robinson, which gives us with accuracy the number of times that a system of hemispherical cups rotates in any specified interval, when mounted in a particular manner. The error, or possible error, in the use of this apparatus enters when we pass from the velocity of the cups to that of the wind. For years it was assumed that the wind velocity was three times that of the cups, a round number which of itself suggested that it was a rough approximation. The factor 2·1 or 2·2 is now proposed as more appropriate. But there is this further difficulty: that while the velocity of the wind in an hour is not constant, the method of registration smooths out the irregularities, so that the variations in the velocities become indistinguishable in the record. The other form of anemometer, known as the Dines Pressure Tube, shows the variation in the wind velocity by recording a succession of oscillations of considerable magnitude. The trace is such as results from a pen moving vertically with comparative rapidity over paper moving more slowly horizontally. To determine the mean velocity from this trace is a matter of some uncertainty. The eye naturally selects a line which may be taken as representing the mean velocity during the interval under examination. But the number of miles per hour indicated by the position of this line can only be known from experimental inquiry. These experiments have been conducted by Mr. Dines in an exhaustive manner, but the results must nevertheless be considered as empirical. It is upon these experiments that the constant for the Robinson anemometer has been changed. Finally, therefore, the problem resolves itself into reading the results derived from the experiments of Mr. Dines into the phenomena observed by sailors and others in deciding on the numbers used in the Beaufort Scale.

But assuming that the hourly wind velocity is correctly known at any moment, it would seem a tolerably simple matter to assign to each of the Beaufort numbers the corresponding wind velocity. We have simply to take the mean value of the velocities for all winds estimated as being of a given Beaufort number to get a scale equivalent in miles per hour. This has been done more than once, and a table of such equivalents has been issued under the sanction of the Board of Trade. Such a simple solution, however, by no means disposes of all the difficulties. Prof. Köppen pointed out that a different scale of equivalents was obtained, when the mean value of all the velocities assigned by estimate as of a given Beaufort number was taken, from that which resulted from taking the mean of the Beaufort numbers corresponding to given velocities. The first method of treatment may be described as that of Curtis, the second as that of Köppen. To explain the cause of the difference betwen the two methods was the problem submitted to Mr. G. C. Simpson, and very ably he has dealt with it. Unfortunately we cannot follow him in his details; we can only point out some of his results. The following table shows the relation between the Beau-

[1] "Report of the Director of the Meteorological Office upon an Inquiry into the Relation between the Estimates of Wind-Force according to Admiral Beaufort's Scale and the Velocities recorded by Anemometers belonging to the Office; with a Report by G. C. Simpson, M.Sc., and Notes by Sir G. H. Darwin, W. H. Dines, and Commander Hepworth." (Printed for His Majesty's Stationery Office. London, 1906.)

fort Scale numbers and the wind velocity measured in miles per hour as derived from the methods of Curtis and Köppen.

Beaufort No.	Miles per hour Curtis	Köppen	Beaufort No.	Miles per hour Curtis	Köppen
0	3·0	0·0	6	24·5	28·0
1	5·0	2·0	7	30·0	34·5
2	8·0	6·0	8	36·0	42·0
3	11·0	10·5	9	44·0	50·0
4	15·0	16·0	10	53	59·0
5	19·5	22·0			

Mr. Simpson not only shows the reason for the discrepancy between these two sets of numbers, but discusses the special problems to which each set is applicable. This part of the report is particularly interesting, since it displays the intricacy of the problems connected with anemometry. Besides the difficulties of a theoretical character, there is the additional fact that the scale is not sufficiently definite, nor the estimates sufficiently accordant, to warrant the presentation of an authoritative table of equivalents applicable to each number of the Beaufort Scale, and the Director contents himself with offering a less detailed statement which for practical purposes expresses the relation between Beaufort numbers and hourly velocities.

Beaufort Scale Nos.	Corresponding Wind	Limit of hourly velocity
0	Calm	Under 2
1–3	Light breeze	2–12
4–5	Moderate wind	13–23
6–7	Strong wind	24–37
8–9	Gale	38–55
10–11	Storm	56–75
12	Hurricane	Above 75

This table shows that 12 was too high a number, or the steps of the scale too small. The difference of velocity must be considerable before it becomes apparent to rough methods of observation.

W. E. P.

PROF. METSCHNIKOFF'S HARBEN LECTURES.

THE Harben lectures of the Royal Institute of Public Health have just been delivered by Prof. Elie Metschnikoff, of the Pasteur Institute, Paris, and Foreign Member of the Royal Society. The lectures, which contained matter of the greatest interest, and were admirably delivered, attracted large and appreciative audiences.

In the first lecture, delivered on May 25, Prof. Metschnikoff directed attention to the fact that persons may harbour disease germs without themselves manifesting any ill effects. A notable instance of this is the case of a woman, the proprietress of a bakery, who suffered from typhoid fever ten years previously, and whose employees always suffered from more or less gastro-intestinal disturbance, two of them dying from typhoid fever. Investigation proved that this woman was excreting numbers of typhoid bacilli. Why should such an infected person remain apparently well? Undoubtedly because she had acquired an immunity, the result of modifications of living parts of the body, in all probability of the phagocytic cells. All the evidence points to the phagocytes being the great line of defence against disease germs. Recently Dr. Wright advanced the hypothesis that the fluids of the body prepared the microbes for ingestion by the phagocytic cells by means of substances named *opsonins*; but experiments were quoted suggesting that phagocytosis takes place without any addition of opsonins. All observations lead to the conclusion that immunity against infective agents is the result of phagocytic action, is a function of the cells.

Persons addicted to alcohol are far less resistant to infective diseases than abstemious individuals, and experiments show that animals subjected to the influence of alcohol become more sensitive to harmful microbes, because the alcohol has a deleterious action on the phagocytes. It was therefore suggested that it might be wise to eschew alcohol (and other drugs) in the treatment of infective diseases. On the other hand, normal blood-serum and weak saline solutions increase the resistance towards pathogenic microbes, and cases were quoted showing the beneficial action of these substances in grave cases of disease and in major operations.

The second lecture, delivered on May 28, was on the hygiene of the alimentary canal. In all probability microbes frequently gain access to the circulation through the intestinal wall, and Prof. Metschnikoff supported the view that the virus of tuberculosis frequently gains access to the body by this portal. Parasitic worms are also a source of danger, and many cases of appendicitis can be ascribed to this cause. The data collected indicates that it is high time to undertake a campaign against the entozoa. To obviate the risk of intestinal infection, much may be done by taking cooked food only—boiled water and milk, boiled vegetables, cooked and not raw fruit, and no raw salads. The precautions suggested may appear difficult to carry out, but, once accustomed to them, they enter into practice without difficulty.

The third lecture, delivered on May 30, was devoted to a consideration of hygienic measures against syphilis. It was pointed out that the sufferers from this malady are very largely innocent victims. The subjects of anti-syphilitic sera and of anti-syphilitic vaccination were considered, and it was shown that both of these are at the present time impracticable. It has been shown that apes can be inoculated with the syphilitic virus, which gives a means of testing prophylactic measures, and as a result of experiment it has been found that the application of a calomel ointment well rubbed into the seat of inoculation will prevent infection if applied within twenty hours of inoculation. The results obtained on lower monkeys and on anthropoid apes agree so well as to justify the conclusion that the same method may also serve for the prevention of syphilis in man. It has been tried with successful results in the case of a medical student who volunteered for the experiment.

No considerations of a moralising tendency should be opposed to the prevention of so disastrous a calamity as syphilis. True morality should rather contribute as much as possible to the prophylaxis of this and many another disease.

The lectures will be published in full in the forthcoming numbers of the *Journal of Hygiene*.

NOTES.

BARON C. R. VON DER OSTEN SACKEN, author of numerous books and papers on the classification of Diptera, died at Heidelberg on May 20 in his seventy-eighth year.

NOTICE has been received that the title of the Field Columbian Museum, Chicago, has been altered. The institution is now designated the Field Museum of Natural History.

THE death is announced of Dr. Ernst Schellwien, professor of geology and palæontology, and director of the Amber Museum, Königsberg University, in his fortieth year.

DR. E. V. DUNGERN, professor of bacteriology and hygiene in the University of Freiburg (Baden), has been appointed director of the scientific section of the Krebsinstitut, Heidelberg.

PROF. ROBERT KOCH has written to the Berlin Medical Society resigning his position on the presidential board on the ground that he expects to remain at least two years in Africa in order to continue his investigations on sleeping sickness in conjunction with the German Imperial Expedition, of which he is the head.

DR. K. PAPE, formerly professor of physics in the University of Königsberg, died at Steglitz on May 9. He was born in Hanover in 1836, and held the professorship of physics in the agricultural academy in Proskau from 1866–1878, that is, until his appointment to the Königsberg chair, which he held until 1904.

IN No. 41 of the *Chemiker Zeitung* is a very useful *résumé* of the experimental advances made during 1905 in the subjects of physics and physical chemistry in so far as they appeal to the chemist. The report deals chiefly with radio-activity, stoichiometry, chemical dynamics, thermochemistry, photochemistry, and electrochemistry.

THE third International Conference on Plant Breeding, whether by hybridisation or by cross-fertilisation, will be held in London on July 30 to August 3 under the auspices of the Royal Horticultural Society. Successful conferences on this subject were held in London in 1899 and New York in 1902. The president of the forthcoming conference will be Mr. W. Bateson, F.R.S.

THE German Bunsen Society for applied physical chemistry held its annual general meeting in Dresden under the presidency of Prof. Nernst on May 20–23. The business of the meeting included some thirty-five papers, in a group of five of which the value and methods of the fixation of nitrogen for industrial and agricultural purposes were discussed, in another group colloidal bodies were considered, whilst other subjects brought forward were such as technical methods for examining explosives, radiation laws, &c.

THE hygienic exhibition in Vienna was opened by Duke Leopold Salvator in the presence of a distinguished company, including some of the chief representatives of Austrian and foreign science, industry, and commerce. Although originating from a private source, the exhibition has, under the support of the municipal and Imperial authorities, and the keen interest displayed by many European exhibitors, proved a great success; the practical results of the more important chemical, hygienic, and medical investigations of the last ten years are well brought out by the numerous exhibits, which have been divided into nine groups:—(1) domestic hygiene; (2) personal hygiene in health and sickness; (3) public hygiene; (4) general industrial hygiene; (5) chemistry, pharmacy, and investigations of foods; (6) hygienic precautions necessary in the liquor and food industries; (7) clothing industries and laundries; (8) travel and association with strangers; (9) hygiene of sport.

ON the recommendation of the Home Secretary, a Royal Commission has been appointed to inquire into the health and safety of miners. Lord Monkswell is chairman of the commission. Science is represented by Dr. J. S. Haldane, F.R.S., university lecturer in physiology, Oxford, and mining engineering by Sir Lindsay Wood, Bart., past-president of the Institution of Mining Engineers. The remaining six members of the commission are politicians and officials of eminence. The secretary of the commission is Mr. S. W. Harris, of the Home Office. Among the questions referred to the commission is whether any change is desirable in the present system of examination for managers' and under-managers' certificates of competency; whether the managers of metalliferous mines should be compelled to hold such certificates; and whether certificates granted by colonial Governments should not be accepted in this country. In view of the great importance of this branch of the inquiry, it is perhaps to be regretted that the commission does not include some recognised authority on mining education. Not any of the commissioners appear to have passed any examination in mining.

DR. L. A. BAUER, who has been in charge of the magnetic survey and observatory work of the United States under the auspices of the Coast and Geodetic Survey since 1899, has accepted an offer, made to him by the Carnegie Institution of Washington, of the post of permanent director of its department of terrestrial magnetism. Since the establishment of this department in 1904, Dr. Bauer has filled the duties of director in conjunction with his official duties in the Coast and Geodetic Survey, but soon after July 1 he will devote his entire time to the Carnegie Institution work, which has developed into what practically amounts to a general magnetic survey of the globe. The annual grants to the department are sufficient to keep in progress continuously an oceanic magnetic survey, besides the sending of expeditions to land areas where no magnetic surveys have as yet been made, and also for conducting various auxiliary investigations. An attempt is to be made to secure the completion of a general magnetic survey of the globe within a period of about fifteen years. During Dr. Bauer's administration of the Coast and Geodetic Survey magnetic work, covering a period of seven years, he has organised and trained a corps of observers, has put in operation five magnetic observatories, has inaugurated magnetic work on the Coast Survey vessels, has practically completed the general magnetic survey of the United States (the three magnetic elements having been observed at about 2500 stations distributed over the United States and outlying territories), and has issued various publications relating to the work.

A PAPER by Mr. Edgar Schuster, on the inheritance of deafness (*Biometrika*, vol. iv., part iv.), was referred to in NATURE of May 17 (p. 63). It was stated in the abstract supplied with the journal that an important point brought out in the paper is "the normal, or even more than average, fertility of deaf-mutes," and this point was mentioned in the note in NATURE. Mr. Schuster writes to say that the meaning can be better expressed by the conclusion "deaf-mutes have on an average the normal or rather more than the normal number of brothers and sisters, although they appear to have considerably less than the normal number of children."

We have received from Mr. T. P. Mallock, the well-known taxidermist and anglers' outfitter at Perth, an excellently illustrated catalogue of apparatus connected with salmon and trout fishing.

The crawfishes of the genus Cambarus inhabiting Mexico, Central America, and Cuba form the subject of a paper by Mr. A. E. Ortmann published in the Proceedings of the Washington Academy of Sciences (vol. viii., pp. 1–24), in the course of which several new forms are described.

The various modes in which insects are naturally protected—whether by mimicry, by resemblance to their surroundings, or by the offensive weapons with which they are furnished—form the chief subject of discussion in the May issue of *Museum News*. We note that the next number of that periodical will not make its appearance until October.

Mr. E. J. Spitta records some experiments relating to the compound eyes of insects (Journ. Quekett Microscopical Club, April). From these it is suggested that the facets of the insect cornea may be nothing but little holes, filled with some non-refractive medium, by which images may be formed in the same way as a pin-hole forms them. Many difficulties presented by the current theories of insect vision would on this hypothesis be obviated.

The articles in part v. of the fifth volume of *Annotationes Zoologicae Japonenses* comprise one by Dr. A. Oka on a new genus (Aphanibranchion) of ascidians from Japan; a second on variations in toads and in an isopod crustacean, by Mr. S. Goto; and a third, by Mr. A. Izuka, on collateral budding in an annelid. In the case of the toad the variations consist of the fusion of the seventh and eighth vertebræ, and of the formation of the sacrum by the tenth instead of by the ninth vertebra.

No. 3 of the Philippine Journal of Science (vol. i.) contains the second part of an article by Mr. C. S. Banks on the principal insects attacking the cocoanut palm, and another by the same author on some new Philippine insects. Messrs. W. R. Brinkerhoff and E. E. Tyzzer contribute an elaborate study of experimental variola and vaccinia in quadrumana, in which it is shown that vaccinia protects against variola and *vice versâ*, and that the structures described by Councilman, Magrath, and Brinckerhoff as intracellular parasitic protozoa (the *Cytoryctes variolae*) are present in the lesions.

The April number of the *Emu* opens with an account of a visit to an ibis "rookery" in a swamp in the Casterton district, Victoria, during the breeding season. The species breeding in the swamp are the straw-necked and the white ibises (*Carphibis spinicollis* and *Ibis molucca*). The firing of a shot reveals the enormous numbers of birds frequenting the rookery. "In a moment there is a wild commotion and the air seems whistling with the sounds of hundreds and thousands of wings, and then in one mighty cloud the whole assembly takes flight, making the sky look black and white; the effect being heightened by the long bills, outstretched necks, and general peculiar appearance of the birds." The coachwhip bird (*Psophodes crepitans*) and its nest form the subject of two excellent reproductions from photographs.

The work done on the insect-collection of the Oxford University Museum during the past year, and the condition and extent of the collection itself, receive special attention in the report of the delegates of the museum for 1905 (issued as a supplement to the *Oxford University Gazette*). Prof. Poulton lays great emphasis on the value of the services of Mr. R. Shelford, who has gained wide experience and knowledge as curator of the Sarawak Museum. Mr. Shelford's efforts have been chiefly directed to reduce to order the collection of Orthoptera, which, although one of the finest in the world, has hitherto been of little use to entomologists on account of want of proper arrangement and classification. In several sections of the collection—notably the one made by Burchell in South Africa—the insects were altogether unnamed, but this serious deficiency is being rapidly put right by Mr. Shelford's labours. In the course of handling the collection a large number of type-specimens have been identified. Many important additions have been made during the year to the collections generally, the curator of the Pitt-Rivers Museum reporting the acquisition of a number of specimens illustrating the ethnology of many parts of the world.

Has the Federal Government of the United States power to take remedial measures to prevent the spread of noxious insects, like the cotton-boll weevil or the gipsy-moth, in cases when individual States in the Union are not doing all in their power in this direction or are unable to do sufficient? Such is the question asked by Prof. E. D. Sanderson in the May number of the *Popular Science Monthly*, and from precedents derived from other legislation answered in the affirmative. It is, however, not only in the case of States that refuse to do their duty that the interference of the supreme Government is invoked. A case in point is afforded by the visitation of the gipsy-moth in Massachusetts. At the present time New Hampshire is able to defend its frontier from the pest, but a time will come when action in Massachusetts will alone prevent an invasion of the neighbouring State. Is it fair, it is asked, that one State should be thus heavily penalised for the common good? Individual adaptation to environment forms the subject of an article in the same issue by Prof. J. H. Blair; while Dr. R. W. Shufeldt communicates an illustrated paper on bird-photography in Norway.

In accordance with instructions of the Government of India, a Bombay correspondent of the *Pioneer Mail* reports, a provincial research laboratory has been established in connection with the existing plague research laboratory at Parel. The main objects of the laboratory are:—(*a*) To afford assistance to all Government medical officers in the discharge of their duties by fulfilling the functions of a "pathological diagnosis institute," to which specimens of all sorts may be sent for opinion. (*b*) To train hospital assistants and others in elementary clinical pathology, performance of inoculations and hypodermic injections, the preparation and use of disinfectants, and other duties they may be called upon to perform in connection with their duties as public health officials. (*c*) To afford opportunities to medical men who may wish to do original work for themselves or to practise or be instructed in new methods of diagnosis.

A report of the fruit conference held in October of last year under the joint auspices of the Royal Horticultural Society and National Fruit Growers' Federation is contained in the April number (vol. xxx.) of the journal of the former society, just issued. The volume includes much information of value to all who are interested in the cultivation of fruit.

IN the Trinidad Bulletin (April) Mr. J. H. Hart gives a list, with descriptions, of fourteen varieties of orange of which well-established plants can be supplied from St. Clair experiment station. The Pineapple and Jaffa are especially recommended; the list also includes Homosassa, Parson Brown, and Washington Navel; in fact, all the varieties have been carefully selected. A new edition of the guide-book to the Trinidad Gardens is to be published shortly, in which there will be special references to the features depicted by Kingsley in "At Last."

THE North American species of Festuca are collated by Mr. C. V. Piper in vol. x., part i., of the Contributions from the United States National Herbarium. In North America twenty-two perennial and twelve annual species are recognised, as compared with twenty-eight perennial and twenty-six annual species in Europe. In addition to the sheep and red fescues, *Festuca altaica* and *Festuca viridula* are regarded as excellent fodder grasses, and *Festuca octoflora* is valuable in semi-arid districts. The term "lemma" is adopted to signify the outer or lower palea. A number of plates accompany the text, and a tentative list of Mexican species is appended.

BOTANISTS who have attempted to classify the different varieties of such plants as rice, cotton, &c., that are extensively cultivated in India have noted the extraordinary power of discrimination manifested by the peasant cultivators. In a Bulletin (No. 55) recently published by the Madras Department of Agriculture on the great millet, *Sorghum vulgare*, a plant grown very widely as a food and fodder crop, Mr. C. K. Subba Rao enumerates with comparative notes more than sixty forms referable to seven botanical varieties. Three of these varieties are represented in other parts of India, and in addition there are the forms that would be grouped under fifteen varieties that are not represented in the presidency.

THE latest number, vol. xix., part i., of the Transactions of the Royal Scottish Arboricultural Society contains, as usual, a number of interesting papers on forestry subjects. A working plan for the Alice Holt woods in the east of Hampshire has been prepared by Dr. Schlich. In 1812 an Act was passed providing for the cultivation of navy timber in the forest, but owing to the low standard of the oak trees that occupy 95 per cent. of the area it is proposed to plant certain portions with beech, larch, and Douglas fir, and others with spruce and pine. Dr. R. S. MacDougall reports the discovery of larvæ of the chalcid species *Megastigmus spermotrophus* in seed of the Douglas fir received from Aberdeenshire, and adduces evidence to prove that the larvæ are really plant parasites. Mr. G. Brown provides some figures in connection with the natural regeneration of Scots pine at Beauly, and Prof. T. Hudson Beare points out a few of the difficulties in obtaining accurate results when testing timbers.

AN excess of rain is again shown by the weekly weather report of the Meteorological Office to have occurred over the entire country for the period ending May 26. The heaviest rains were experienced in the south-west of England, the measurement for the district being 1·64 inches, which is more than three times the average. The rainfall was about double the average in different parts of the kingdom. The aggregate rainfall for the spring months is deficient in the Midland counties and in the south and east of England, as well as in the Channel Islands, but mostly in excess in other parts of Great Britain. The total measurement since the commencement of the year is everywhere considerably in excess of the average.

THE eighth Bulletin of North Queensland Ethnography is entitled "Notes on Government, Morals, and Crime," but the four plates and part of the text deal with message sticks. Dr. Roth takes the view that they are merely mnemonic, and convey no communication properly so called. This statement seems to require qualification outside the area with which he deals; for instance, among the Mundainbura of Durham Downs certain marks have recognised meanings, and indicate the marriage classes; in a case reported by Dr. Howitt another tribe with the same classes interpreted correctly a stick sent to put this question to the test. The ordinary use of the stick is, however, mnemonic, and it also guarantees the *bona fides* of the messenger. In North Queensland the stick is sometimes carried at the end of a rod, as shown in NATURE of April 26 (vol. lxxiii., p. 610), but held vertically; the object of this is unknown. In addition to being figured in the plates, the thirty-three specimens are elaborately described. The purely mnemonic character of Dr. Roth's specimens is shown by the accompanying figures, which are alternative forms of stick for the same message. Interesting information is also given on customs of inheritance, a remarkable feature being the succession of females only to property in certain edible plants.

a *b*

FIG. 1.—So-called "letter" or "message" sticks, Boinjé tribe, Boulia. (*a*) Length, 6½ in.; breadth, ⅞ in. (*b*) Length, 5½ in.; breadth, ⅝ in., made in place of (*a*), which was stated to have been lost, in order to ascertain whether the same message necessitated similar markings, which it clearly did not.

WE have received a copy of the meteorological report of the Survey Department of Egypt for the year 1903, containing hourly observations at Abbassia Observatory (Cairo), monthly summaries at eighteen climatological stations in Egypt and the Sudan, and some additional rainfall results. The value of the work is much enhanced by graphical representations of the Abbassia observations. In a preliminary examination of some of the data, the superintendent points out that the rainfall at Abbassia and the southern Delta generally is small and irregular, but that it was thought worth while to see whether it showed any signs of periodicity such as that assigned to it in India or Mauritius by Sir Norman Lockyer. A smoothed rainfall curve for the years 1888–1900 shows some resemblance to the inverse sun-spot curve, especially in the coincidence of the maximum of the sun-spots and the minimum of the rainfall in the year 1893.

DR. W. N. SHAW's lecture at the University of London on May 24 brought this most interesting series to a close. The audience no doubt shared the lecturer's views as to the difficulty of dealing sufficiently with the subject in the space of four hours; we hope that the matter will not be allowed to drop, and that the example set by the London University will be followed by other institutions. The subjects specially dealt with in this last lecture were the variations in the several elements from year to year, the relation of the yield of wheat to rainfall in the British Isles, and illustrations of sequences in seasonal variations in various parts of the globe. Some slides lent by Dr. Lockyer showed very clearly the opposite variations of the pressure curves for different localities, and the similarity between the march of rainfall and inverted pressure curves. The lecturer pointed out that several such relations were beginning to be detected, but that more work was wanted; some of the results could only be considered as temporary at the present time. Some very remarkable illustrations were given of the apparent dependence of the yield of wheat on the rainfall of the previous autumn, although other factors, *e.g.* temperature and spring rainfall, undoubtedly exert an influence on the general result. The values seemed to show an unmistakable relation to an eleven years' periodicity. Diagrams were also shown exhibiting an apparent notable connection between the south-east trade wind velocity in the Atlantic and English rainfall (see also NATURE, December 21, 1905).

The Maryland Geological Survey has established a permanent State mineral exhibit in the old House of Representatives at Annapolis. We learn from *Science* that the materials forming this exhibit have been gradually collected by the survey during the last few years, the nucleus being the Maryland mineral exhibit at Buffalo in 1901. This was materially added to in the preparation of the State's exhibit at Charleston the following winter, and was still further increased for the Maryland exhibit for the Louisiana Purchase Exposition at St. Louis in 1904. The latter display has again been much enlarged for the present purpose, and is intended to illustrate thoroughly the mineral resources and industries of the State.

We have received a copy of the report issued by the Home Office (Cd. 2911, price 1*s.* 9*d.*) on statistics relating to persons employed, output, and accidents at mines and quarries in the British colonies and in foreign countries in 1904. The number of persons employed at home and abroad was about five millions, of which one-fifth were employed in the United Kingdom and one-third in the British Empire. More than half the total were employed in getting coal, of which the world's production was 886 million tons, valued at 295 million pounds sterling. Of the world's gold output, 16,593,856 oz., valued at 67,000,000*l.*, the British Empire supplied 60 per cent., the Transvaal contributing $22\frac{3}{4}$ per cent., Australia $22\frac{1}{2}$ per cent., and Canada $4\frac{3}{4}$ per cent. The United States contributed $23\frac{1}{2}$ per cent. In coal mines the death-rate from accidents per 1000 employed was 1·24 in the United Kingdom, 1·24 in the British Empire, 1·90 in Germany, and 3·35 in the United States.

The *Pioneer Mail* states that the establishment of permanent wireless telegraph stations at Frasergunj and Akyab is now under the consideration of the Government of India.

The April and May numbers of the Journal of the Franklin Institute are devoted almost entirely to a report of the proceedings on the occasion of the 200th anniversary of Franklin's birth. An address delivered by Prof. Edwin J. Houston, on Franklin as a man of science and an inventor, is printed in full, and gives an extended account of the life-work of the great discoverer. An account is also given of the Benjamin Franklin trust funds to the cities of Boston and Philadelphia. The Journal of the Society of Arts for April 27, referring to the bicentenary celebration, of which an account was given in NATURE of May 10 (p. 36), provides interesting particulars of Franklin's relations with the Society of Arts.

Messrs. Dickinson and Shields, Alliance Mills, Stoke Newington, have sent us a short pamphlet with respect to their bubble fountain, the chief fault of which is that it does not contain any description of how the bubble fountain is formed. However, assuming it to be formed, the bubble fountain consists of a series of soap bubbles, made even at the rate of 20,000 per minute, which may be blown with coal gas, and sent up by day or by night, when, if illuminated by the sun or artificially, it affords an interesting and beautiful phenomenon. At night, further interest may be given by firing the fountain, when the flame will run up the stream of bubbles. Intermittent groups of bubbles are suggested as an excellent target for gun practice, cheaper than glass or clay, and obviously it is more humane than the murder of live pigeons. It is stated that a large example may shortly be seen at the Crystal Palace.

On the British Association journey to and from South Africa a careful watch was made by many members of the party for the "green ray" visible for an instant just at the time of disappearance of the setting sun below a clear horizon. A note has been contributed on this subject to *Symons's Meteorological Magazine* for March and April by Prof. Rambaut, F.R.S., who was one of the party. Prof. Rambaut finds that the phenomenon can be entirely accounted for by the generally received view of the chromatic dispersion of the atmosphere combined with selective absorption. It is not necessary to make elaborate experiments or to go a sea voyage in order to observe the "green ray." By fixing a screen half covering the focal plane of a telescope, or, better still, a diaphragm with a narrow diametral slit, a green or blue flash can be seen at the top of the sun's disc and a red fringe at the bottom any time that the sun is near the horizon, and the observation can be repeated as often as desired.

"The Grape Curculio" is the title of the 100th Bulletin of the West Virginia University Agricultural Experiment Station at Morgantown, in which Mr. F. E. Brooks deals with the damage inflicted on vineyards by the weevil *Craponius inaequalis*. For several years past complaints have come from vine-growers in Virginia in regard to insects that "sting" grapes, causing them to become "wormy" and to drop from the vines while unripe. The insect is the above-named weevil, and careful experiments have been conducted with the view of mitigating the damage caused by its attacks. Spraying and protecting the clusters by enclosure in bags are recommended as the most effectual remedies.

The first division of the third part of the catalogue of the Indian decapod crustacea in the collection of the Indian Museum has been received. Part iii. deals with the Macrura, and in the section just issued Dr. A. Alcock, F.R.S., describes the prawns of the Peneus group.

In the notice of the okapi in our last week's issue (p. 88) the description of the animal's habitat should have been attributed to Captain Gosling instead of to Captain Alexander.

Messrs. Philip Harris and Co., Ltd., have just issued an illustrated catalogue of instruments for practical work in geography. The catalogue includes descriptions of simple instruments for map making and other field work, determination of position, and meteorological observations.

In the notice of "Oologia Universalis Palæarctica" in Nature of May 24 (p. 79) reference was made to the shortcomings of the English text. Messrs. Williams and Norgate ask us to state that arrangements have been made with Mr. Oliver G. Pike to revise the English text, so that in future the work may not suffer from imperfections of expression due to poor translation.

The "Statesman's Year-book" (Macmillan, price 10s. 6d. net) continues to grow in size and value. The 1906 issue is some 150 pages larger than its immediate predecessor. Separate notices of the States included in the American union have this year been introduced for the first time. Recent important events have led to other changes in the year-book, and among these may be mentioned the dissolution of the union between Sweden and Norway, the peace between Russia and Japan, the mission to Tibet, and the last general election. The maps and diagrams, which are always an attractive feature of the publication, this year deal with the economic development of the United States, the new provinces of Canada, the division of Bengal, the Anglo-Portuguese Barotse boundary, the political changes in the Far East, the races of Russia, and the tariff chart of the world. The volume now runs to lxiv+1604 pages. The editor, Dr. J. Scott Keltie, is to be congratulated upon the forty-third issue of this indispensable work of reference.

OUR ASTRONOMICAL COLUMN.

Astronomical Occurrences in June:—

June 2. 15h. Conjunction of Venus and Neptune. (Venus 2° 24′ N.).
7. 10h. 45m. to 11h. 51m. Moon occults μ Sagittarii (mag. 4·0).
10. 3h. Jupiter in conjunction with the Sun.
,, 13h. 43m. to 14h. 46m. Moon occults ι Capricornii. (mag. 4·3).
12. 18h. Saturn in conjunction with the Moon. Saturn 0° 56′ N.).
15. Venus. Illuminated portion of disc = 0·849. Of Mars = 0·997.
16. 10h. 19m. Minimum of Algol (β Persei).
21. 21h. Sun enters Cancer. Summer commences.
24. 10h. Venus in conjunction with the Moon. (Venus 2° 29′ N.).
26. 5h. 3m. Moon approaches very near to α Leonis (Regulus).
28. 16h. Uranus in opposition to the Sun.
,, Saturn Outer major axis of outer ring = 41″·47. Outer minor axis of outer ring = 2″·31.

Photographing the Corona without a Total Eclipse.—Numerous experiments have been devised and carried out in the attempt to obtain photographs of the solar corona during ordinary sunlight, without waiting for the rare occasions on which the sun is totally eclipsed. Hitherto no decided success has rewarded these efforts, but another attempt is to be made by MM. Millochau and Stefanik with an equipment mounted on the summit of Mont Blanc.

These observers propose to employ a spectroheliograph such as is now used at several solar physics observatories to obtain monochromatic images of the chromospheric clouds and prominences, but, instead of using one of the calcium or hydrogen lines on the second slit, they propose to isolate the chief corona line, at λ 5303, and to eliminate the light of other radiations by means of an appropriate green screen.

Preliminary experiments with this apparatus at Meudon have given encouraging results, and the observers hope that, in the clear atmosphere of the mountain summit, indubitable success will be attained (*Comptes rendus*, No. 17, 1906).

Terrestrial Temperatures and the Solar Radiation.—In the report of the Smithsonian Institution for the year ending June 30, 1905, Mr. C. G. Abbot, who has charge of the Astrophysical Observatory, discusses the recent observations of solar radiation and its connection with terrestrial temperatures.

This matter was discussed by the late Prof. S. P. Langley in the *Astrophysical Journal* for June, 1904, who then arrived at the conclusion that the evidence available indicated that the total solar radiation may vary in comparatively brief periods, and that the irregular variations were frequent and large enough to produce considerable changes of the earth's mean temperature.

In the present communication Mr. Abbot summarises the results obtained since 1902, and, by comparing the values found for the transmission of the solar envelope, and the consequent transmission of the solar radiations to the earth, with the variations of temperature at a number of stations situated in the terrestrial north temperate zone, he has deduced evidence which strongly supports Prof. Langley's theory.

High values of solar radiation and solar transmission appear to precede and to accompany high temperatures in the north temperate zone, and *vice versâ*.

The tables and curves which appear in the report substantiate this view, and Mr. Abbot expresses the hope that the study of the solar radiation will soon prove a valuable aid in forecasting climate.

The Distribution of the Stars.—In No. 7 of the Publications of the Groningen Astronomical Laboratory Prof. Kapteyn published the material on which he based his studies on the distribution of the stars in space, the distribution of cosmical velocities, &c., and also gave the results of five separate computations based on three different values of the precession and three different positions of the apex of the solar motion.

In this publication 2640 stars of Bradley's catalogue were grouped in ten degrees of declination, and the results given in two tables, the first of which contained the stars having spectra of Secchi's second type, the second the stars of type i. and unknown spectra.

No. 9 of the same publications contains the results of a *sixth* computation based on more refined data and arranged in a different manner. Instead of grouping the stars according to declination, Prof. Kapteyn has arranged them in zones of Galactic latitude, because, in considering the structure of the universe, it is obviously desirable to take the Milky Way as the fundamental plane. Also, instead of including the stars having unknown or peculiar spectra with those of type i., he has placed them in a table by themselves. In this way he has discussed the distribution and proper motions of 1093 stars belonging to type ii., 1144 stars belonging to type i., and 381 stars the spectra of which have not yet been recognised as belonging to either of Secchi's groups.

The complete catalogue should prove of exceptional interest and usefulness to anyone engaged in any discussion on cosmical evolution, and it would be exceedingly interesting to see what modifications might be necessary if the stars were divided into subgroups according to their ascending and descending temperatures as given in Sir Norman Lockyer's classification.

Observations of Comets.—The results of a number of observations of various comets, made at the Chamberlin Observatory (Denver) by Prof. H. Howe during the period November, 1904, to June, 1905, appear in No. 4091 of the *Astronomische Nachrichten*.

Six comets are included, of which comet 1905 i. (Encke) was observed from November 11 to December 27, 1904, and at times appeared to have a faint nucleus and an eccentric, fan-shaped tail. At 6h. 20m. (local M.T.) on December 5 a star of mag. 9·0 shone so lustrously through the comet that the nucleus was invisible.

Half an hour later the nucleus, which was near the following end of the comet, was plainly visible.

THE TARPAN AND ITS RELATIONSHIP WITH WILD AND DOMESTIC HORSES.[1]

SO much progress has been made during recent years in working out the origin and history of domesticated horses that the time has now come when inquiries may be profitably pursued along certain definite lines.

In the first place (assuming that horses have had a multiple origin), inquiries should be instituted with the view of ascertaining so far as possible the characteristics of the post-Glacial species and varieties which have taken part in forming the present domestic races and breeds; in the next place, inquiries should be instituted with the view of ascertaining to which of the lower Pleistocene species the more immediate ancestors of the living horses are most intimately related; and, in the third place, an attempt should be made to determine from which of the ancestral forms the various domesticated breeds have inherited their more striking characters, *i.e.* to ascertain to which ancestral types the Shire, Clydesdale, Percheron, and other heavy breeds, the Barb, Arab, thoroughbred, Kattiawar, and other slender-limbed breeds, are indebted for their chief peculiarities.

In this paper I shall not attempt to show that either Prejvalsky's horse, the Celtic pony, or the Libyan variety recently described by Prof. Ridgeway[2] is genetically related to pre-Glacial species, or entitled to be regarded as an ancestor of one or more domestic breeds.

Sufficient data for a discussion of this kind is not yet available. I propose now, by way of clearing the ground for the investigations mentioned above, to inquire whether the Tarpan (long regarded as the wild progenitor of the common horse of Europe) deserves a place amongst the ancestors of living races and breeds.

The first account of the Tarpan[3] we owe to Gmelin, who came across a troop near Bobrowsk during his journey through Russia between 1733 and 1743. He describes them as mouse-coloured, with a short, crisp mane; the tail always shorter than in domestic horses, sometimes full, sometimes only furnished with short hair; the legs dark from the knees and hocks to the hoofs; and the head thick, with the ears sometimes long, sometimes short.

Since this description appeared, some Continental naturalists have regarded the Tarpan as a true wild species; others, like Dr. Nehring, considered it the last survivor of the ancient prehistoric horses of Europe modified by an infusion of domestic blood; while not a few agreed with Pallas that the Tarpan herds might very well be the offspring of escaped domestic horses.

English naturalists have, as a rule, adopted the view of Pallas.

Notwithstanding all that has been written on the subject since Gmelin's time, hippologists agree with Salensky that the relationship of the Tarpan with wild and domestic horses has not yet been cleared up.[4]

During the nineteenth century very little was done towards determining the systematic position of the Tarpan; but in 1866 a Tarpan foal was captured in the Zagradoffe Steppe and reared by a domestic mare. When about eighteen years old this specimen was sent to the Moscow Zoological Garden, and eventually described in a paper published by Schatiloff.

This, like Gmelin's specimen, had a somewhat coarse head, was of a mouse colour, with legs black below the knees and hocks. The mane, however, instead of being short and crisp, as in Gmelin's specimen, was 48 cm. in length and hanging to one side of the neck.

As clearly realised some years ago by Gray, of the British Museum, certain vestigial structures, known as callosities, warts, or chestnuts, are of considerable taxonomic value. Warts or chestnuts, as is well known, are present on both the fore and hind limbs of the common horse, and they also occur on the hind as well as the fore limbs of Prejvalsky's horse; while in the Celtic pony, as in asses and zebras, the hind chestnuts are completely absent. It is especially worthy of note that though the hind chestnuts were not invariably present in Tarpans (they were absent in a Tarpan described by Krymsch), they were present in the Moscow specimen.

It thus appears that the Moscow Tarpan agreed in its colour with the specimens referred to by Gmelin and Pallas, but differed in the mane and tail, in both of which, as in its callosities, it resembled the common horse, *Equus caballus*. Two Tarpan skeletons have been preserved. The chief point of interest about these skeletons is that, as in the kyang and Prejvalsky's horse, and in certain Arabs, there are only five lumbar vertebræ.

In having only five lumbar vertebræ these Tarpans differed from the common horse of Europe, at least from the forest variety *E. caballus typicus*, in which I have invariably found eighteen pairs of ribs and six lumbar vertebræ.

G. A. Ewart.

FIG. 1.—The mouse-dun Tarpan-like cross between a Shetland mare and a black Welsh pony. This pony, though a cross, looks as if it belonged to an old-established race. It has a striking, well formed, massive head, well-placed ears, full eyes, good quarters, and excellent limbs. The mane is, however, short and semi-erect, while the tail consists of three kinds of hair which differ in structure, thickness, colour, and arrangement. From a photograph taken September, 1905.

From this striking difference in the skeleton it follows that, even should the Tarpan turn out to be a true wild species, it cannot be regarded as the sole ancestor of the common horse of Europe.

As to the skull of the Moscow skeleton, Czerski came to the conclusion that it has, on the one hand, all the characteristics of Oriental horses, while on the other it approaches the Scottish breed to which belongs the pony.

The skull of the Tarpan in the St. Petersburg Museum resembles skulls of immature specimens of *E. prejvalskii*, but the bones of the limbs and limb girdles are decidedly more slender, and have less pronounced muscular ridges than in the wild horse of Central Asia.

It may here be mentioned that for more than a century all the horses living in a wild state in Europe, which happened to be of a mouse-dun colour, seem to have been regarded as Tarpans.

Seeing that herds of mouse-dun wild horses no longer occur in Europe, and have not during recent years been met with in even the most remote parts of Central Asia, it might perhaps be assumed that the Tarpan's place in nature must for ever remain a mystery.

[1] By Prof. J. C. Ewart, F.R.S. Abridged from the Proceedings of the Royal Society of Edinburgh, Session 1905–6, vol. xxvi., part i.

[2] "Origin and Influence of the Thoroughbred Horse" (Cambridge, 1905).

[3] By the Tarpan I mean the mouse-dun horse of Russian and other Continental naturalists, not the so-called "true" Tarpan of Hamilton Smith ("Naturalists' Library," vol. xii., 1841).

[4] The chief papers on the Tarpan are mentioned by Salensky, "Monograph on Prejvalsky's Horse" (St. Petersburg, 1902).

This was the conclusion I arrived at when my attention was first directed to the subject. But having ascertained that, by crossing carefully selected forms, remote types are sometimes restored in all their original purity, I thought it worth while to make some experiments.

I selected for my Tarpan experiments a mouse-dun Shetland pony mare, which seemed to me to be a blend of at least three varieties—in its head it suggests the wild horse; in its mane, tail, and trunk it takes after the forest variety; while in the limbs and hoofs it approaches the Celtic pony. This mare was crossed with a black Welsh pony, which belongs to an ancient British race, and doubtless has in its veins not a little Celtic blood.

The first foal, black like the sire, but Celtic in make, failed to throw any fresh light on the question at issue.

G. A. Ewart.

FIG. 2.—Tail and hind quarters of the Scottish Tarpan from a photograph taken at the same time as Fig. 1. As in the wild mare the hair of the tail consists of three portions. The basal portion only essentially differs from the corresponding portion in Fig. 3 by being of less extent and lighter in colour; the middle portion is also lighter in colour and more plentiful than in the wild mare, while the hair growing from the end of the dock in the Tarpan very closely agrees in colour and amount with the terminal portion of the tail in Prejvalsky's horse.

Though in the first foal the Celtic blood prevailed, the second foal by the same sire has developed into an animal (Fig. 1), now three years old, which, though bred in Scotland, will, I believe, be regarded by Continental naturalists as typical a Tarpan as ever roamed the Russian steppes.

This Scottish Tarpan, a mouse-dun with black points, has a distinct dorsal band (10 mm. to 15 mm. in width) and faint bars above the knees and hocks, a somewhat heavy head, but a short body and well-formed limbs. The mane, of a light colour along each side, but dark in the centre, is semi-erect, some of the hair arching to the right, some to the left, and some forwards between the ears to form an imperfect forelock. The mane, which resembles that of zebra-horse hybrids, conforms to the description of the mane given by Pallas, but differs from the short crisp mane of Gmelin's specimen, and still more from that of the Moscow Tarpan, which, it will be remembered, reached a length of 45 cm., and hung to one side of the neck. In the dun Shetland dam, the mane lies close to the right side of the neck, but never exceeds a length of 35 cm. In the Scottish Tarpan the mane, from 15 cm. to 27·5 cm. in length, is either nearly upright, or, as already mentioned, arches outwards well clear of the neck (Fig. 1), whereas in a Fetlar (Shetland-Arab) pony of the same age the mane reaches a length of 45 cm. and clings to the side of the neck. The tail of the new Tarpan (Fig. 2) is even more remarkable than the mane. The dock, which is 27·5 cm. in length, is furnished with three kinds of hair. The basal portion for 6·5 cm. carries fine hair nearly circular in section, which, except in the part continuous with the dorsal band, is almost colourless; the middle portion of the dock—about 13·75 cm.—carries thicker hair, slightly oval in section, with a thick cortex containing in some cases a considerable amount of pigment; from the terminal part of the dock—about 7·5 cm.—spring coarse black hairs, which are now long enough to reach the ground. These long hairs are oval in section, have a very thick cortex, and only a small central axis or medulla.

The fine, short, light-coloured hairs (7·5 cm. to 15 cm. in length) at the base of the tail form a conspicuous somewhat lozenge-shaped bunch (Fig. 2); the thicker hairs growing from the middle section of the dock reach a length of 30 cm. They emerge from under the light-coloured root hairs and expand to form a sort of fringe, from which escape the relatively few long black hairs of the distal part of the dock.

G. A. Ewart.

FIG. 3.—Hind quarters and tail of a three-year-old wild mare (*E. prejvalskii*) from a photograph also taken in September, 1905. In the upper part of the tail the hair, light in colour and relatively fine, grows obliquely outwards from the caudal portion of the dorsal band; the hair of the middle part of the tail, darker and stronger than that of the root, lies nearly parallel with the dock and reaches to the level of the hocks; the hair of the tip, black, coarse and scanty, but long enough to reach the ground, emerges from within the hair forming the middle part of the tail. Like the hair of the mane, the light hair at the root of the tail is shed annually.

In having a limited number of long hairs growing from the distal end of the dock, this cross-bred pony decidedly differs from the Celtic as well as from the forest types of horses. The interest of the tail in the Scottish Tarpan is not so much that it suggests a mule as that it has a very striking resemblance to the tail of Prejvalsky's horse (Fig. 3). The only difference is that in the true wild horse the upper or light-coloured section of the tail is longer than in the Shetland-Welsh cross, which has, in fact, the kind of tail one would expect in a Prejvalsky hybrid in which the wild blood was dominant.

A study of the mane and tail of the Shetland-Welsh cross, and of certain other crosses and breeds, strongly suggests that we must include amongst the ancestors of our domestic horses a species having a mane and tail such as we find in the wild horse still living in Central Asia. In the body hair and the foot-locks the Scottish Tarpan closely resembles the wild horse. Further, it resembles the wild horse in having a very short flank feather, but differs in having the face whorl situated above the level of the eyes, as in the Celtic pony; in Prejvalsky's horse, as in the kyang, this whorl lies well below the level of the orbits.

In the Shetland mare the dorsal band is nearly as narrow as in the Celtic pony; the right hind chestnut measures 1·5 cm. by 0·4 cm., while the left is only 0·5 cm. in diameter; the front ergots are absent, and the hind ergots are very small. In all these points the Shetland mare approaches the Celtic type. In the Scottish Tarpan the front ergots are small, the hind normal; the front chestnuts are oval as in the wild horse, but decidedly smaller, while the hind chestnuts are only one-fifth the length of those in the wild horse. Finally, in the head, ears, form of the limbs and hoofs, the Tarpan-like Shetland-Welsh cross is as nearly as possible intermediate between a wild horse and a Celtic pony. Of the skeleton it is, of course, impossible to speak, but, judging by the shortness of the trunk, the form of the head, and the conformation of the limbs, the probability is that there are only five lumbar vertebræ, as in the Moscow and St. Petersburg skeletons, and that the skull and limb bones resemble those of a young Prejvalsky horse. After very full consideration, Salensky some years ago came to the conclusion that the Tarpan is a type specialised more to the side of *E. caballus* than to *E. prejvalskii*.

When all the facts now available are taken into consideration, there seems no escape from the conclusion that the Tarpan, once common in the east of Europe, cannot be considered as a true wild species.

Further, it may be assumed that the Tarpan herds were derived from at least three primitive stocks, viz.:—(1) from a variety or species identical with or closely related to the wild horse (*E. prejvalskii*) still surviving in Central Asia; (2) from a variety having the characteristics of the Celtic pony—*E. c. celticus*; and (3) from a variety resembling the forest horse—*E. c. typicus*. It is only by assuming the multiplex origin of Tarpans that it is possible to account for some of them having a heavy head, long ears, a nearly upright mane, a mule-like tail, and five lumbar vertebræ, thus suggesting *E. prejvalskii*; for others, wanting the hind chestnuts and possessing a skull like that of certain Scottish ponies, thus suggesting *E. c. celticus*; and for others having a thick head, full mane and tail, and hind as well as front chestnuts, thus suggesting *E. c. typicus*.

By experiments now in hand I hope to settle what part Prejvalsky's horse has taken in forming the Tarpan. If I succeed in showing that crosses between Prejvalsky's horse and either the forest, Celtic, or Libyan variety are practically identical with the cross between the Shetland mare and the Welsh pony stallion, I shall prove that at least certain of the domesticated breeds are indebted to Prejvalsky's horse for some of their characteristics, and at the same time bring additional evidence in support of my view that domesticated races have had a multiple origin, and include plain as well as striped forms amongst their less remote ancestors—have not, in fact, as Darwin thought, descended from a single dun-coloured more or less striped primitive stock.

THE FIGURE AND STABILITY OF A LIQUID SATELLITE.[1]

MORE than half a century ago Edouard Roche wrote his celebrated paper on the form which a liquid satellite will assume when revolving, without relative motion, about a solid planet.[2] As far as I know, his laborious computations have never been repeated, and their verification and extension form a portion of the work contained in the present paper.

Two problems involving almost identical analysis, but very distinct principles, are here treated simultaneously. If we imagine two detached masses of liquid to revolve about one another in a circular orbit without relative motion, the determination of the shapes of each of them is common to both the problems; it is in the conditions of their secular stability, according to the suppositions made, that the division occurs.

The friction of the tides raised in each mass by the attraction of the other is one cause of instability. If now the larger of the two masses were rigid, whilst still possessing the same shape as though liquid, the only tides subject to friction would be those in the smaller body. It amounts to exactly the same whether we consider the larger mass to be rigid or whether we consider it to be liquid, and agree to disregard the instability which might arise from the tidal friction of the tides generated in it by the smaller body. Accordingly I describe secular stability in the case just considered as "partial," whilst complete secular stability will involve the tidal friction in each mass.

The determination of the figure and partial stability of a liquid satellite is the problem of Roche. It is true that he virtually considered the larger body or planet to be a rigid sphere, but in this abstract the distinction introduced by the fact that I treat the planet as ellipsoidal may be passed over. It appears that, as we cause the two masses to approach one another, the partial stability of Roche's satellite first ceases to exist through the deformation of its shape, and certain considerations are adduced which show that the most interesting field of research is comprised in the cases where the satellite ranges from infinite smallness relatively to the planet to equality thereto.

The limiting partial stability of a liquid satellite is determined by considering the angular momentum of the system, exclusive of the rotational momentum of the planet. This corresponds to the exclusion of the tidal friction of the tides raised in the planet. For any such given angular momentum there are two solutions, if there is any. When these two solutions coalesce for minimum angular momentum, we have found a figure of bifurcation; for any other larger angular momentum one of the solutions belongs to an unstable series and the other to a stable series of figures. Thus, by determining the figure of minimum partial angular momentum, we find the figure of limiting partial stability.

The only solution for which Roche gave a numerical result was that in which the satellite is infinitesimal relatively to the planet. He found that the nearest possible infinitesimal satellite (which is also in this case the satellite of limiting partial stability) has a radius vector equal to 2·44 radii of its spherical planet. He showed the satellite to have an ellipsoidal figure, and stated that its axes were proportional to the numbers 1000, 496, 469. In the paper the problem is solved by more accurate methods than those used by Roche, and it is proved that the radius vector is 2·4553, and that the axes of the ellipsoid are proportional to 10,000, 5114, 4827. The closeness with which his numbers agree with these shows that he must have used his graphical constructions with great care.

For satellites of finite mass the satellite is no longer ellipsoidal, and it becomes necessary to consider the deformation by various inequalities, which may be expressed by means of ellipsoidal harmonic functions.

The general effect for Roche's satellites of finite mass in limiting partial stability is that the ellipsoidal form is very nearly correct over most of the periphery of the satellite, but at the extremity facing the planet there is a tendency to push forth a protrusion towards the planet. In the stable series of figures up to limiting stability this protrusion is of no great magnitude, but in the unstable series it would become strongly marked. When the unstable figure becomes much elongated, we find that it finally overlaps the planet, but before this takes place the approximation has become very imperfect.

Turning now to the case of complete secular stability, where the tidal friction in each mass is taken into account, we find that for an infinitely small satellite limiting stability occurs when the two masses are infinitely far apart. It is clear that this must be the case, because a rotating liquid planet will continue to repel its satellite so long as it has any rotational momentum to transfer to orbital momentum through the intervention of tidal friction. Thus an infinitesimal satellite will be repelled to infinity before it reaches the configuration of secular stability. As the mass of the satellite increases, the radius vector of limiting stability decreases with great rapidity, and for two equal masses, each constrainedly spherical, the configuration is reached when the radius vector is 2·19 times the radius of either body.

When we pass to the case where each liquid mass is a figure of equilibrium, the radius vector for limiting stability is still infinite for the infinitely small satellite, and diminishes rapidly for increasing mass of the satellite. When the two masses are equal the radius vector of limiting stability is 2·638 times the radius of a sphere the mass of which is equal to the sum of the masses of the two bodies. This radius vector is considerably greater than that found in the case of the two spheres, for the 2·19 radii of either sphere, when expressed in the same unit, is only 1·74. Thus the deformations of the two masses forbid them to approach with stability so near as when they were constrainedly spherical.

[1] By Sir G. H. Darwin, K.C.B., F.R.S. Read before the Royal Society on February 8.

[2] Mém. Acad. Sci. de Montpellier, vol. i., 1847–50, p. 243.

In all these cases of true secular stability, instability supervenes through tidal friction, and not, as in the case of Roche's problem, through the deformation of figure.

When Poincaré announced that there was a figure of equilibrium of a single mass of liquid shaped something like a pear, he also conjectured that the constriction between the stalk and the middle of the pear would become developed until it was a thin neck; and yet further that the neck might break and the two masses become detached. The present revision of Roche's work was undertaken in the hope that it would throw some light on the pear-shaped figure in the advanced stage of development.

As a preliminary to greater exactness, the equilibrium is investigated of two masses of liquid each constrainedly spherical, joined by a weightless pipe. Through such a pipe liquid can pass from one mass to the other, and it will continue to do so until, for given radius vector, the masses of the two spheres bear some definite ratio to one another. In other words, two spherical masses of given ratio can be started to revolve about one another in a circular orbit, without relative motion, at such a distance that liquid will not pass through a pipe from one to the other.

The condition for equilibrium is found to be expressible in the form of a cubic equation in the radius vector, with coefficients which are functions of the ratio of the masses. Only one of the three roots of the cubic has a physical meaning, and in all cases the two masses are found to be very close together; but the system can never possess secular stability.

When the masses are no longer constrainedly spherical the equation of condition for equilibrium, when junction is effected by a weightless pipe, becomes very complicated, and can only be expressed approximately. It appears that in all cases, even of Roche's ellipsoids in limiting stability, the masses are much too far apart to admit of junction by a pipe; but when we consider the unstable series of much elongated ellipsoids, it seems that such junction is possible, although the approximation is too imperfect to enable us to draw the figure with any approach to accuracy. If two ellipsoids are unstable when moving detached from one another, junction by a pipe cannot possibly make them stable. This then points to the conclusion that the pear-shaped figure is unstable when so far developed as to be better described as two bulbs joined by a thin neck.

Mr. Jeans has considered the equilibrium and stability of infinite rotating cylinders of liquid.[1] This is the two-dimensional analogue of the three-dimensional problem. He found solutions perfectly analogous to Maclaurin's and Jacobi's ellipsoids and to the pear-shaped figure, and he was able to follow the development of the cylinder of pear-shaped section until the neck joining the two parts had become quite thin. The analysis, besides, points to the rupture of the neck, although the method fails to afford the actual shapes and dimensions in this last stage of development. He is able to prove conclusively that the cylinder of pear-shaped section is stable, and it is important to note that he finds no evidence of any break in the stability up to the division of the cylinder into two parts.

The stability of Maclaurin's and of the shorter Jacobian ellipsoids is well established, and I imagined that I had proved that the pear-shaped figure with incipient furrowing was also stable. But M. Liapounoff[2] now states that he is able to prove the pear-shaped figure to be unstable from the beginning. For the present at least, I still think it is stable, and this belief receives powerful support from Mr. Jeans's researches.

But there is another difficulty raised by the present paper. I had fully expected to obtain an approximation to a stable figure consisting of two bulbs joined by a thin neck, but although the present work indicates the existence of such a figure, it seems conclusive against its stability. If then Mr. Jeans is right in believing in the stable transition from the cylinder of pear-shaped section to two detached cylinders, and if I am now correct, the two problems must part company at some undetermined stage. M. Liapounoff will no doubt contend that it is at the beginning of the pear-shaped series of figures, but for the present I should dissent from that view.

[1] Phil. Trans., A, vol. cc., pp. 67–104.
[2] Acad. Imp. des Sci. de St. Pétersbourg, vol. xvii., No. 3, 1905.

One question remains: If the present conclusions are right, do they entirely destroy the applicability of this group of ideas to the explanation of the birth of satellites or of double stars? I think not, for we see how a tendency to fission arises, and it is not impossible that a period of turbulence may naturally supervene in the process of separation. Finally, as Mr. Jeans points out, heterogeneity introduces new and important differences in the conditions.

THE RUSTING OF IRON.

THE first view taken of the atmospheric corrosion or rusting of iron was that it was due to a simple process of oxidation. In 1888 Prof. Crum Brown suggested, on the basis of experiments described by Crace Calvert in 1871, that the first stage in the rusting of iron is the production, under the influence of carbonic acid, of ferrous carbonate, which is subsequently converted, by atmospheric oxygen in presence of moisture, into ferric hydroxide or rust. In 1898, however, Prof. Dunstan, in a lecture delivered to the Royal Artillery Institution, put forward another explanation; he considered that pure oxygen in presence of water is capable of attacking iron, giving rise to ferrous oxide and hydrogen peroxide, part of the latter then converting the ferrous oxide into rust, while the remainder directly attacks the iron, giving rise to a fresh quantity of ferrous oxide, which in turn is again oxidised in a similar manner.

A detailed account of the experiments made in conjunction with Drs. Jowett and Goulding, and of the theory, which may be called the hydrogen peroxide theory of rusting, was published in October of last year in the Transactions of the Chemical Society (vol. lxxxvii., p. 1548). The theory was based on certain phenomena of oxidation in which hydrogen peroxide was known to be formed, and on the consideration that certain substances which decomposed hydrogen peroxide were found to prevent the conversion of iron into rust by damp air. The older theory, that rusting was due to carbonic acid, was considered "quite untenable, since it has been shown that rusting can take place in the absence of carbonic acid"; the part played by carbonic acid was regarded as "subsidiary and not essential," and it was held to be proven that the "aërial oxidation of iron can take place in the absence of carbonic acid." This view was arrived at as the results of experiments in which the authors failed, by attempting to exclude carbon dioxide, to prevent iron from rusting in presence of oxygen and water.

In the April number of the Transactions of the Chemical Society, however, Dr. G. T. Moody shows that these attempts to prevent iron from rusting were unsucessful owing to the extreme difficulty of completely excluding traces of carbon dioxide. When very special precautions are taken to eliminate this substance iron may be left in contact with pure oxygen and water for many weeks without undergoing change. In one experiment thirty times the quantity of oxygen necessary to convert the whole of the iron into oxide was passed during the course of five weeks, but not even a speck of rust appeared. On the other hand, by removing the scrubbing arrangement by which the air was freed from carbon dioxide, so as to permit the ingress of this gas with the air, rusting commenced almost immediately, and in seventy-two hours the whole of the surface of the metal was seen to be corroded, and a considerable quantity of red rust was formed. Specimens of iron which had been exposed for several weeks to the action of pure oxygen and water without rusting were exhibited by Dr. Moody at the recent conversazione of the Royal Society.

It is also shown by Dr. Moody that while rust is being formed from iron under natural conditions a large proportion of ferrous carbonate is produced; the composition of rust in the course of formation is thus altogether out of harmony with the hydrogen peroxide theory, since this theory postulates that twice as much hydrogen peroxide is produced by the interaction of iron, oxygen, and water as is necessary completely to oxidise the ferrous oxide to the ferric state. The fact that certain compounds such as the alkalis, sodium nitrite, and potassium ferrocyanide prevent rusting is due, not to their power of decomposing hydrogen peroxide, but of interacting with carbon dioxide. Some substances, such as potassium iodide, which destroy hydrogen peroxide do not inhibit, but actually accelerate, the rusting of iron.

The facts recorded thus afford no basis for the assumption that iron can be caused to rust by pure water and pure oxygen alone, and give a satisfactory explanation of phenomena which were considered as being explicable only in the light of the hydrogen peroxide hypothesis.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—The Herbert Spencer lecture will be delivered in the examination schools on Thursday, June 7, at 3 p.m., by the Hon. Auberon E. W. M. Herbert, St. John's College.

Dr. G. C. Bourne, fellow of New College, has been nominated to the office of public examiner in zoology for 1906 in succession to the late Prof. Weldon.

At a meeting of the Junior Scientific Club on May 25 some experiments on "liquid crystals" were shown by Messrs. H. B. Hartley (Balliol) and H. L. Bowman (New College).

The following is the text of the speech delivered by Prof. Love in presenting Captain H. G. Lyons for the degree of D.Sc. *honoris causa* on May 29:—

Magnas profecto gratias hodie debemus Aegypto fluvioque Nilo, quo quotannis campos inundante, orta est ex necessitatibus hominum agellos suos summa cura dimetientium, Geometria, subtilissimae cuiusque scientiae parens. Debitum pro portione solvit Magna Britannia, cum moribus institutisque Europaeis in Aegyptum inducendis, tum viris ingenio et scientia pollentibus eo missis, qui ipsis rei publicae rectoribus quasi moderatores et gubernatores sint. In hoc numero locum insignem obtinet Henricus Georgius Lyons, qui cum decem abhinc annos omnia quae ad agrorum dimetiendorum, ad astrorum observandorum rationem pertinent, intermissa invenisset, non solum operam instauravit, sed etiam ipse nova quaedam commentus est, cum de harenae solique aevo et materia, de varia camporum planitie, de imbrium diversitatibus diligentissime quaereret: quod genus cognitionis quam late pateat nemo non videt. Agrorum quidem irrigandorum causa hoc opus noster suscepit, neque praeclarissimos fructus in hac re non assecutus est: nunc agit ut, custodibus et speculatoribus in ripis Nili tanquam in statione dispositis, his nuntiis fretus fluminis incrementum quantum anno proximo futurum sit ante praedicat: qua de re voce non incerta iam loquitur augur optimus. Neque tamen huic viro satis est scientiae et rei publicae inservire: quin vetustissimis illis monumentis quibus abundat Aegyptus magno opere delectatur. Veluti cum Nili regendi causa maximus ille prope Philas agger aedificaretur verebantur homines ne amplificata fluminis vis templis nobilissimis damnum adferret, huius viri laus est fanorum fundamentis confirmatis stabilitisque ita civium commodis consuluisse ut antiquitati venerandae parceretur.

Cambridge.—The voting on the proposals of the studies and examinations syndicate, which took place last Friday and Saturday, is likely to be misunderstood. The proposals put forward were those suggested by the Bishops of Bristol and Ely and by Mr. S. H. Butcher when the previous recommendations of the syndicate had been rejected. The committee presided over by Dr. Henry Jackson, which exists for the support of the movement in favour of the abolition of compulsory Greek, took no part in the recent agitation; indeed, many of its members voted against the proposals of the syndicate. The committee made no effort to bring up its supporters from the country, and regarded, in fact, the proposals of the syndicate as hardly worth accepting. The studies and examinations syndicate will probably now cease to exist. It has sat for three years and has produced two reports, both of which have been rejected in the main by the clerical vote. It is a well-known fact that in the first contest over compulsory Greek there was a majority of residents in the University and a majority of laymen in favour of its abolition. It now seems as if nothing but a Royal Commission can remove what to many is an absolute bar to their entrance to the University.

The Hopkins prize of the Cambridge Philosophical Society for the period 1897–1900 has been adjudged to Mr. S. S. Hough, F.R.S., of St. John's College, for his papers on the dynamical theory of the tides, published in the Philosophical Transactions of the Royal Society.

The professor of chemistry gives notice that the chemical laboratory of the University will be open for the use of students in the Long Vacation during July and August. Dr. Fenton will give a course of fifteen lectures on general chemistry on Tuesdays, Thursdays, and Saturdays, beginning on July 5. Mr. J. E. Purvis will give a course of lectures and practical demonstrations in pharmaceutical chemistry for the first part of the third examination for the degree of M.B. on Mondays, Wednesdays, and Fridays, beginning on July 4; and also a revision practical course in the chemistry and physics of hygiene.

The Board of Agricultural Studies announces that an examination will be held for one "Surveyors' Institution scholarship" on July 24–27. The scholarship is tenable for three years, and is of the value of 80*l.* per annum.

Prof. F. Franz Martens, privat docent for physics in the University of Berlin, who, on Prof. Matthiessens's resignation of the physics chair of the University of Rostock was temporarily appointed as his substitute, has been appointed professor of physics in the Berlin Handelshochschule.

At the May meeting of the Columbia University trustees, Mr. J. K. Rees, Rutherfurd professor of astronomy and head of the astronomical department, was made a professor emeritus. Mr. Harold Jacoby succeeds Prof. Rees; Dr. C. Lane Poor will be associated with him as a professor in the department, and Dr. S. A. Mitchell has been promoted to an instructorship in astronomy.

It is reported, says *Science*, that the University of California will lose 12,000*l.* yearly by the destruction of buildings owned by it in San Francisco, and that it will lose a further sum of 10,000*l.* yearly by the reduction in value of assessable property in the State. Our contemporary hopes, however, that the loss of income on the San Francisco property is only temporary, and that the State will not permit the University to suffer from the decrease in the taxes.

The Society for the Advancement of Mathematical Scientific Instruction will hold an annual general meeting in Erlangen during next week. Among the papers of general interest will be:—the investigations of glaciers, by Prof. Hess, of Ausbach; the experiment in ancient times and in the Middle Ages, by Prof. Wiedemann, of Erlangen; the proposals of the education commission of the Naturforschergesellschaft (p. 92), by Prof. Pietzker, of Nordheim; and the conception of number and quantity in teaching, by Prof. Wieleitner, of Speyer. Excursions will be made to Nürnberg and the French Switzerland.

An agreement for the mutual recognition of certificates has been arrived at between the Universities of Manchester, Liverpool, Leeds, and Sheffield Joint Matriculation Board and the Universities of Oxford and Cambridge. This Joint Matriculation Board will grant exemption from its matriculation examination to persons who have passed Responsions at Oxford with one additional subject, or have passed parts i. and ii. of the Previous Examination at Cambridge with one of the additional subjects. Under certain conditions as to the subjects taken, exemption will also be granted to holders of higher certificates of the Oxford and Cambridge Senior Local examinations. It will be remembered that a similar arrangement between the Universities of Oxford, Cambridge, and London has been announced already. Holders of Oxford and Cambridge Local certificates or higher certificates of the Oxford and Cambridge Joint Board are, if they have taken certain subjects, given exemption from the London Matriculation. Similarly, the Matriculation examination, in certain circumstances, gives exemption from Oxford Responsions and the Cambridge Previous examination.

An important advance in the development of the forestry branch of Armstrong College has been made by an agreement effected between H.M. Office of Woods and the college authorities, by which the latter take over the local management of Chopwell Woods, in the county of Durham. These woods are within a few miles of the college, extend over an area of nearly 900 acres, and carry crops of larch, spruce, Scotch pine, oak, ash, and other trees, most of which were planted about fifty years ago. The woods will be gradually brought under a proper rotation of cropping by the clearing and replanting of the more mature portions from time to time, and the carrying out of this work will afford favourable opportunities for demonstrating the various operations relating to practical forestry. H.M. Commissioner of Woods, Mr. J. F. F. Horner, has obtained the consent of the Treasury to a house being provided in the woods as a residence for the college lecturer in forestry, Mr. A. C. Forbes, and to continue to pay as heretofore the ordinary working expenses of the woods. The arrangement will facilitate the holding of short courses for practical foresters and others desirous of acquiring a knowledge of the subject, while as a practical demonstration area for the students attending the college forestry class the woods will be invaluable, and should render Newcastle one of the most favourable centres for forestry instruction in the United Kingdom.

In a paper on social conditions in Australia, read at a meeting of the Society of Arts on May 1, the Hon. J. G. Jenkins, Agent-General for South Australia, dealt with the educational advantages of the country. "Generally speaking," he said, "the system of public education is free, compulsory, and secular, the whole expense being met out of the general revenue. The greatest care is taken to provide schools in every part of the country as well as in the thickly populated cities, and in some of the thinly settled districts schools of from ten to fifteen children are established. Fortunately, Australia's educational advancement has not been delayed by sectarian interference. There it is generally considered that a country's advancement rests on the education of its people, and that as national education is a national gain, the nation's treasury should meet the bill. Efforts have been made from time to time by zealous propounders of sectarian beliefs to incorporate religious instruction with the Education Acts of the different States, but the majority of the people are strongly opposed to any form of State aid to religion. They feel that in the bitter strife for sectarian supremacy the efficiency of the schools would become impaired and the practical education of the children neglected. The parents generally take advantage of the public schools for their children, but for those who object, either from class prejudice or religious scruples, good private schools are available."

Prof. J. F. Sellers, of Mercer University, recently sent out a number of inquiries to forty-four teachers of chemistry in the southern States of the American union; the answers made by forty of the teachers form a symposium on chemical requirements which was presented to a meeting of the American Chemical Society. The paper is printed in *Science* of May 11. In reply to a question asking if chemistry should be taught in preparatory schools, a majority of five thought it should. Answers to a second question showed that in a small majority of colleges only does chemistry follow a course of physics. Prof. Sellers found that about equal time is given to lectures and to laboratory work, and most teachers consider that individual laboratory work should always form part of a chemistry course. Similarly, there is a consensus of opinion that qualitative analysis should follow general chemistry. The majority of the institutions represented offer graduate work in chemistry. The paper shows that few southern chemistry teachers carry on research themselves, and this is because they are overloaded with instruction or executive duties, and are not supplied with adequate library or laboratory facilities for advanced students. The majority of southern colleges give technical courses, and these are controlled by local demands and natural supplies. The sting of the paper, so far as our universities are concerned, lies in the tail, which is as follows:—"Once the American universities were replicas of the British system, but now the German university sets the standard. It is this shifting of method and manner that affords us of to-day, in the matter of the practical virtue of our courses in science, an assured guarantee of commercial and industrial progress."

SOCIETIES AND ACADEMIES.

London.

Royal Society, March 1.—"The Specificity of the Opsonic Substances in the Blood Serum." By Dr. William **Bulloch** and G. T. **Western**. Communicated by Leonard Hill, F.R.S.

Conclusions.—(1) When staphylococci are brought into contact with normal human serum, and are subsequently removed by centrifugalisation, the serum loses its opsonic power for Staphylococcus, although the opsonic power of *Bacterium pyocyaneum* is preserved.

(2) Contact of normal human serum with tubercle bacilli leaves the opsonic power of that serum for staphylococcus almost intact, while the opsonic power for tubercle bacillus is completely removed.

(3) Contact of normal human serum with staphylococcus leaves the opsonic power of that serum for tubercle bacillus almost intact, while the opsonic power for staphylococcus is completely removed.

(4) Inoculation of a human being with tuberculin causes quantitative increase in the tuberculo-opsonin, whereas the quantity of staphylococcus opsonin is unaltered.

(5) Inoculation of a human being with staphylococcus vaccine causes a quantitative increase in the staphylococcus opsonin, whereas the quantity of tuberculo-opsonin is unaltered.

March 8.—"On the Relationship between Hæmolysis and the Phagocytosis of Red Blood Cells." By Dr. R. D. **Keith.**

The conclusion come to is that the phagocytosis of red blood cells does not depend on the presence of the hæmolytic amboceptor, since:—

(1) The substance which induces phagocytosis is partially destroyed by heat, while the hæmolytic amboceptor is entirely thermostable.

(2) The hæmolytic amboceptor may be present in considerable amount in a hæmolytic serum without inducing phagocytosis, notwithstanding prolonged contact of the amboceptor with the red blood cells.

Dean has suggested that phagocytosis may be caused by a complement acting through an amboceptor, and that the partial destruction, of the property in the serum inducing phagocytosis, by heat may be due to the destruction of the complement, while the amboceptor, even in the absence of the complement, may still be capable of inducing phagocytosis. This theory, while it is difficult to disprove directly owing to the complement being destroyed at the same temperature as the thermolabile part of the substance inducing phagocytosis, seems to be an improbable one for the following reasons:—

(1) That it is not an action analogous to that of other amboceptors, *e.g.* that concerned in hæmolysis. If one destroy the complement of a hæmolytic serum by heat, no hæmolysis takes place, notwithstanding the presence of the amboceptor in large amount.

(2) The hæmolytic amboceptor may be present in large amount in a diluted serum, without that serum having the power of inducing phagocytosis even when Dean's method of testing is employed.

(3) In the dilution experiments recorded in the paper it is shown that one may dilute the complement to such an extent as to abolish hæmolysis, and yet such a serum has a greater "opsonic" power in these dilutions than has the same serum when heated and employed in corresponding dilutions.

"Upon the Properties of an Antityphoid Serum obtained from the Goat." By Dr. Allan **Macfadyen.** Communicated by Dr. C. J. Martin, F.R.S.

Conclusions.—(1) The intravenous injection of the goat with the toxic cell juices of the *B. typhosus* (obtained under the conditions described) in small and carefully regulated doses resulted in the production of an antiendotoxin.

(2) The antiendotoxin value, as so far tested, reached a point at which 1/50 c.c. of the serum neutralised thirty lethal doses of the toxic typhoid cell juice. This action was not demonstrable in 3 c.c. of normal goat's serum, and was obtained after about four months' treatment of the goat. The results, after a more rapid method of immunisation, are better *qua* goat and rabbit than those obtained by Dr. Besredka in the course of two years with dead and living bacilli *qua* horse and guinea-pig.

(3) The serum was also agglutinative for the *B. typhosus*, the titrate rising to 1/1,000,000.

(4) The serum was also bacteriolytic, 1/10,000 c.c. neutralising ten lethal doses of the *B. typhosus*.

(5) The serum did not give a precipitin reaction with typhoid cell juices.

(6) The serum, whilst neutralising the typhoid, did not neutralise the cholera endotoxin.

Entomological Society, May 2.—Mr. F. Merrifield, president, in the chair.—Fourteen examples of both sexes of *Hystrichopsylla talpae*, Curtis, the largest British flea, taken in the nest of a field-mouse in a tuft of grass at Grange, near Gosport, Hants, on March 28: Commander J. J. **Walker**.—Living specimens of *Apate capucina*, *Deilus fugax*, a *Cryptocephalus* (*rugicollis*), two species of Anthaxia, &c., forwarded by Dr. T. A. Chapman from Ste. Maxime, South France: G. C. **Champion**.—An example of the weevil *Procas armillatus*, F., taken near Dartford, Kent, on April 13: F. B. **Jennings**. This species appears to be extremely scarce in Britain, and, with the exception of a single specimen taken near Chatham by Commander Walker in 1896, has not been recorded from this country for a considerable period.—Beetles from New Guinea, including *Aesernia mecki*, Jac., *A. costata*, Jac., *A. gestroi*, Jac., and Cetoniadæ and Lucanidæ from South Africa and Borneo: M. **Jacoby**.—Specimen of *Hydrochus nitidicollis*, Muls., a beetle not hitherto recorded in Britain, taken at Yelverton, in the River Meavy, in April: H. St. J. **Donisthorpe**.—Lantern-slide photographs (from nature) of the ♀ calcaria postica in Hymenoptera belonging to divers groups, mostly Aculeate, but including also representatives of chrysids, ichneumonids, and sawflies: Rev. F. D. **Morice**. Mr. Morice submitted that, in all the examples shown, the structure of the calcaria themselves (and also of the parts adjacent to them) clearly indicated that their main function was that of an elaborately constructed instrument for toilet purposes.—Specimens of *Mylothris agathina*, Cram., and of *Belenois thysa*, Hopff.: Dr. F. A. **Dixey**. The close resemblance between these species obtained chiefly in the dry-season form of the latter, and not in the wet. Dr. Dixey considered this to be a fresh illustration of the special liability to the attacks of enemies experienced under dry-season conditions, leading in some cases to the adoption of a cryptic coloration, and in others, as here, to mimicry of a protected form such as *M. agathina*.—A criticism of the late Prof. Packard's paper on the markings of organisms: H. **Eltringham**.—The genus Imma, Walk. (=Tortricomorpha, Feld.): E. **Meyrick**.

Royal Astronomical Society, May 11.—Mr. W. H. Maw, president, in the chair.—Some points arising out of a discussion of the double stars in Struve's "Mensuræ Micrometricæ": T. **Lewis**. A memoir upon the subject had just been completed, and was about to be published by the society. Questions concerning the distribution of double stars, and the relation between those relatively fixed and those in motion, were considered. The facts appeared to point to the conclusion that the sun is situated in a cluster, but not centrally.—The orbit and mass of 85 Pegasi: W. **Bowyer** and H. H. **Furner**.—Some considerations concerning the number of the stars: Miss W. **Gibson**. The conclusions were derived from a discussion of seventy-two stars, and the relations between parallax, magnitude, and proper motion were considered.—Observations of Jupiter's sixth and seventh satellites, from photographs taken at the Royal Observatory, Greenwich: **Astronomer Royal**. A large number of plates had been taken for the positions of the satellites with exposures of five minutes to nearly three hours. Photographs of Jupiter had also been taken, which showed that the tabular errors are very small. The results were confirmed by meridian observations.—Prints from negatives of the solar eclipse of August, 1905: **Astronomer Royal**. Seismographic records taken at the Royal Observatory, Edinburgh: Prof. F. W. **Dyson**. The records showed that the trace of the San Francisco earthquake reached Edinburgh in about seven minutes.—Observations of the magnitude and position of Nova Geminorum: E. E. **Barnard**. Photographs of the Milky Way taken at Mount Wilson, California, during the spring and summer of 1905: E. E. **Barnard**.—The president announced that news had been received that no injury had been caused to the Lick Observatory by the recent earthquake.

PARIS.

Academy of Sciences, May 14.—M. H. Poincaré in the chair.—A singular effect of friction: E. **Guyou**. An explanation of an experiment of M. de Saintignon. A spherical glass globe, filled with water and containing a fine powder, is rotated with a high velocity round one of its diameters as axis. The powder, if lighter than water, collects along the axis of rotation, but if heavier than water the sphere is divided into three zones, separated by two parallels of latitude equidistant from the equator. The upper and lower segments are clear, the powder being distributed in the central zone and mainly on the two boundary lines. A simple explanation is given of this paradoxical effect.—The influence of velocity on the law of deformation of metals: P. **Vieille** and R. **Liouville**.—Low temperatures and chemical analysis: MM. **d'Arsonval** and **Bordas**. An arrangement is described permitting of the direct determination of water in aqueous solutions by distillation at the ordinary temperatures, the receiver being kept at −80° C. The method is very rapid compared to those in ordinary use.—New researches on diastatic saccharification: L. **Maquenne** and Eug. **Roux**. The action of malt on starch has been studied under varying conditions of time, acidity, and nature of the starch, and the experimental results tabulated.—Three toxins of human trypanosomiasis of different origin: A. **Laveran**. The cases studied came from Gambia, Uganda, and Ubanghi. From the morphological point of view, no difference could be noted between them. Experiments with guinea-pigs, rats, and mice showed slight differences only. All the observations support the view that the three trypanosomes from the different localities belong to the same species.—The centres of gravity of discontinuous systems: Haton **de la Goupillière**.—A new octane, hexamethylethane: Louis **Henry**. This hydrocarbon is formed as a bye-product in the action between the magnesium compound of tertiary butyl bromide and acetaldehyde, probably by the action of some unchanged butyl bromide upon the magnesium compound. It is a solid, volatile at the ordinary temperature, and possessing a penetrating odour. It boils at 106° C. to 107° C. under 765 mm.—An account of an earthquake at Bogota on January 31 last: M. **Souhart**.—A new arrangement for the spectroscopy of phosphorescent substances: C. **de Watteville**. The phosphorescent substance under examination is illuminated by an electric spark about eighty-two times per second, the interval of time elapsing between the exposure to the spark and exposure to the photographic plate being about 1/3000th of a second. The period of the spark is governed by a rotating disc, and is independent of the speed of the contact breaker of the coil. The phosphorescence of bodies examined with this apparatus is very bright, and in the spectra obtained, which are rich in ultra-violet lines, none of the lines corresponding to the metal of the electrodes are visible.—The measurement of very short intervals of time by means of a condenser: M. **Devaux-Charbonnel**. The method is based on the measurement of the charge of a condenser through a variable resistance, first during the short interval of time to be measured, and then completely. Experimental results are given showing the accuracy obtainable to be of the order of 0·0001 sec.—The conductivity of ammonium sulphate in mixtures of sulphuric acid and water: G. **Boizard**.—The complete synthesis of some camphor derivatives. Isolaurolene and isolauronolic acid: G. **Blanc.** The starting point of these syntheses is αα-dimethyladipic acid, the synthesis of which has been described in a previous note. The anhydride of this acid by slow distillation at the ordinary pressure gives 2 : 2-dimethylcyclopentanone. The tertiary alcohol obtained from this by Grignard's reaction on distillation at ordinary atmospheric pressure splits up into water and isolaurolene.—α-Chlorocyclohexanone and its derivatives: L. **Bouveault** and F. **Chereau.** This substance is obtained by chlorinating either cyclohexanone or cyclohexanol in the presence of calcium carbonate. The chlorine in this derivative is reactive, potassium carbonate solution giving α-oxycyclohexanone. Substituted homologues of cyclohexanone are obtained without difficulty by the action of alkyl-magnesium compounds on chlorocyclohexanone; the methyl, ethyl, and isopropyl derivatives are described.—Stereoisomerism in the group of unsaturated αβ-acyclic compounds: E. F. **Blaise** and P. **Bagard.**—The genus Mascarenhasia: Marcel **Dubard.**—A case of a green organ deprived of assimilating power: Jean **Friedel.** The ovary of *Ornithogalum arabicum* is green and contains chlorophyll, but is devoid of assimilating power, although the ovary of *Ornithogalum umbellatum*, which is also green, has a well-developed assimilating power. The difference is possibly due to a superficial alteration of the chlorophyll grains.—The diseases of the coffee plant in the Congo Free State: E. **De Wildeman.**—The replacement of the vibrating muscles of the wing by adipocyte columns in ants after the nuptial flight: Charles **Janet.**—A new myxosporidium of the common tench: Louis **Léger.** This species was discovered in looking for the cause of a heavy mortality of the tench, and is named by the author *Chl. cristatum*. The disease of the fish was due to other causes.—Culture of the spirillum of recurrent African fever in man (tick fever): C. **Levaditi.** Details of the method of culture are given. The virulence of the spirillum was maintained through a long series of cultures.—The pathogeny of tuberculosis: H. **Vallée.**—The terraces of the Rhone valley below Lyons: M. **de Lamothe.**—The tectonic and stratigraphical relations of Sicily and Tunis: Émile **Haug.**—The geology of Calabria: Maurice **Lugeon** and Émile **Argand.**—A method of taking samples of sea-water for bacteriological studies: P. **Portier** and J. **Richard.** The construction and use of the apparatus are made clear by four diagrams.—The increase in the flow due to the cold season in the Seine and Loire basins: Edmond **Maillet.**—The mineralisation of subterranean waters and the causes of its variation: F. **Dienert.**—The Ahannets of Nimes, Belgium: E. A. **Martel** and E. Van den **Broeck.**

DIARY OF SOCIETIES.

THURSDAY, May 31.

Royal Society, at 4.30.—On the Main Source of "Precipitable" Substances and on the *Rôle* of the Homologous Proteid in Precipitin Reactions: D. A. Welsh and H. G. Chapman.—The Viscosity of the Blood: A. du Pre Denning and J. H. Watson.—The Affinity Constants of Amphoteric Electrolytes, i., Methyl Derivatives of Para-Aminobenzoic Acid and of Glycine: J. Johnston.—The Affinity Constants of Amphoteric Electrolytes, ii., Methyl Derivatives of Ortho- and Meta-aminobenzoic Acids: A. C. Cumming.—The Affinity Constants of Amphoteric Electrolytes, iii., Methylated Amino-acids: Prof. J. Walker, F.R.S.

Royal Institution, at 5.—Man and the Glacial Period: Prof. W. J. Sollas, F.R.S.

FRIDAY, June 1.

Royal Institution, at 9.—L'Ébullition des Metaux: Prof. H. Moissan, For. Mem. R.S.

TUESDAY, June 5.

Royal Institution, at 5.—Northern Winter Sports, Sweden and its People: Colonel V. Balck.

WEDNESDAY, June 6.

Society of Public Analysts, at 8.

Entomological Society, at 8.—(1) Predaceous Insects; (2) On some Forms of *Papilio dardanus*: Prof. E. B. Poulton, F.R.S.—Notes on the Blattidæ: R. Shelford.—On the Bionomics of some Butterflies from the Victoria Nyanza Region: S. A. Neave.

THURSDAY, June 7.

Royal Society, at 4.30.—*Probable Papers*: On the Osmotic Pressures of some Concentrated Solutions: The Earl of Berkeley and E. G. J. Hartley.—An Account of the Pendulum Observations made at Kew and Greenwich Observatories in 1903: Major G. P. Lenox-Conyngham.—The Self-induction of an Iron Cylinder: Prof. E. Wilson.

Royal Institution, at 5.—Man and the Glacial Period: Prof. W. J. Sollas, F.R.S.

Linnean Society, at 8.—On Two New Species of Populus from Darjeeling: H. H. Haines.—Biscayan Plankton, part viii., The Cephalopoda: W. E. Hoyle.—Part ix., The Medusæ: E. T. Browne.

Chemical Society, at 8.30.—Ammonium Selenate and the Question of Isodimorphism in the Alkali Series: A. E. H. Tutton.—An Improved Beckman Apparatus for Molecular Weight Determination: J. M. Sanders.—Resolution of Lactic Acid by Morphine: J. C. Irvine.—The Vapour Pressures of Binary Mixtures, part i., The Possible Types of Vapour-pressure Curves: A. Marshall.—Action of Sodium on αα-Dichlorpropylene: I. Smedley.—Thiocarbamide as a Solvent for Gold: J. Moir.—The Action of Sulphur Dioxide and Aluminium Chloride on Aromatic Compounds: S. Smiles and R. Le Rossignol.

FRIDAY, June 8.

Royal Institution, at 9.—Studies on Charcoal and Liquid Air: Sir James Dewar, F.R.S.

Physical Society, at 8.—On the Solution of Problems in Diffraction by the Aid of Contour Integration: H. Davies.—The Effect of Radium in Facilitating the Visible Electric Discharge *in vacuo*: A. A. Campbell Swinton.—Mr. J. Goold's Experiments with a Vibrating Steel Plate, exhibited by Messrs. Newton and Co.—Fluid (liquid) resistance: Col. de Villamil.

Royal Astronomical Society, at 5.

Geologists' Association, at 8.—The Higher Zones of the Upper Chalk in the Western Part of the London Basin: H. J. Osborne White and Ll. Treacher.

Malacological Society, at 8.—Mollusca of the *Porcupine* Expeditions, 1869–70, Supplemental Notes, part iii.: E. R. Sykes.—Notes on the Dates of Publication of the "Mineral Conchology" and "Genera Rec. Foss. Shells": E. R. Sykes.—Description of *Oliva ispidula*, L., var. *longispira*: F. G. Bridgman.—On *Chloritis heteromphalus*: H. A. Pilsbry.

CONTENTS.

THURSDAY, JUNE 7, 1906.

THE ROTHAMSTED EXPERIMENTS.

The Book of the Rothamsted Experiments. By A. D. Hall. Pp. xl+294. (London: John Murray, 1905.) Price 10s. 6d. net.

ALTHOUGH the Rothamsted experiments have formed the subject of over 200 papers and reports, no book describing them has hitherto been published in this country. The present volume, by Dr. Gilbert's successor, is therefore a welcome addition to agricultural literature. We do not forget that two works entitled "The Rothamsted Experiments" were published respectively in 1888 and in 1897, but the former was an account of a few experiments only, and the latter discussed the practical results rather than the experiments themselves.

Mr. Hall's book has been written chiefly for the general reader who may be interested in agricultural experiments, but it is also intended for the student and the teacher. It opens with biographical notices of the two remarkable men who have made the name of Rothamsted familiar. Then follow three introductory chapters—the first mainly historical, the second dealing with meteorological observations, and the third describing the soils of the experimental fields. At the end of the book there are three appendices, the most important being a list of Rothamsted publications. These sections of the work, with the index, occupy some 90 out of a total of 334 pages. The remainder of the book consists of ten chapters, each dealing with one experiment, or with groups of similar experiments. The text is illustrated by fourteen full-page plates, and by a large number of diagrams, while figures obtained in the experiments occupy ninety-two tables.

Those who conduct field experiments will read with some surprise the account given of the soil of Rothamsted. The estate was recently surveyed by Mr. H. B. Woodward, of the Geological Survey, and he described the experimental fields as resting on a very mixed deposit of clay-with-flints overlying chalk. The chalk is extensively piped, and appears occasionally in irregular pinnacles near the surface. The soil is a grey, flinty, or pebbly loam, ten inches or more in thickness, and varying in character according to the number of stones in it. From this description the soil would appear to be anything but an ideal one for agricultural experiments, but we know that on the whole it has been satisfactory. It would seem, therefore, that where the soil is of moderate depth, variations in the subsoil may not interfere seriously with field plots.

Lawes and Gilbert had wide interests, and at one time or another they touched upon almost every important subject dealt with by the agriculturist. Their main work was on what may be described as the balance-sheet of the soil, and most of the crop and feeding experiments were planned to throw light upon the soil's losses and gains; but they found time for investigations on many other subjects, such as the source of fat in the animal body, the economic feeding of live-stock, ensilage and sewage farming.

The experiments upon field crops at Rothamsted were chiefly of one type. The land was divided up into plots, usually of from one-eighth to one-half of an acre in size; the plots received different manures such as farmyard manure, superphosphate, nitrate of soda, and the sulphates of ammonia, potash, soda, and magnesia. The artificial manures were employed in various combinations. With few exceptions, plots received the same manures year after year, and the field was occupied by the same crop either permanently, as in the case of the wheat and barley experiments, or so long as the crop could be got to grow, as in the case of clover and potatoes. The primary object of these experiments was to ascertain how crops grow, and more especially to discover what capacity the important farm crops have of obtaining nourishment from unmanured soil, and what class of manure is most necessary for the healthy development of each. As the work progressed, other points were brought to light—thus, for example, in connection with the wheat experiments it was shown (1) that the fertility of ordinary soils was of two types—one quickly exhausted (condition), the other of a very enduring character (inherent fertility); (2) that high farming is not a remedy for low prices in the case of wheat; (3) that superphosphate and the sulphates of potash and ammonia do not occur in appreciable quantities in the drainage waters from corn-fields, but that nitrates readily pass through the soil and are lost. In the experiments on meadow herbage, as with wheat, it was soon shown what classes of manure were required, but after a time it became apparent that different species in the meadow were differently affected by the treatment the plots received, and for many years the interest has centred in the varying fortunes of the combatants in this "battle of the meadow." There is an excellent account of these changes, and the diagrams in this section of the book are particularly striking—not so striking, however, as the plots themselves now are. There are no field experiments so full of interest to the naturalist as the plots in the park at Rothamsted.

Mr. Hall gives a very good summary of the Rothamsted work, and his book forms a complete guide to the experiments. It contains just the information which the visitor wants, and it is also well adapted for the agricultural student. But in the interests of the visitor and the student we hope that a new edition of smaller size may be published before long. A royal octavo page, "English" type, and thick paper make the book in its present form an admirable library edition, but the student wants something more compact and less expensive.

We venture to make a further suggestion. It is that in subsequent editions the "Practical Conclusions" which are appended to most of the chapters should be omitted. They do not harmonise with the rest of the work—in a good many cases, indeed, they seem to be based on general agricultural principles rather than on results obtained in the Rothamsted experiments—and in their present form they are more likely to cause readers to underestimate than to appreciate the great value of the work of Lawes and Gilbert. Take, for example, the "Practical Conclusions" which follow Chapter IV.—"Experiments upon Wheat." The chapter extends to thirty-eight pages, and deals with some of the most important work done at Rothamsted. The conclusions are three in number, and in effect are as follow:—(1) Wheat is in less need of direct manuring than most other crops of the farm, and "can usually be grown with the residues in the soil, especially if it follows a clover crop." (2) Manures for wheat should be mainly nitrogenous, and nitrate of soda is generally better than sulphate of ammonia. (3) "When wheat is grown two or three times in succession, about 1 cwt. per acre of some slow-acting nitrogenous manure and 2 cwt. of superphosphate should be ploughed before seeding, and a top-dressing of 1 to 2 cwt. per acre of nitrate of soda should be applied in February. Only on the lightest sandy and gravelly soils will any return be obtained for the use of kainit and other potash salts with wheat."

These conclusions do not represent the "practical" teaching of Lawes and Gilbert, and although it is admitted that they are conclusions which may be fairly drawn from the Rothamsted experiments on wheat, we think the book would be improved by their absence.

Rothamsted has exercised a great influence on practical agriculture, but in perusing Mr. Hall's book we have been impressed by the fact that the experiments, important as they are, do not in themselves account for the estimation in which Rothamsted has been held by agriculturists. If, however, the reader turns to the list of papers in appendix i. he will there find the explanation of much of Lawes and Gilbert's influence. They began their experiments as students of nature, and with the one object of adding to the existing knowledge of agriculturists. As their work progressed they not only came to possess an unrivalled acquaintance with the general facts of agricultural science, but they gained a very close knowledge of the business of the practical farmer. They were thus able to find in their experiments much that explained the farmer's difficulties, and, as they were always careful to place their results before farmers, their papers in the agricultural journals soon attracted the notice of practical men. As long ago as 1856 a writer on Rothamsted says: "These lessons the English farmers have learnt from Mr. Lawes. They have accepted them with becoming gratitude. They are practising them with increasing confidence day by day to their great and proved advantage."

It was not the habit of Lawes and Gilbert to confine themselves to Rothamsted data; they drew freely on other sources of information in compiling their papers; and they wrote upon subjects rather than upon experiments; to quote Mr. Hall, "The papers on specific investigations often tend to be less accounts of the experiment as a whole than discussion of such of its results as bear upon the dominant idea with which Lawes and Gilbert were then engrossed." This habit, possibly undesirable in a scientific report, was most valuable to the readers of their general papers. To the agriculturist, Lawes and Gilbert were known as teachers rather than as experimenters, and while the accuracy and extent of their experiments brought them scientific fame, it was as interpreters of science, as men who thoroughly appreciated both the scientific and the practical aspects of their subject, that they became leaders in the agricultural world, and for close on two generations continued to be the trusted advisers of the British farmer.

T. H. Middleton.

EVOLUTION AND PHILOSOPHY.

Evolution the Master-key. By Dr. C. W. Saleeby. Pp. viii + 364. (London: Harper and Brothers, 1906.) Price 7*s.* 6*d.*

Dr. Saleeby has written a very interesting book. The grand range and sweep of his reasoning is remarkable. He deals, and generally very ably though very briefly, with most of the profoundest problems of science and philosophy. As the title of his book proclaims, his object is to apply the doctrine of evolution to all problems and to show that, though some entirely baffle human thought and reasoning, yet to most there is a key, and one key only. They must be studied from the evolutionary standpoint. Each train of thought is pursued till its logical conclusion is reached. There is no stopping half-way. When great principles are expounded, Dr. Saleeby does not leave them in barren solitude, but boldly faces the inferences that inevitably follow. He is, in fact, very thoroughgoing. Dr. Saleeby's science and philosophy are always alive and human, for he always traces new thoughts and new discoveries to their originators. In his admirations he is very hearty and genuine. His heroes are the men who have advanced human knowledge and helped to emancipate the human intellect. Occasionally he rises to eloquence.

After part i., which is preliminary and general, our author proceeds to inorganic evolution. The evolution of sun and planets from a nebula, the gradual dissipation of the sun's heat, and the possible return to the nebula state through collision with another celestial body—all this is excellently described. After this, radium and the architecture of the atom come up for investigation. Part iii. deals with organic evolution, beginning with a discussion of the origin of life, and not omitting the practical question of eugenics. The subject of part iv. is superorganic evolution—the evolution of mind, the human will, the origin of ideas, the evolution of religion, evolution and marriage, evolution and education, and so forth. In part v. we have evolution and optimism. In part vi. Dr. Saleeby tackles the difficult subject of dissolution. Though energy never disappears, yet it is dissipated, and so becomes unavailable. Is the death of the whole universe in prospect? Are there alternate periods of evolution and dissolution? Part vii. is occupied with evolution and the religion of the future.

In a book covering so wide a field it is inevitable that there should be a good deal to criticise. Part i., which deals with preliminary questions, is too long. The chapter on the philosophic temper is quite unnecessary. Dr. Saleeby's overpowering admiration for Herbert Spencer occasionally leads him astray. Herbert Spencer attributed organic evolution mainly to the inheritance of acquired characters, tracing even the stag's antlers to this principle. Though a large majority of biologists think otherwise, our author maintains that time has vindicated Spencer. The evidence he himself produces is worth little or nothing. Pathogenic bacteria, he says, quoting Haeckel, when they "are passed through the body of a highly susceptible animal become possessed of a much greater degree of virulence than formerly." "The progeny of such bacteria, often after tens and hundreds of generations, are possessed of a character which was acquired by their ancestors during their passage through the body of the susceptible animal." Grant that this is so, still the unicellular organisms are in quite a different category from the higher animals.

Dr. Saleeby's optimism sometimes affects his judgment. Natural selection, he maintains, is still making for the improvement of the human breed. Is this really so among civilised races? And, if so, what need of Mr. Galton's eugenics, which he highly commends? Again, Dr. Saleeby denies the freedom of the will. Like nearly all modern psychologists, he is a determinist. Like a true optimist, he finds a satisfaction in the fact that we cannot act without motive—in other words, that we are automata. He tells us that we have will, but this turns out only to mean that the brain can inhibit the working of the lower nerve-ganglia. If a slave is allowed to keep a slave, he does not thereby cease to be a slave himself. After all, what we want is a working belief in free will, and this is the inalienable property of every healthy man. When it comes to action a healthy determinist throws aside his theories and his philosophic temper, and has as strong a sense of freedom as any barbarian. In conclusion, we must congratulate Dr. Saleeby on having produced so readable and so able a book.

F. W. H.

THE UNIVERSITY IDEA.

The Launching of a University, and Other Papers. A Sheaf of Remembrances. By Dr. J. D. C. Gilman. Pp. 386. (New York: Dodd, Mead and Co., 1906.) Price 2.50 dollars net.

THE launching of the Johns Hopkins University could not be more fitly or more intimately described than by one who has "the advantage of knowing more than anyone else of an unwritten chapter of history." Such a record could hardly fail to throw interesting sidelights on the growth of the idea of the University in its modern conception. It is interesting to notice that the launchers of the Johns Hopkins University were largely influenced, not only by the evidence of University Commissions in Great Britain, but also by the writings of Newman and Matthew Arnold, of Pattison and Appleton. The actual founder was as liberal in his ideas as he was in his gifts, and the administrators of his gift made the fullest use of their discretion. President Gilman himself had a roving commission to pick the brains of the older Universities in England, France, and Germany. The main problem was to disengage the University from the college idea, and to give to the University point of view all the distinctness of which it was capable. The selection of the original faculty was sufficient to secure this result. It included such men as Sylvester, Martin, Rowland, Morris (from Oriel College), Gildersleeve, and Remsen, who succeeded Dr. Gilman as president in 1902. We are given interesting glimpses of these and other noteworthy teachers, as also of other famous English and American savants who were at different times and in different degrees associated with the Johns Hopkins University—such as Freeman and Huxley, Cayley and Kelvin—and of such celebrities as Dean Stanley, Lowell, Child, and Lanier, the poet. The interest of these chapters is, in fact, largely personal and local, interspersed with general reflections on the advancement of science, the conflict of studies, and the idea of research. Brief notices are also given of what are perhaps the two most distinguished features of the Johns Hopkins University—its publications and its medical school.

The "addresses on various occasions, historical and educational," are of somewhat unequal interest. For the most part they are too occasional, as well as too topical in character, to be of very general interest. Some of them are fitly characterised as "a sheaf of remembrances"; some touch, without going very deeply into, University problems; while others, again, are of the nature of social and ethical homilies. Here, as elsewhere, the author dwells on the progress which has been made towards the recognition of "the true significance of University work, as distinguished from collegiate discipline," and at the same time indicates that the development of graduate study has not been without its influence upon the organisation of collegiate work. "Two gains are doubtless permanent"—elective courses or an option between "groups" of undergraduate studies, and the "rapidly increasing" recognition of the value of "liberal education"—not only as the preliminary antecedent to higher and special studies, but also as a preparation for business and politics. We are not sure, however, how far Dr. Gilman's estimate of the value of the "elective" system is representative of opinion among home or foreign observers. In another place he describes the system as "a triumph of the last thirty years." With regard to liberal culture, Dr. Gilman observes that "a liberal education is not now complete unless it includes a knowledge of French and German." Both these points deserve the consideration of University reformers in other places.

Perhaps the most striking note of Dr. Gilman's addresses on University subjects is his strenuous plea for "research." To the term itself he takes not unreasonable exception; for the thing he has nothing but enthusiasm; and in this connection what he has to say about the magnificent promise of the Carnegie Institution, with which he has been prominently associated, will be read with interest. Among the gevelopments of University activity in America which Dr. Gilman selects for commendation are the growth of scientific laboratories (including observatories and surveys), the expansion of libraries, the adjustment of the claims of science and letters, the "clarification" of the idea of the University, the admission of women to the advantages of higher education, and the advancement of professional schools, especially schools of medicine and law. Dr. Gilman also notes with satisfaction the mutual growth of "sweet reasonableness" among the leaders of religious and of scientific thought. The remaining addresses on such miscellaneous subjects as "Hand-craft and Redecraft," "Greek Art in a Manufacturing Town," "Civil Service Reform and Education in Philanthropy," do not seem to call for special notice. They are all, however, animated by the same lofty enthusiasm and the same large outlook that characterise the author's "idea of the University," and of the future which it has before it in the general life of the nation.

A RAMBLE IN THE WEST.

Highways and Byways in Oxford and the Cotswolds. By Herbert A. Evans. Illustrated by Frederick L. Griggs. Pp. viii+407. (London: Macmillan and Co., Ltd., 1905.) Price 6s.

OXFORD and its colleges are always before the world. Early Oxford, Mediæval Oxford, Stuart Oxford, Modern Oxford, it has been described over and over again in all its phases and all its moods. It has furnished the artist with unfailing inspiration, it has been the excuse for endless reminiscences, we have seen it approach "the cross-roads," and recently it has been held to account in the columns of *The Westminster Gazette*.

The author of this volume may well be pardoned if he does not write of the city at length. The few pages which he spares to it are given up for the most part to the archæology of the less visited portion to the west of the north and south artery, the quarter which centred round the castle still in existence, and the magnificent foundations of Osney and Rewley long since levelled with the dust. He does not attempt anything in the nature of a general survey. If Oxford has a place in his book it is mainly because, situated as it is, at a point where the hills from east and west most nearly meet, it is, as it were, the gate into the country whither he would lead us, the country that is bounded by the fringe of the Cotswold on the west and the Cherwell on the east, in other words the northern half of the basin of the Upper Thames. He does not claim to have described this exhaustively—he has merely tried to point out what struck him as attractive in its history and scenery, in the hope of making it seem attractive to others. That he has succeeded in so doing is certain. Whether he takes us in thought to the Cotswolds proper, to Painswick or Winchcombe or Stow on the Wold, whether he writes ot the escarpment of Edgehill, or the Vale of Evesham, of the Forest of Wychwood, or of regions still nearer the city, he inspires us with the same feeling of interest, the same desire to set out and see for ourselves.

If we have any complaint to make it is that the author has not told us more about the natural features of the district. To the fauna and flora we find only scattered allusions, *e.g.*, to the Arion and the Acis on the hills near Barton, or the Salvia Pratensis in the Forest of Wychwood. Of the geology and hydrography he writes as little as possible. Like most other nations, the British are surprisingly ill acquainted with the land in which they live, but it does not follow that they are past educating.

For our own part we should have liked more than a mention of the botany of Tadmarton Heath, we should have been glad to have a general idea of the course of the Upper Thames, or the formation and lie of the Cotswolds, the more westerly portion of the great oolite sheet, which starts from the borders of Dorset and runs north-east across England to find its termination in the Yorkshire moors. On the other hand the author is generous with historical and antiquarian details. His pages are full of memories of the Civil War, of which this region was one of the chief theatres; the battles, Edgehill, Cropredy, &c., are brought clearly before our minds. He is a good raconteur, and his notes on the old families and local worthies are very good reading. The great houses (Broughton, Sudeley, Compton Wynyatts, &c.) receive full justice at his hands, while his descriptions of the churches, not only of the great wool-churches of Cirencester, Chipping Campden, &c., but of the humbler village types, are instructive, and all things considered wonderfully free from monotony.

We have no hesitation in recommending the book. It is not only attractive, but taking it as a whole it is accurate and valuable; between its covers is store both of pleasure and of profit. Like others of this series it has been illustrated by Mr. Frederick L. Griggs.

OUR BOOK SHELF.

A Manual of Geometry. By W. D. Eggar. Pp. xxiii+325. (London: Macmillan and Co., Ltd., 1906.) Price 3*s*. 6*d*.

A NEW text-book of elementary geometry by the author of the well-known "Practical Exercises in Geometry" will be eagerly welcomed. The "Manual of Geometry" is based on the earlier treatise, but the subject has been extended by the introduction of theorems side by side with the practical work. In deciding on the ground to be covered the author has been largely guided by the revised syllabuses of various examining bodies, and the manual will be found specially suited to students preparing for the Oxford and Cambridge Locals, London Matriculation, Littlego, Army and Navy Qualifying, and similar examinations.

After a short preliminary course of practical and experimental work, practice and theory proceed together. The experimental method is always prominent, being continually used in leading up inductively to the theorems. As each theorem is reached a strict deductive proof is informally and partially outlined, and the student keeps a note-book in which the theorems are entered, accompanied by a complete formal proof written out in his own words. Sets of problems and exercises are likewise provided. The style of the author is attractive, and the course as a whole has great educational value; in fact, we know of no text-book which presents the subject in a way more suited to the natural capacities of the youthful reader, or which is better adapted to impart a thorough knowledge of concrete geometry, and at the same time to develop the reasoning faculties in a legitimate manner.

There is a chapter describing the vernier, spherometer, callipers, and the micrometer screw gauge, and also treating briefly of the mensuration of the simpler geometrical solids. There are selections of recent examination papers, four-figure logarithms and trigonometrical ratios, answers to numerical problems, and a very useful general index.

If a draughtsman were to criticise the book he would probably say that in measuring and setting off lengths the scale should be directly applied without the intervention of dividers; that a line to be accurately measured should have its ends clearly defined by short cross-lines; and that diagonal scales, being of little or no practical use, are made rather too much of in the chapter devoted to them. But these are very minor matters, and do not detract from the general excellence of the work. We know of no text-book of elementary geometry which can be more confidently recommended to teachers, and none from which students are likely to derive more profit.

Les Procédés de Commande à Distance au Moyen de l'Électricité. By Captain Régis Frilley. Pp. vii + 190. (Paris: Gauthier-Villars, 1906.) Price 3.50 francs.

THE problem considered in this volume is that of communicating to a distant mechanism a movement the magnitude, direction, and sense of which are definite functions of those of a transmitting mechanism. The character of the movements which it is desired to transmit varies very much in degree from the simplest of all (traction), in which the three "commands"—*forwards, backwards, stop*—are alone the orders to be obeyed. The author classifies the different mechanisms employed, not according to their complication, but according to the methods that are characteristic of them. These form seven groups—(1) direct action apparatus, (2) apparatus using relays, (3) apparatus employing rotating fields, (4) Wheatstone's bridge devices, (5) apparatus based on the use of induction sparks, (6) escapements, (7) Hertzian waves. The various devices that have been used from time to time are very clearly described under these headings with the aid of diagrams. In chapter viii. an account is given of the commutating device of Lieutenant-Colonel Rivals, by which the sending and receiving instruments can be used as either in turn. Altogether the book forms a very useful and suggestive summary of this very important branch of modern military practice.

Das Radium und die radioactiven Stoffe. By Karl Frhr. von Papius. Pp. viii + 90. (Berlin: Gustav Schmidt.) Price 2 marks.

THIS book contains a semi-popular account of radioactive phenomena. The leading experimental facts and the conclusions of their discoverers are described clearly enough, but with little in the way of suggestive comment. The printing and illustrations are good, but we notice a serious error in Fig. 10, which suggests that the β-rays of radium, when deflected by magnetic force, lie in the same plane as the poles of the deflecting magnet. The contrary is, of course, the fact, and such a mistake cannot but suggest serious doubts as to the competence of the author's general scientific knowledge. R. J. S.

LETTERS TO THE EDITOR.

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

Ionisation and Temperature.

THE discourse by Prof. J. J. Thomson, published in NATURE of March 22 (vol. lxxiii., p. 495), was of importance from several points of view. The explanation of the method of ionisation which he suggests was of especial interest to myself, and I should be pleased if I might be allowed to raise one query concerning it.

Prof. Thomson does not regard the temperature of the gas as having any effect upon the ionisation. It has, indeed, never been shown that high temperature alone would produce ionisation. On the other hand, is there any reason for supposing that ionisation by impact may not take place much more easily at high temperature than at low, and that this is the explanation of the discharge observed by Prof. Thomson? That the gas in this case must have a very high temperature would seem exceedingly probable, for the amount of electrical energy lost in the discharge is very great when compared with the thermal capacity of the gas through which the discharge occurs. Thus in one case when the discharge became luminous the current was 0·045 ampere, the potential difference 50 volts, the distance between the electrodes 5 mm., and the pressure of the gas 0·01 mm. The dimensions of the tube are not given, but if we assume the volume of the gas to be 2 c.c., the residual gas to be atmospheric gas, and that the whole electrical energy is used in heating the gas, we should conclude that it would raise it $7 \cdot 4 \times 10^7$ degrees. It is, of course, not to be supposed that the temperature does reach any such value, but we have reason to believe that it reaches a very high temperature, and may it not be that this has a very great effect upon the production of the ions? C. D. CHILD.

Colgate University, Hamilton, N.Y., May 11.

THE average temperature of the gas when the discharge first became luminous was comparatively low; for example, a fine platinum wire immersed in it did not become hot enough to be visible. The figures quoted by Prof. Child refer to the current after the luminous discharge had been well established; the current when the transition from dark to luminous discharge took place was very much smaller, generally less than 10^{-5} ampere.

J. J. THOMSON.

A Horizontal Rainbow.

J'AI étudié récemment un arc-en-ciel horizontal qui se montrait à la surface d'un petit étang dans les premières heures de la matinée. On l'observait, comme celui dont Mr. W. R. M. Church a envoyé la description à NATURE (April 26, p. 608), en tournant le dos au soleil; et il disparaissait quand la hauteur du soleil était de 44° environ. Il avait la forme d'un arc d'ellipse dont un foyer se serait trouvé à peu près dans l'ombre de la tête de l'observateur. Ses caractéristiques étaient les mêmes que celles de l'arc-en-ciel ordinaire: ouverture angulaire de 42° sur le bord rouge, largeur de 2°, apparition à 53° (plus rare) d'un second arc plus faible et plus large avec les couleurs disposées dans l'ordre inverse, obscurité de l'espace compris entre les deux arcs.

Tout invitait donc à chercher l'origine du phénomène dans des sphérules d'eau, qui ne pouvaient être que répandues sur la surface calme. C'est effectivement ce qu'une étude attentive m'a fait découvrir. Les sphérules en question ont généralement quelques dixièmes de millimètre de diamètre. Elles sont très nettement visibles quand on se penche sur l'étang, mais la moindre agitation les fait disparaître. Je les attribue à la rosée déposée à la surface de la nappe tranquille, laquelle est un peu grasse par suite de l'existence de nombreuses colonies d'animalcules et de végétaux dans ses eaux stagnantes. L'arc-en-ciel observé par Mr. Church me semble dû à la même cause: dépôt du brouillard à l'état sphéroïdal sur la surface calme du lac. V. SCHAFFERS.

Louvain (Belgium), rue des Récollets, 11.

NOTES ON SOME CORNISH CIRCLES.[1]

III.

Boscawen-un, N. lat. 50° 5′ 20″.

MY wife and I visited Boscawen-un on a pouring day, when it was impossible to make any observations. Mr. Horton Bolitho, who was with us, introduced us to the tenant of Boscawen-noon—Mr. Hannibal Rowe—who very kindly, in spite of the bad weather, took us to the circle and the stone cross to the N.E. of it.

Lukis thus described this monument[2] :—

"The enclosed ground on which this circle stands is uncultivated and heathy, and slopes gently to the south. Twenty years ago a hedge ran across it and bisected the circle.

monolith enclosed within it was inclined, it is possible that it was upright at that time.

"Dr. Stukeley's supposition was that it originally stood upright, and that 'somebody digging by it to find treasure disturbed it.'

"On the north-east side there are two fallen stones which Dr. Borlase, in 1749, imagined to have formed part of a cromlech. It is more probable that they are the fragments of a second pillar which was placed to the north-east of the centre, and as far from it as the existing one is. There are instances, I believe, of two pillars occupying similar positions within a circle. One of the stones, that marked C in my plan, on the eastern side of the ring was prostrate in the doctor's time.

"At a short distance to the south-east and south-west there are cairns, which have been explored."

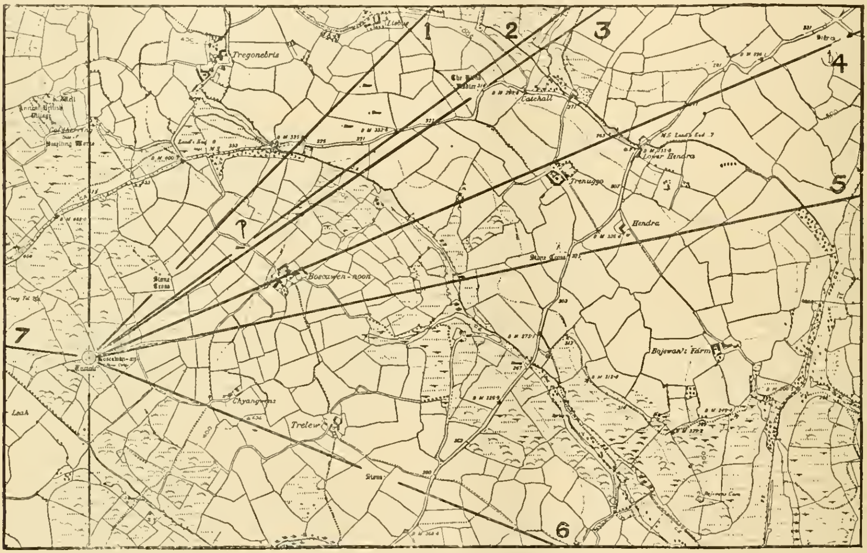


FIG. 8.—Photograph of the Ordnance Map showing sight-lines.

"This monument is composed of nineteen standing stones, and is of an oval form, the longer diameter being 80 feet and the shorter 71 feet 6 inches. One of the stones is a block of quartz 4 feet high, and the rest, which are of granite, vary from 2 feet 9 inches to 4 feet 7 inches in height. On the west side there is a gap, whence it is probable that a stone has been removed. Within the area, 9 feet to the south-west from the centre, is a tall monolith, 8 feet out of the ground, which inclines to the north-east, and is 3 feet 3 inches out of the perpendicular.

"In 1594 Camden describes this monument as consisting of nineteen stones, 12 feet from each other, with one much larger than the rest in the centre. It must have been much in the same condition then as now. As he does not say that the

For this monument I have used the 6-inch map, as the circle lies nearly at the centre, and all the outstanding stones are within its limits. The heights of the sky-line were measured by Mr. H. Bolitho at a subsequent visit with a miner's dial; the resulting declinations have been calculated by Mr. Rolston. A theodolite survey will doubtless revise some of them :—

Marks	Az.	Hills	Dec.	Star	Date
	° ′	° ′	° ′		
1. F. Stone cross	N. 43 15 E. ...	2 7	+29 26	Capella	2250
2. P. fine menhir	N. 53 30 E. ...	2 23	23 59	Solstitial Sun	
3. B. Blind Fiddler	N. 54 30 E. ...	2 23	23 25	,,	
4. 2 Large menhirs	N. 66 50 E. ...	1 0	14 55	May sun	
5. Stone cross	N. 78 0 E. ...	1 0 (?)	+ 8 8	Pleiades (May)	1480
6. Stone	S. 66 30 E. ...	1 0 (?)	− 14 32	November sun	
7. Stone	N. 83 30 W. ...	1 0 (?)	+ 4 36	Pleiades (September)	2120

I gather from a report which Mr. H. Bolitho has been good enough to send me that modern hedges

[1] Continued from vol. lxxiii., p. 563.

[2] "Prehistoric Stone Monuments of the British Isles : Cornwall," W. C. Lukis, p. 1.

and farming operations have changed the conditions of the sight-lines, so that 1 and 3 are just invisible from the circle. This is by no means the only case in which the sighting stone has just been hidden over the brow of a hill and in which signals from an observer on the brow itself have been suggested, or a *via sacra* to the brow from the circle; there are many monoliths in this direction which certainly never belonged to the circle. From menhir P (No. 2) a fine view is obtained from N. to S. through E., so that the Blind Fiddler and the two large menhirs, and almost the circle, are visible. The curious shapes of 1 and 2 are noted, the east face vertical and the west boundary curved, like several sighting stones on Dartmoor.

The circle itself has several peculiarities. In the first place, as shown by Lukis, it is not circular, the diameters being about 85 and 65 feet; the minor axis runs through the pillar stone in the centre and the "fallen stones" of Dr. Borlase towards the "stone cross" (which is no cross but a fine menhir) in Az. N. 43° 15′ E. This would suggest that this was the original alignment in 2250 B.C., but against this is the fact that the two stones of the circle between which the "fallen stones" lie are more carefully squared than the rest. It is true, however, that this might have been done afterwards, and this seems probable, for they are closer together than the other circle stones.

The one quartz stone occupies an azimuth S. 66° W. It was obviously placed in a post of honour. As a matter of fact, from it the May sun was seen to rise over the centre of the circle.

As there are both at Tregaseal and Boscawen-un alignments suggesting the observation of the summer solstice sunrise, it is desirable here to refer to the azimuths as calculated. For this purpose Fig. 9 has been prepared, which shows these for lat. 50° both at the present day and at the date of the restoration at Stonehenge.

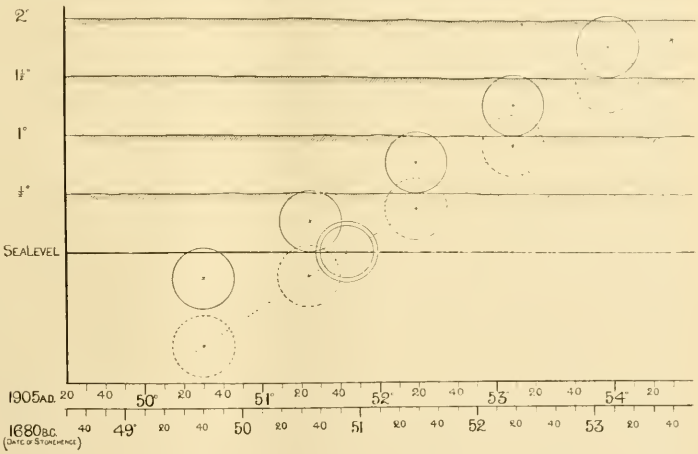


FIG. 9.—Showing the azimuths at the present time and in 1680 B.C. at which the sun rose in Cornwall at the solstice, with different elevations of the sky-line. These are shown at the side.

My readers should compare this with the table on p. 33, vol. lxxii., which gives the solstice sunrise conditions of Stenness in lat. N. 59°. Such a comparison will show how useless it is to pursue these inquiries without taking the latitude and the height of the sky-line into account.

The "Stripple Stones" (lat. 50° 32′ 50″ N., long. 4° 37′ W.)

This is a very remarkable circle consisting of 5 erect and 11 prostrate stones situated on a circular level platform 175 feet in diameter on the boggy south slope of Hawk's Tor on Hawkstor Downs in the parish of Blisland. The circle itself is about 148 feet in diameter, and the whole monument is, in Lukis's opinion, the most interesting and remarkable in the country. Surrounding the platform there is a ditch 11 feet wide, and beyond that a penannular vallum about 10 feet in width. The peculiarity of the vallum is that it has three bastions situate on the north-east, north-west, and east sides. It is to the north-east bastion that I wish to refer.

Sighting from the huge monolith, which is now prostrate but originally marked the centre of the circle along a line bisecting the arc of this bastion, we find that the azimuth of the sight-line is N. 25° E.; the angular elevation of the horizon from the 1-inch Ordnance map appears to be about 0° 22′. Thus we get in the same form as before:—

Alignment	Dec.	Star	Date
Centre of circle to centre of bastion ...	35° 1′ N. ...	Capella	1250 B.C.

indicating that this alignment was formed for the same purpose as that which dominated the erection of "The Pipers."

The "Nine Maidens" (lat. 50° 28′ 20″ N., long. 4° 54′ 35″ W.)

In this monument we find a very different type from those considered previously.

The Nine Maidens are simply 9 stones in a straight line 262 feet in length at the present day; possibly, as suggested by Lukis, it may have extended originally to the monolith known as "The Fiddler," situated some 800 yards away in a north-easterly direction. Measuring the azimuth of the alignment on Lukis's plan, and finding the horizon elevations from the 1-inch Ordnance map, we have the following:—

Az	Hills	Dec.	Star	Date
N. 28° E. ...	0° 0′ ...	33° 47′ N. ...	Capella ...	1480 B.C.

It may be remarked that here we have a date for the use of Capella intermediate between those obtained for "The Pipers" and the "Stripple Stones" respectively.

NORMAN LOCKYER.

THE STABILITY OF SUBMARINES.

THE construction of submarines for the Royal Navy began about five years ago. On March 31, twenty-five vessels of the class had been completed, fifteen were building, and twelve more were projected in the Navy Estimates for 1906–7. France at the same date had thirty-nine submarines completed, and fifty building or projected. Russia had thirteen vessels completed and fifteen building. The United States had eight vessels completed and four building, while Congress has recently sanctioned a special vote of 200,000*l.* for further work on submarines. Germany, Italy, and Japan as yet have done but little, but they are moving in the same direction. An American engineer, Mr. Holland, has exercised the greatest influence on recent submarine design, having worked at the problem for thirty years, and proved himself a worthy successor of his fellow-countrymen Bushnell and Fulton, who were pioneers in submarine construction in the closing years of the eighteenth century and the commencement of the nineteenth. The first five British submarines, ordered in 1900, were repetitions of a type designed by Mr. Holland, tried and approved by the United States Navy Department. Great developments have taken place in later British submarines. Those first built had displacements of 120 tons, surface speeds of eight to nine knots, and gasoline engines of 160 horse-power. Vessels now building have displacements exceeding 300 tons, a surface speed of thirteen knots, and gasoline engines of 850 horse-power. The cost of the earlier vessels was about 35,000*l.*; that of the later vessels must be twice as great. Other countries have taken similar action, and some are building still larger vessels.

British submarines are kept continuously at work, and this experience has yielded valuable information leading to successive improvements. The vessels chiefly used for experimental purposes up to date belong to the "A" class 200 tons in displacement and ten knots surface speed. Vessels of this class consequently have been most before the public. Their active employment has not been free from accidents, but, having regard to novelty of type and special risks which unavoidably accompany the power of submergence, it is a matter for congratulation that these accidents have not been more numerous and serious in their consequences. Official inquiries have been made into the causes of accidents, and reports have been published. In the opinion of the writer these proceedings showed a tendency to minimise risks necessarily encountered in working submarines. He consequently undertook a lengthy series of calculations for typical submarines of different dimensions, in order to ascertain their conditions of stability in various conditions which occur on service. The results for one class are embodied in a paper presented to the Royal Society on May 3, which paper contains also the results of similar calculations made for a cruiser of ordinary form. The distinctive conditions of submarines were emphasised by comparing these results, and the editor of NATURE has suggested that an explanation in popular language of the principal conclusions, based on the investigations, may be of general interest.

Submarines are generally "cigar-shaped," with circular or nearly circular cross-sections. This form is adopted in order to provide, with a minimum expenditure of weight, structural strength sufficient to meet severe external fluid pressures which may come upon the hulls if submarines sink to considerable depths. Such depths are not reached intentionally, but experience shows that they may be attained accidentally, and that very quickly.

In ordinary vessels the freeboard is considerable, and the sides are approximately vertical between the lightest draught reached on service and the deepest (load) draught; consequently, within these limits of draught, horizontal sections of the vessels coincident with the water-surface—known as *planes of flotation*—remain practically constant in form, area, and moments of inertia. In cigar-shaped submarines, with circular cross-sections, the freeboard is small, and the lightest draught of water bears a large proportion to the diameter of the largest circular cross-section. For the typical submarine dealt with in the Royal Society paper, the extreme breadth (diameter of largest cross-section) is a little more than twelve feet, and the lightest draught of water is about ten feet. The circular form of cross-section involves rapid diminution in lengths, breadths, areas, and moments of inertia of successive planes of flotation as the draught of water is increased from light to load. These changes are accompanied by rapid and considerable losses in the stability, and the conditions differ radically from those of ordinary ships. For the typical submarine the extreme length is 150 feet, and breadth extreme 12.2 feet; but the length of water-line at the lightest draught is only 94 feet, and breadth 8.2 feet. When the draught of water is increased eighteen inches (by admitting water-ballast) and the vessel is prepared for diving, the length at the water-line falls to 41 feet, and the breadth to 3.6 feet. In the cruiser of ordinary form an equal change of draught produces small change in length, breadth, and area of the planes of flotation, and these dimensions are practically equal to the extreme length and breadth of the vessel. For the cruiser the moments of inertia of successive planes of flotation about their principal axes remain nearly constant within these limits of variation in draught; whereas for the submarine moments of inertia diminish rapidly as the draught of water is increased. In the cruiser the extreme length is 260 feet, and the metacentre for longitudinal inclinations is 352 feet above the centre of buoyancy at light draught, and 328 feet when the draught is increased by eighteen inches. In the submarine the extreme length is 150 feet, but the corresponding height of longitudinal metacentre above centre of buoyancy is only 37 feet at lightest draught, and falls to $1\frac{1}{4}$ feet when the vessel is prepared for diving. At the lightest draught the power of the submarine to resist longitudinal inclinations (changes of trim) is relatively small; in the diving condition it is diminished almost to vanishing point. It will be understood, therefore, that when a submarine is prepared for diving every man has to remain at his station, and no weights must be moved; every opening into the interior must be closed hermetically. The reserve of buoyancy is extremely small in the diving condition. A submarine of more than 200 tons weight may have only 400 to 800 pounds reserve—representing 40 to 80 gallons of water.

Even at their lightest draughts the reserve of buoyancy of submarines is very small as compared with that in other vessels. In good examples it is 6 per cent. of the corresponding displacement—little more than half the lowest percentage accepted for low-freeboard monitors when fully laden, and about one-fourth the corresponding percentage for the deepest laden cargo steamers. Openings into the interior are placed at the tops of conning towers at a considerable height above water, and Admiralty regulations provide that all openings shall be closed before water-ballast is admitted to bring a vessel into the diving condition. Further, it is now provided that before proceeding at full speed at the surface, the maximum reserve of buoyancy shall be secured by emptying ballast tanks. One of the most serious accidents that have occurred to British submarines—that to A 8—was unquestionably due in great measure to proceeding at full speed with about half the maximum reserve of buoyancy, certain tanks containing water-ballast. The vessel was driven under water as she gathered speed, dipped her bow suddenly, brought the open top of the conning tower to the water-level, was partly filled, and foundered.

Maintenance of the full reserve of buoyancy and lightest draught of water when proceeding at the surface increases safety in two directions. It secures much greater longitudinal stability, and diminishes the tendency to plunge produced by the relative motions of the water surrounding the vessel, especially at the bow. These motions are largely discontinuous, broken water being piled upon the bow, and the phenomena being of such a character that only direct experiment on models or vessels can give accurate information. Such experiments have been made both in this country and abroad, and they indicate the occurrence of a tendency to plunge at certain critical speeds. The problems are still only partially solved, but it is certain that the maximum reserve of buoyancy should be maintained. It also appears desirable to keep the vessels on an even keel, since a cigar-shaped form has then its maximum longitudinal stability for a given mean-draught of water. In the Royal Society paper calculations are recorded showing the diminution of stability accompanying changes of trim in submarines.

In modern submarines of large size the operation of diving is performed when the vessels have headway. Horizontal rudders, controlled by skilled men, are employed as the active means of depressing the bow. The pressures on the upper surface of the vessel resulting from the relative movement of the surrounding water develop a vertical component acting downwards which overcomes the small reserve of buoyancy and the vertical component of the pressures on the rudder. The submarine then moves obliquely downwards. When the desired depth below the surface has been reached the steersman operates the horizontal rudders in such a manner that the vessel shall advance on a practically horizontal course, although it really is an undulating one. Watchfulness and skill are necessary to achieve this result, and there must be no movements of men or weights which would vary the position of the centre of gravity. If such movements become necessary—as, for example, when torpedoes are discharged—compensation must be arranged to take effect at once. Failures to comply with these conditions may involve serious consequences, and have caused submarines to dive to great depths. With trained and disciplined crews such accidents are rare. Plans for automatic maintenance of any desired depth—similar to those used in locomotive torpedoes—have been brought forward and tried; but for large submarines manual control has been found preferable. In small submarines it has been found possible to dive without headway by varying the volume of displacement, admitting water into suitable chambers from which it can be readily expelled when the desired depth has been reached, and a balance restored between weight and buoyancy. Such methods involve the necessity for minute and rapid adjustments, which can be secured on a small scale much more readily and certainly than on a large scale. As a consequence, horizontal rudders and headway have been generally adopted for large submarines, and have answered well on the whole. One great advantage of the plan is that when headway ceases the horizontal rudders become inoperative, the small reserve of buoyancy reasserts itself, and the submarine comes to the surface. The other system—varying the volume of displacement especially when applied to large vessels, involves risks of reaching great depths in a short time before buoyancy can be restored. This is recognised in vessels which work on that system, and detachable external weights are fitted, so as to restore buoyancy in cases of emergency.

There has been a considerable increase in the speed of submarines, both at the surface and when submerged. Our latest types are said to have surface speeds of thirteen knots and a radius of action of 500 miles with their gasoline engines, while the underwater speed is nine knots and radius of action 90 miles. These higher speeds are attainable, no doubt, but they necessarily involve greater risks, especially in the diving condition. Pressures on horizontal rudders increase as the *squares* of the speeds, and the extreme sensitiveness of submarines when submerged to the action of external forces tending to produce changes of trim must demand much greater watchfulness, skill, and promptness of action on the part of steersmen than are now required, if greater speeds are to be attained under water. The risks of attaining rapidly excessive depths of submergence must increase as speeds are raised, and they are now far from negligible. At the lightest draughts increase of speed would also involve greater risks of accidental plunging. Exhaustive experiments are necessary, therefore, before designers of submarines commit themselves to the production of vessels having much greater surface speeds, and still more of vessels having much greater under-water speeds. Submarine design is not a task to be lightly undertaken by amateurs; it requires thorough experimental and scientific treatment by competent naval architects, who should be furnished by naval officers with the strategical and tactical conditions to be fulfilled in the completed vessels, and should ascertain what is involved in the fulfilment of these conditions.

W. H. White.

THE RISE AND PROGRESS OF THE ZOOLOGICAL SOCIETY.[1]

It was a happy thought on Mr. Scherren's part to tell the story of the Zoological Society of London, and he is to be congratulated on the success with which he has accomplished his evidently congenial task. The history of a development is always interesting, especially when it is still progressing, and there is, moreover, a strong personal interest in the book, since many eminent workers, whose names and deeds are familiar, have cooperated in various ways in furthering the welfare of the society since its inception in 1826. Mr. Scherren's book is not only a careful contribution to the history of zoology in Britain during the last eighty years, but is at the same time good reading for its revelation of what goes on behind the scenes in a scientific society, and for its record of many interesting events in what is familiarly called the "Zoo."

On November 29, 1822, John Ray's birthday, a bud from the Linnean Society formed itself into a "Zoological Club," which four years afterwards took shape as the Zoological Society. There were 342 members at the close of the year, and there are now ten times as many. In 1828, when the gardens were opened to the public, there were about 600 specimens, and there is now a specimen for each F.Z.S. A farm for breeding purposes and experimental work (from which nothing very noteworthy ever resulted) was established in 1829 at Kingston Hill, and scientific meetings began to be held in 1830. Such were the

[1] "The Zoological Society of London: a Sketch of its Foundation and Development, and the Story of its Farm, Museum, Gardens, Menagerie and Library." By Henry Scherren, F.Z.S. Pp. xii+252; 12 coloured plates, 50 uncoloured plates, 9 plans. (London: Cassell and Co., Ltd., 1906.) Price 30s. net.

beginnings of the Zoological Society. How it grew from more to more Mr. Scherren tells us with no lack of circumstantial detail. We see the long procession into the scientific ark, we hear the quaint comments made when conspicuously new creatures arrived, we can realise from the abundant plates how the "houses" increased in number, size, and efficiency, and we are reminded how men like Owen, Yarrell, Waterhouse, Gould, Huxley, Flower, Sclater, Murie, and Wolf helped the Society forwards in varied ways. From time to time there were new departures, such as the publication of Proceedings and Transactions, the institution of aquarium and insect-house, the formation of a library, the experiment of the Davis lectures. As in many a development there were periods of rapid growth and of temporary arrest, of crisis and metamorphosis, and there was quite recently a general reorganisation. The author gives expression to the view forced upon him by the history "that before the Zoological Society was half a century old its bionomical work practically ceased owing to the increasing influence of morphographers and systematists in its councils. The election of the Duke of Bedford as president, the recommendations of the Reorganisation Committee, and subsequent changes, mark a return to lines laid down by the charter." We fervently hope that this policy will be adhered to, and that the "Zoo" will gradually become a recognised centre of bionomical research and evolutionist experiment.

Photo.] [*Cassell & Co., Ltd.*

FIG. 1.—Rocky Mountain Goat. From "The Zoological Society of London."

No naturalist can read this well-told history without having his gratitude to the Zoological Society revived, not only for what it has directly accomplished through the gardens and the workers there, through the scientific meetings and the publication of what has been submitted there, but also for the way in which the society has given aid and encouragement to bibliography (notably through the Zoological Record), to institutions such as the biological stations of Naples and Plymouth, as also to travellers, collectors, and, indeed, zoologists at large. The excellence of the plates which adorn Mr. Scherren's volume reminds us also of the important part the society has played in sustaining and raising the standard of zoological illustration.

THE INTERNATIONAL FISHERIES INVESTIGATIONS.

THE latest publications of the International Fisheries Organisation consist of the part of the *Bulletin des Resultats* containing the results of the quarterly cruises carried out in May, 1905, the fourth volume of *Rapports et Procès-Verbaux*, and Nos. 28 to 32 of the *Publications de Circonstance*. The bulletin contains the usual data—hydrographical and plankton observations obtained in the course of the obligatory voyages made by the exploring vessels. At first the west coast of England and the coasts of Ireland were not included in the area to be investigated, but for the last year the Irish Board of Agriculture and Technical Instruction have allowed their steamer to make the necessary quarterly cruises, and a report on these is now made to the International Council by Mr. E. Holt.

The *Publications de Circonstance* include an account of an investigation of the fisheries for salmon and sea-trout in the rivers and neighbouring waters of the Baltic, with special reference to measures of artificial culture, being the report of an international commission appointed by the International Council for Fishery Investigations, and two papers by Dr. R. J. Witting, of a very technical nature, dealing with the measurement of ocean currents, one of them describing a new electrically registering current meter. The two remaining reports are by Dr. C. Kofoid and Dr. L. Gough, the former dealing with a means of studying plankton from deep water layers, and the latter describing the migrations of an oceanic species of Siphonophore.

In the former paper Dr. Kofoid describes the construction of a bucket for obtaining samples of water from considerable depths. Plankton from deep water has hitherto been obtained chiefly by means of self-closing nets, or by bringing up water from the requisite depth by a pump and hose-pipe, both methods of some uncertainty in their results. The apparatus described consists of a bucket of considerable dimensions which is lowered down to the depth required, where it fills with water, and is then closed by means of a specially constructed catch and "messenger." The samples of sea-water obtained by making a number of hauls with this apparatus are then filtered in the ordinary way, and the organisms present are so obtained. It is claimed that the apparatus is simple and certain in its results, and that it can also be used for obtaining temperatures from the depths to which it is lowered.

Dr. Gough describes the distribution of the Monophyidan genus *Muggiaea atlantica*, Cunn., in the waters of the English Channel, the Irish Sea, and off the south and west coasts of Ireland during the year 1904. It is shown that a shoal of Muggiæa entered the Channel in May, and that the shoal was introduced into this area by the current of Atlantic water which, just before this time, had set into the Channel as a stream flowing north past Ushant from the Bay of Biscay. The shoal entered the English Channel and reached as far as Plymouth, from which region it disappeared at the end of the year. After entering the Channel the shoal divided, and, rounding Land's

End, one portion entered the Irish Sea, and by September had reached as far north as the Cardigan Bay and south Arklow light-ships. The other part of the shoal passed along the south coast of Ireland, and was observed in November as far along the west coast of Ireland as Galway Bay. The disappearance of the shoal from the Irish Sea in September is attributed to the southerly flow of water from that area into the Channel blocking its further northerly migration. It is shown that the shoal must have entered the Irish Sea from the south, for plankton collections taken from the Bahama light-ship in the north of that area did not contain the organism, which could not, therefore, have passed through the north channel. The paper is illustrated by charts which show the distribution of Muggiæa from month to month during the year 1904.

The volume of *Rapports* is noteworthy only because of a statement made by Mr. Archer, the English Chief Inspector of Fisheries, at one of the "reunions," that it is the wish of the British Government "that no tasks should be undertaken or interests created the conclusion of which could not be reasonably looked for by July, 1907," since it is not the intention of the Government to continue the large expenditure involved beyond the five years originally contemplated. It is very probable, then, that the British share of the work will cease in the course of another year, and that with the withdrawal of this country the international investigations will come to a close.

It has, indeed, been apparent for some time past that the International Organisation, as at present constituted, could not continue on a permanent basis. For the last five years it has been necessary to maintain, at a very great expense, the Bureau at Copenhagen, the Central Laboratory at Christiania; and a complex system of "reunions" of the council, the "commissions," the "special commissions," and "sections." All this organisation was no doubt necessary, in the first instance, to bring together those engaged in the work, and to secure the necessary coordination in the hydrographical investigations. But since this preliminary organisation must now have been completed, it is desirable in any case that some simpler and less expensive means of coordination should have been evolved. It should be remembered that the international scheme of investigations originally included fishery research proper, hydrographical investigations, and, though this has never been stated in so many words, the promotion of international agreement with respect to the observance of "closed areas," such as the Moray Firth, and the regulation of fishing on the high seas. With regard to the latter point one cannot speak at present, but it may be pointed out that fishery legislation on an international scale has been notoriously difficult to obtain in the past, and that the chances of securing this at the present time ought not to be jeopardised by the unconditional withdrawal of Great Britain from the scheme of international work. Purely fishery investigations need not be imperilled by any such action. There does not appear to be any real advantage in the prosecution of these on an international scale. No amount of research carried out in another area than our own will relieve us of the necessity of investigating fishery questions locally with respect to the special economic and legislative problems involved. Fishery research with regard to such issues as the protection of immature fishes, closed areas and closed seasons, the regulation of fishing methods, and the like, must be carried on if fishery restrictions are ever to be more than an expensive and vexatious interference with the legitimate operations of our fishermen. If a fair proportion of the annual grant at present made to the International Organisation is in the future made to supplement the efforts of existing fishery research institutions, with, of course, proper Government inspection, then the withdrawal of our Government from the international scheme need cause no apprehensions.

It is different with regard to the hydrographical investigations. If these are to be carried on at all it must be on an international scale, and with proper coordination as regards methods and publication of results. Quite apart from the assistance which such research is likely to afford meteorological science, it seems now to be certain that it is sure to throw light on the ultimate causes which affect the shoaling movements and migrations of food fishes. There is really no good reason why, even if the fishery investigations of the International Organisation be dropped, the hydrographical work should not go on. The present hydrographical cruises could be continued by the national staffs; and methods having already been worked out, the coordination of the work and the publication, in a uniform style, of the results need entail no great expense. The international conferences which have become so marked a feature of fishery affairs, both on the administrative and scientific sides, might be dispensed with, and no really useful object would be sacrificed.

NOTES.

THE council of the Society of Arts has awarded the Albert medal for the present year to Sir Joseph W. Swan, F.R.S., "for the important part he took in the invention of the incandescent electric lamp, and for his invention of the carbon process of photographic printing."

A LARGE physical laboratory is, the *Pioneer Mail* states, to be built by the Punjab Education Department in Lahore on the present camping-ground of the Public Works Department, as soon as the new Public Works offices are constructed.

THE *British Medical Journal* states that a general institute of psychology specially intended for the study of the phenomena of subconsciousness, the investigation of the causes of criminality, and the discovery of means of curing social evils will shortly be formally constituted in Paris. Among those to whom the initiation of the scheme is mainly due are Profs. Brouardel, d'Arsonval, and Gariel, and MM. Boutroux, Giard, and A. Picard.

WE notice with regret the announcement of the death, at eighty-three years of age, of M. Raphael Bischoffsheim, honorary member of the Paris Academy of Sciences. M. Bischoffsheim was a generous benefactor to science. He contributed largely to the Pic du Midi Observatory, bore the expense of the great equatorial at Paris Observatory, gave largely to the Montsouris Observatory, and founded the fine observatory at Nice. He was elected a member of the Institut de France in 1890 in succession to M. Cosson.

A COMMITTEE has been formed with the object of establishing a memorial of the late Sir William Wharton, K.C.B., F.R.S., whose death at Cape Town in September last was a sad incident of the British Association meeting in South Africa. For a long period Sir William Wharton filled with distinguished ability the important post of hydrographer to the Navy, and the committee has decided that the most appropriate testimonial would be such as would follow the same lines and exist for the same purpose as the Beaufort testimonial, which is awarded as a prize to the officer who has distinguished himself as having passed the best examination in mathematics and nautical astronomy for lieutenant in his year. This Sir William Wharton won in the year 1865. By the proposed arrangement two awards for the same object would be given under the names of "The Beaufort Testimonial" and "The Wharton Testimonial," thus associating the names of the two eminent hydrographers who have served for the longest periods in that capacity. It is proposed in addition, if the funds admit, to present a medal, having on the obverse a bust of the late Sir William Wharton, and on the reverse a suitable inscription. The committee includes Vice-Admiral Sir Charles Drury, K.C.B., K.C.S.I.; Captain A. Mostyn Field, F.R.S.; Vice-Admiral Swinton C. Holland; Admiral of the Fleet Sir F. Richards, G.C.B.; and Captain T. H. Tizzard, C.B., F.R.S. Messrs. Coutts and Company, Bankers, 440 Strand, London, have arranged to receive contributions to the fund.

ON May 25 Lord Avebury presided at the annual conversazione of the Selborne Society and delivered his presidential address. He spoke of the coming of age of the society, of the interest which many members were taking in the forthcoming "Country in Town" Exhibition, and of the bird sanctuary maintained by the Ealing branch. He also alluded to the destruction of roadside beauty, to the way in which ladies prefer the authority of shopkeepers to that of ornithologists with regard to "artificial ospreys" so called, and to the injury to birds, which gamekeepers still continue to do. In the latter part of his remarks Lord Avebury dwelt upon the manner in which the study of nature adds to the happiness of life. Nearly 700 guests were present, and there was a large number of interesting exhibits, including some fifty microscopes exhibited by members of the Royal Microscopical Society, the Quekett Club, and other institutions.

MESSRS. R. B. Woosnam, D. Carruthers, and A. F. R. Wollaston, three members of the zoological expedition sent to Africa under the auspices of the Natural History Museum, South Kensington, have made the following ascents in the Ruwenzori range. On April 1 they ascended Duwoni, the peak rising to the north-east of the Mubuku Glacier. This peak has two tops of apparently equal altitude; the southern top, which was reached, was found to be 15,893 feet. On April 3 they ascended Kiyanja, the peak at the western end of the Mubuku group of peaks. The altitude was found to be 16,379 feet. (The altitudes were taken by aneroid and by the boiling-point thermometer.) Both these peaks have been thought by different explorers to be the highest points in Ruwenzori, but from the summit of Kiyanja a still higher peak with two tops was seen in a north-westerly direction. The weather at this season of the year is very unfavourable, the mountains being almost constantly buried in clouds with frequent snowstorms, which prevented the party from making further explorations.

ON Friday last, June 1, the Secretary for Scotland received a deputation of the Royal Scottish Geographical Society, laying before him the claims of the society in connection with the proposed National Galleries Bill (see p. 137). The deputation was introduced by Mr. C. E. Price, M.P., and the society's position and claims were explained by Prof. Geikie (president), Mr. W. B. Blaikie, Dr. George Smith, Mr. W. C. Smith, K.C., and Mr. Ralph Richardson. The national character of the society was touched upon, as also the important work it did in fostering the study of geography, in providing lectures by eminent travellers in the four great centres of population, and in giving facilities for the inspection of maps and valuable geographical works. It was claimed that the society should be recognised officially as one of the scientific societies of Scotland, to be provided with premises free of rent (at present 120*l*. is paid in rent), to have a grant from State funds, and to be represented on the new Board of Trustees. Reference was also made to the present endeavour to found a chair of geography in the University of Edinburgh. The Secretary for Scotland in reply thanked the members of the deputation for their presence, and pointed out that their memorial went further than the recommendation of the departmental committee which recommended the remission of the rent of 120*l*. which the society pays for its accommodation in the National Portrait Gallery. He was not sure that this was a convenient time to urge the Government to further expenditure, but he would not fail to take into serious consideration all that had been urged in the interests of the society.

WE regret to announce the death on May 29 of Dr. William Fream, who since 1894 acted as the agricultural correspondent of the *Times*, and was formerly a frequent contributor to our columns. Born in 1854, Dr. Fream was educated at the Royal College of Science, Dublin, and became professor of natural history at the Royal Agricultural College at Cirencester. After lecturing for a time on botany at the Guy's Hospital Medical School he became professor at the Downton College of Agriculture. Later he was chiefly engaged in writing, and for ten years acted as editor of the Journal of the Royal Agricultural Society. His best-known books were one on the Rothamsted experiments and his "Elements of Agriculture," written for the Royal Agricultural Society, which reached its seventh edition last year. Dr. Fream will be remembered for the part he took in a controversy as to the merits of perennial rye grass in pastures, a controversy which cannot yet be regarded as settled. Mr. Faunce de Laune, and with him Mr. Carruthers, maintained that rye grass was neglected by stock, and should be excluded from any mixture used for sowing down land to grass. Dr. Fream, however, by growing pieces of turf selected from the most famous pastures in the country, demonstrated that rye grass was a large constituent of such good grass land, and in consequence argued strongly in favour of the high opinion in which this grass has always been held by practical farmers.

PRELIMINARY arrangements have been made for the establishment of a great marine museum in New York with an astronomical museum as an adjunct to it. The New York Observatory and Nautical Museum will, according to *Science*, have an endowment of not less than 100,000*l*., and, in addition to this, it is expected that the city of New York will provide a site in Bronx Park adjacent to the botanical garden and zoological park, and will also erect the museum building and the domes and smaller buildings for the observatory. In the nautical museum will be collected and exhibited models of all types of vessels, safety and signal devices, nautical instruments and methods of determining position, charts, marine engines and motors, and historic instruments and relics. The museum and collections will be arranged so that properly qualified persons can avail themselves of the facilities there offered for investigation and research. The observatory will be provided with a great telescope, for photographic and visual work, astrophysical instruments for the investigation of solar problems, magnetometers, seismographs, and other necessary instruments. A time service will be instituted so that chronometers may be rated, marine instruments will be tested, and tidal investigations will be inaugurated.

Commenting upon Mr. Southerden's letter on "Carbon Dioxide in the Breath," published in Nature for May 24 (p. 21), Mr. E. A. Parkyn writes to direct attention to the well-recognised fact that the presence of 0·06 per cent. of carbon dioxide in the atmosphere need not be injurious, but that the gas is generally found in bad company, for an increase of carbon dioxide is almost invariably accompanied by a corresponding increase of organic impurity. In other words, the importance attaching to the rise of carbon dioxide to 0·06 per cent. is a true indication of the vitiation of the air by organic matter given out during respiration.

A communication from the Zi-ka-wei Observatory, near Shanghai, informs us that the great San Francisco earthquake was registered by the seismographs there. The shocks were fairly strong, and they lasted a little more than 1h. 34m. The first preliminary tremors, transmitted through the mass of the globe, began at 9h. 35m. 0s. p.m. Chinese coast time. The first large waves, travelling along the crust, on an arc of a great circle, were felt at 9h. 55m. 54s. The last waves of decreasing amplitude left their trace at 10h. 31m. 35s. p.m., and the last slight movements of the ground died away at 11h. 9m. 44s. p.m. April 18. These records should be of service in determining the velocity of propagation of the seismic undulations by connecting them with observations of the exact minute and second of the occurrence at San Francisco.

Mr. Charles Van Norden, writing from East Auburn, California, U.S.A., says that he was on the fourth floor of the Palace Hotel, San Francisco, on April 18, when the disastrous earthquake occurred. The movement seemed from south to north, and the rocking of the massive walls of the hotel was so violent that its continuance even for a few seconds seemed impossible. To Mr. Norden, who was in bed, the motion seemed like that of a small rowing boat on a choppy sea. The shock occurred at 5.13 a.m., and at 6 a.m. Mr. Norden had left San Francisco by the ferry boat for Oakland. While sitting on the deck of the ferry boat, looking at the many fires gathering together in a great conflagration, he noticed a thunder-cloud—a white, cumulous mass, dark at the bottom—hanging over the city. The morning was clear and mild for San Francisco, and no other cloud was in sight. None of the descriptions of the catastrophe mentions this feature, and Mr. Norden is curious to know if other observations were made of it.

An excellent little *résumé*, by Mr. D. J. Scourfield, of the leading features and possible developments of Mendel's law of heredity appears in the Proceedings of the South London Entomological and Natural History Society for 1905–6. Other articles are devoted to the British plume-moths, the lengthened pupa-stage of certain Lepidoptera, and notes on Hawaiian entomology.

The contents of the *Sitzungsberichte und Abhandlungen* of the Dresden Isis for the second half of 1905 include an article by Prof. O. Drude on the meaning and scope of the term œcology (ökologie), or the manifestations of plant and animal life in regard to the struggle for space (or existence) in connection with climate and other external influences. Mr. H. Engelhardt contributes an illustrated article on the Tertiary flora of Chili.

A striking instance of increased patronage due to the adoption of "popular prices" is recorded by Captain Stanley Flower in his report of the Giza Zoological Gardens for the past year. By the reduction of the gate-money the number of visitors to the garden leaped up from 64,711 in the previous year to 177,587, an excess of 112,876 over any other year. The receipts showed, however, but a comparatively small increase £E.1402 against £E.1388 in 1904. The stock of animals has been largely increased, and a notable new feature in the gardens is the formation of an extensive enclosure, where a number of the larger birds of the Nile Valley are allowed to roam at comparative liberty.

Old churchwardens' accounts of various Bedfordshire parishes have been utilised by Mr. J. Steele-Elliott, for an article which appears in the May number of the *Zoologist*, to afford information with regard to the fauna of the county during the last two and a half centuries. The entries cited refer to sums paid for the destruction of "vermin." The absence of mention of birds of prey is noticeable, as is the infrequent occurrence of rats, but special interest attaches to certain entries referring to martens. Polecats were evidently once abundant, and it is curious to note the persistent war waged against the hedgehog probably on account of its supposed milk-sucking propensities. Mr. Heneage Cocks refers, in the same issue, to an artificial cave at Park Place, Remenham, Berks, which forms the abode of a number of bats, some belonging to rare species, including *Myotis bechsteini*.

We have received seven parts (Nos. 1448, 1449, and 1452 to 1456) of the Proceedings of the U.S. National Museum, which include descriptions of Japanese Hymenoptera and of South American geometrid moths and grasshoppers, as well as of two American river-mussels; fully illustrated notes on molluscs of the family Pyramidellidæ from Japan, America, and the intermediate areas; a synopsis of Japanese sturgeons; and an account of the osteology of the creodont carnivorous mammals of the genus Sinopa. The latter genus, which occurs in the Lower and Middle Eocene of North America, according to Mr. W. D. Matthew, may be regarded as an extremely primitive form, with cheek-teeth of the opossum-type, from which have been evolved the more specialised Cynohyænodon, Pterodon, and Hyænodon of the Oligocene. Japanese sturgeons are, it appears, represented only by two species. Of the Pyramidellidæ, Messrs. Dall and Bartsch name a number of new species, and also figure others.

The application of De Vries's mutation-theory to molluscs forms the subject of an article by Mr. F. C. Baker in the May number of the *American Naturalist*. The shells selected for observation are fresh-water snails, more especially Limnæa and Valvata, the former of which is well known to be an exceedingly variable or "unstable" type. Series of specimens of Limnæa from particular localities are figured to exhibit the range of variation, which is so great that the extreme forms, if isolated, would be allowed specific rank. Special attention is directed to the sudden development of an apparently new species in a newly-formed pond in the United States. While the mutation-theory seems to account more satisfactorily than any other for these variations, the author deprecates haste in applying a hypothesis founded upon plant-variation to animal life. In the same issue Dr. E. A. Andrews discusses the mode in which American crayfish of the genus Cambarus lay their eggs. The first process is the careful cleansing of the lower surface of the body preparatory to the extrusion of a glairy substance from the "cement-glands" in which the eggs are afterwards laid. During oviposition the female lies supine and externally inert, but after this occurs a long, rhythmic alternation of poses connected with the fastening of the eggs to the abdominal appendages.

THE *Haslemere Museum Gazette* is the title of a new serial published by the institution the name of which it bears, and to be issued in monthly parts at the price of sixpence. The Haslemere Museum specially devotes itself to education at first-hand, that is to say, by inculcating familiarity with actual specimens rather than the cultivation of mere book-knowledge. One of the objects of the new journal is to assist and amplify this excellent conception. It is proposed to refer in turn to the chief museums in London (including those devoted to art), the Zoological Society's Gardens, &c., and to direct the attention of readers to some of the most noteworthy objects in each. By this means—without in any way usurping the function of a "guide"—it is urged that the educational value of such establishments will be largely increased. Nor will nature itself be neglected, as is demonstrated by the frontispiece, representing two oaks growing under similar conditions, but one with and the other without leaves. Excellent "lecturettes" on prehistoric times and the severance of Britain form part of the contents of the first number. Giraffes in the British Museum, with a (not absolutely accurate) transcript of the accompanying label, form the subject of another section.

IN connection with the study of the occurrence of glycogen and paraglycogen in fungi, the late Prof. Errera compiled a bibliography of the subject. The list of papers with his abstracts on their contents is published in *Recueil de l'Institut botanique*, Brussels, vol. i., 1905.

IN the *Bulletin du Jardin impérial botanique*, vol. vi., part ii., Madame O. Fedtschenko writes a note on species of Eremurus in which she refers the species *Eremurus Aucherianus* and *Eremurus Korolkowi* from Turkestan to *Eremurus anisopterus* and other species. Mr. V. Arcichovskij discusses the size of plants as a specific character.

To replace the list of ferns and fern-allies cultivated in the Royal Gardens, Kew, issued in 1895 and now out of print, a second edition compiled by Mr. C. H. Wright has been published. The plants are enumerated under the three groups of ferns, fern-allies, and cultivated forms of British ferns. The table of fern-distribution throughout the world, drawn up by Mr. J. G. Baker for the previous edition, has been revised, showing a considerably increased percentage for temperate Asia.

A DETAILED account of the distribution of the forest flora of the Bombay Presidency and Sind has been contributed by Mr. W. A. Talbot to the *Indian Forester* (January to March). Mr. Talbot distinguishes an evergreen forest flora of Malabar showing a decided Malayan affinity, a Deccan dry deciduous flora in which African elements predominate, and the flora of the Western Ghats and Konkan, in which there is a mixture of high deciduous and evergreen forests. The dry Deccan flora includes such typical species as *Zizyphus jujuba*, *Acacia catechu*, *Sterculia urens*, and *Bombax malabaricum*. Myristicas, Dipterocarpeæ, laurels, and palms are characteristic of the tropical evergreens.

THE Bulletin of the Johns Hopkins Hospital for May (xvii., No. 182) is mainly devoted to medical subjects. Dr. Cushing contributes an interesting article on a course of instruction in operative medicine, and Dr. Pratt one on the home sanatorium treatment of consumption, in which the problem of applying the open-air treatment of tuberculosis in the homes of the poor is dealt with. The proceedings of the Johns Hopkins Historical Club are devoted to a "symposium" of the "gold-headed" cane, a stick or cane, now in the possession of the Royal College of Physicians of London, which made its appearance in medical circles about the year 1689, and for one hundred and thirty-six years was carried by a leading London practitioner, including John Radcliffe, Richard Mead, Anthony Askew, William Pitcairn, and Matthew Baillie, all well-known names in medical history.

WE have received from Mr. Herbert Kynaston, director of the Transvaal Geological Survey, a copy of his memoir on the geology of the Komati Poort coalfield (Pretoria, 1906, price 7s. 6d.). It covers 55 pages, and constitutes the second of the series of descriptive memoirs which it is the intention of the Geological Survey to issue from time to time. It is an admirable piece of work, giving a connected account of the character, behaviour, and distribution of the coal-bearing strata of the Komati Poort district. A description is also given of the associated sedimentary and igneous rocks. Apart from the prevalence of intrusive sheets and dykes of igneous rock throughout the coal-bearing strata, the conditions are favourable, and no evidence was observed of the beds having been disturbed by faulting in a manner that would be discouraging to mining operations. The actual Coal-measure series occupy 150 square miles, and the great thickness of the coal-bearing strata, and the favourable situation of the better portion of the field, render the prospects eminently satisfactory. The memoir is accompanied by two coloured geological maps and six sections, and six photographic views giving an excellent idea of the character of the scenery on the Crocodile and Komati rivers.

SOME valuable results of an experimental investigation on the effect of fire on building stones were described by Mr. W. R. Baldwin-Wiseman at a meeting of the Surveyors' Institution on May 14. The purpose of the research was not so much to determine the design of a building for fire resistance as to estimate the ultimate stability of an edifice after subjection to a severe conflagration, and to afford some small assistance to those who may be called upon to decide whether demolition or reconstruction shall succeed the wrecking influences of a big conflagration. The points of primary importance in determining the most efficient design for fire resistance are summarised as follows:—(1) That the edifice should in no wise be flimsy; (2) that it should be constructed of stone possessing a uniform or fairly uniform coefficient of expansion, and retaining a considerable strength after subjection to high temperatures; (3) that all combinations of different stones should be avoided as much as possible; (4) that combinations of stone and metal should be avoided, especially when the former rests directly upon the latter, even when the metal is entirely enshrouded in stone, for stone acts as a fairly good conductor of heat; (5) that stair wells and lift wells should open as little as possible on to the main building, and should preferably be enclosed and glazed with wired glass from basement to roof; (6) that floor areas should not be unduly large or corridors unduly long.

THE first parts of two serial publications, issued by Messrs. Cassell and Co., Ltd., have been received. A new edition of Prof. G. S. Boulger's "Familiar Trees" is to be completed in twenty-nine fortnightly parts, and will contain 114 coloured plates and 114 illustrations from photographs. Mr. W. F. Kirby's "Butterflies and Moths of Europe" will be published in thirty-two instalments at fortnightly intervals; and the completed volume, with its large pages and fifty-four coloured plates, will form an attractive addition to the naturalist's reference library.

Mr. T. Fisher Unwin has published a second edition of "Methods in Plant Histology," by Dr. C. J. Chamberlain, of the University of Chicago. The first edition of the book appeared in 1901, and was reviewed in our issue of November 28, 1901 (vol. lxv., p. 75). It is only necessary to say of the present edition that more attention has been given to the collection of materials. Prof. Kleb's methods for securing various reproductive phases in the algæ and fungi have been outlined, and methods for growing other laboratory material are more complete. New chapters dealing with microchemical tests, free-hand sections, special methods, and the use of the microscope are included.

OUR ASTRONOMICAL COLUMN.

Sun-spot and Chromospheric Spectra.—A paper of exceptional interest to workers in solar physics was read by Prof. A. Fowler at the April meeting of the Royal Astronomical Society.

Whilst observing the bright lines in the spectra of metallic prominences on the sun's limb, Prof. Fowler has been able to classify them into "long" and "short" lines, a fact which points to their origin being in the higher and the lower chromosphere respectively; he also states the fact that the lines emitted by the upper chromosphere, the "long" lines, are those which, speaking generally, are enhanced when passing from the arc to the spark in terrestrial spectroscopy.

Further, Prof. Fowler found that these long lines are generally *weakened* in sun-spot spectra, whilst the short lines are generally widened, or *strengthened*. The evidence for this differential treatment of "enhanced" and "arc" lines in the solar atmosphere is most conclusive for the elements iron, titanium, and chromium (the *Observatory*, No. 370).

Proposed Daily Photographs of Chromospheric Radiations.—A paper by M. Deslandres, which is published in the *Comptes rendus* for May 7, discusses in detail the possibility of obtaining daily photographs of the radiations emitted by the solid and liquid particles of the chromosphere, without waiting for the rare occasions afforded by total eclipses of the sun.

In order to do this M. Deslandres proposes to employ an apparatus similar to that used by him for the same purpose during the last eclipse, and to obtain a concentrated image of the chromosphere, without the photosphere, by a special arrangement of mirrors and lenses.

If the coloured screens are insufficient, it is suggested that the spectroheliograph might be employed. By obtaining the ordinary spectroheliograms with K_1 and K_2, and then another in which the bright interspaces, *i.e.* the continuous spectrum, were projected on to the primary slit, it would be possible to separate the parts due to the particles from those parts of the chromospheric radiations due to permanent gases.

M. Deslandres further suggests that the same methods, if successful in this instance, might be employed for the analysis of the structure of other celestial bodies such as nebulæ and comets.

Stars with Variable Radial Velocities.—A list of four stars the radial velocities of which have been found to be variable is published by Mr. J. H. Moore in No. 3, vol. xxiii., of the *Astrophysical Journal*.

The radial velocity of τ Ursæ Majoris has been found to vary between -1 km. and -10 km., that of λ Hydræ between $+15$ km. and $+24$ km., and that of μ Ursæ Majoris between -16 km. and $+27.4$ km. In the case of Y Ophiuchi, discovered to be a spectroscopic binary by Mr. S. Albrecht, the variation of the velocity is found to agree, in point of time, with the light variation, both having the period 17·12 days.

Four other spectroscopic binaries with variable velocities are announced by Prof. Frost in the same journal. The first two, B.D. $-1°.1004$ and 29 Canis Majoris, are remarkable for the long range of their velocities and their short periods. In the former of these two, the radial velocity changed from $+132$ km. on February 12 to -34 km. on February 16, whilst that of the second star changed as follows:—1906 January 26, -164 km.; January 29, -3 km.; February 12, -243 km.; February 16, -92 km. Owing to under-exposure, these results are, however, slightly uncertain.

The stars μ Orionis and T Monocerotis have also been shown to have variable velocities in the line of sight.

Observations of Nova Persei No. 2.—No. 96 of the Lick Observatory Bulletins is devoted to the publication of the results obtained by Messrs. Townley and Maddrill from magnitude observations of Nova Persei No. 2.

The observations extended over the period February 24, 1901, to July 5, 1902, the magnitude on the latter date being 9·4.

The table given contains the weighted, mean magnitudes of the Nova on more than one hundred nights, with notes on the observing conditions and the comparison stars and instruments employed.

Observations of Shadow Bands.—In No. 4086 of the *Astronomische Nachrichten* Dr. M. Roso de Luna, of Madrid, briefly describes a new arrangement of screens for the observation of the shadow bands during total eclipses of the sun. Altogether he proposes to employ six screens, one horizontal, two vertical (N. and S. and E. and W.), one oriented to the azimuth of the sun at the moment of totality and another perpendicular to it, and one placed in the direction of the wind.

Such an arrangement was employed at Soria (Spain) during the last eclipse, and the following results obtained:—breadth of bands, 2 cm.; distance from one band to the next, 6 cm.; velocity of the movement of the bands, 30 metres per minute.

The Radial Motion of β Arietis.—In No. 4090 of the *Astronomische Nachrichten* Herr H. Ludendorff publishes the results obtained from an investigation of the radial velocities of β Arietis during the period October 21, 1902, to December 16, 1904.

Thirty-seven spectrograms were obtained with the spectrograph No. iv. (three prisms) of the Potsdam Observatory attached to the 32·5 cm. refractor, and the range of the velocities determined was from $+60$ km. (on January 19, 1903) to -17 km. (on December 25, 1903).

From an analysis of the results, Herr Ludendorff concludes that the period of β Arietis is $321/n$ days, where n is equal to or less than 5.

Publications of the Nicolas Observatory, St. Petersburg.—We have just received vols. iii. and xiv. (series ii.) of the "Publications de l'Observatoire central Nicolas, St. Petersburg."

The former contains a catalogue of right-ascensions of the principal stars contained in the Pulkowa catalogue for the epoch 1885·0, the results being based on observations made between September, 1880, and November, 1887, with the meridian telescope. The catalogue is published in the same form as those which appeared in 1845 and 1865.

Vol. xiv. contains a part of the results of the observations made with the vertical circle of the observatory between May 1, 1896, and May 19, 1899. The remaining part of the results and the discussion of the whole are reserved for the next volume (xv.) of the publications.

THE ROYAL OBSERVATORY, GREENWICH.

The annual inspection of the Royal Observatory, Greenwich by the Board of Visitors took place on Wednesday, May 30, when the Astronomer Royal submitted a report of the work accomplished during the twelve months May 11, 1905, to May 10, 1906. A brief summary of this report is given below.

The new working catalogue of stars of the ninth magnitude and brighter, situated between declinations $+24°$ and $+32°$, is now complete, and includes more than 12,000 stars; the star-places have all been accurately brought up to 1910 from the Astronomische Gesellschaft catalogues.

A new determination of the pivot errors of the transit instrument, made during November, showed that the errors in the form of the pivots are insensible. The determination of the co-latitude for 1905 has been delayed by the necessity of applying the corrections to the star-places due to the variation of latitude. The value found for 1904, with Bessel's refractions, is 38° 31′ 21″·74.

The second nine-year catalogue, for epoch 1900, which was completed last year, will be divided into two sections, one containing the fundamental and zodiacal stars, the other the astrographic reference stars. For the second section the places (for 1900) of the stars within 10° of the pole have already been determined, and a comparison of these with the places given in Carrington's Redhill catalogue should discover a number of proper motions hitherto undetermined, thereby providing new material for the discussion of the solar motion.

Mr. Cowell has completed the discussion of the Greenwich meridian observations of the moon from 1750 to the present time, and has found the necessity of introducing three empirical terms, of which the third has a period of about 300 years. Because the introduction of this term renders the determination of the secular acceleration of the moon from modern observations impossible, Mr. Cowell has worked up the conditions for six ancient eclipses of which the historical records seem to be fairly authentic. By introducing accelerations of eleven seconds per century for the moon and four seconds for the sun, he found it possible to bring the conditions of every one of these eclipses into agreement with the historical records of the phenomena attending them. By treating ten of the lunar eclipses recorded in the Almagest in the same way, additional evidence for the existence of these accelerations was obtained. At first glance the acceleration for the sun was difficult to account for, and Mr. Cowell hypothecated a resisting medium through which the earth travels; but more recently he has found that a lengthening of the day by the two-hundredth part of a second per century would account for the quantity required for this acceleration. As one of the principal features of Mr. Cowell's discussion was the employment of the day as the unit of time, the lengthening of that unit would produce the apparent acceleration.

Owing to the re-mounting and re-polishing of the object glass the altazimuth was out of use from July 12 to August 30, but for the remainder of the year it was employed for observations of the sun, moon, planets, and fundamental stars. The lunar crater Mösting A was observed whenever the conditions were favourable, and, as the same kind of observations are being made at the Cape Observatory, the results will serve to determine anew the parallax of our satellite. The value obtained from the discussion of the two sets of observations should be more trustworthy than that previously obtained, which depended solely upon observations of the moon's limb, a much more difficult feature to "set on" than the crater. Mösting A was also observed with the transit circle whenever possible, and the mutual agreement of the two sets of results was very satisfactory.

Eight hundred and twenty-three double and twenty-four single observations of various stars were made with the reflex zenith tube, and the results have been reduced up to March 31.

The weather was not favourable during the year for observations of difficult double stars with the 28-inch refractor, but the time was utilised in completing the measures of neglected doubles in Struve's "Mensuræ Micrometricæ"; the total number observed was 606, of which 158 have their components separated by less than 1″·0, and seventy by less than 0″·5. The diameters of Jupiter and his satellites were also measured with this instrument. Both the polar and equatorial diameters of Jupiter were observed, first with the filar micrometer and then with the double-image micrometer, on each night, and it was found that the mean of the results of the two methods produced a very good value for the diameter. The error caused by irradiation in the filar micrometer observation is apparently exactly corrected by the error introduced in the second method by the fact that when the two images are apparently in contact they actually overlap to a slight extent.

The 26-inch refractor was employed on twenty-eight nights in obtaining seventy-two photographs of Neptune and its satellite, using the occulting shutter as in previous years. These photographs are now being measured.

A number of photographs of Jupiter's newly-discovered satellites vi. and vii. were obtained with the 30-inch reflector. This success is remarkable because it was the expressed opinion of the discoverer of the satellites that vii. was too faint to be photographed through our British atmosphere. Yet nineteen photographs of this object were secured at Greenwich on fifteen nights, and eighty-six negatives of satellite vi. were taken on thirty-six nights. The 30-inch reflector was also employed for obtaining photographs of twenty-three minor planets, five comets Nova Aquilæ, and several nebulæ.

The reduction of the Eros plates is complete, and the results have been communicated to M. Lœwy.

At the date of last year's report the measurement of the Greenwich plates for the Astrographic Catalogue was complete, but a number of the measures have been repeated, and the press copy has been prepared for the seven zones 80° to 86°. The measures of the eight zones 77° to 84° have been printed during the year, and include 46,329 separate stars covering an area of 450 square degrees of sky. The remaining 78·5 square degrees between 85° and the pole will include about 6000 stars. An interesting table given in the report shows the number of stars which have been measured, and will be contained in the Greenwich section of the catalogue, and compares it with the number shown in each of the corresponding zones of the Bonn Durchmusterung and the Astronomische Gesellschaft catalogues. Thus it is shown that the total in the Greenwich section will be about 178,380, whilst for the same region the B.D. contains only 25,184 stars. A similar table compares the number of stars shown on the Greenwich chart plates in several zones with those contained in the corresponding zones of the B.D. In the total area of 558·3 square degrees the latter contains 2259 stars of magnitude 9·0 and brighter, and 6542 altogether, whilst for the different exposures given for the Greenwich plates the following numbers are shown:—

Exposure	20 secs. ...	3m. ..	6m. ...	40m.
Number of stars...	12,019 ...	56,921 ...	58,393 ...	170,180

Thus on the plates taken at Greenwich with forty minutes' exposure there are 304·8 stars per square degree, and about twenty-six times as many stars as are given in the corresponding region in the B.D. The second Greenwich volume of the Astrographic Catalogue is printed up to the end of 84°, and will soon be ready for publication. Twelve thousand photographic prints, reproducing on double scale 191 plates in zones 65° to 70°, have been made during the year, bringing the total number of plates reproduced since the work began up to 401, or rather more than one-third of those contained in the Greenwich section. During the year under report the astrographic telescope has been used to obtain duplicate plates for the chart to replace previous ones which are not entirely satisfactory for reproduction purposes.

Heliographic observations were carried out as usual, the sun being photographed on 210 days. The solar activity was very pronounced during 1905, the record for that year being about double that for 1904.

The magnetic observations were made as in former years, and the principal results for the magnetic elements for 1905 were as follow:—

Mean declination	16° 9′·9 West
Mean horizontal force	4·0173 (in British units) 1·8523 (in metric units)
Mean dip (with 3-inch needle)...	66° 55′ 55″

There were no days of "great" magnetic disturbance, and only twelve days of lesser disturbance in 1905.

The various meteorological observations were continuously maintained throughout the year, the mean temperature being 0°·2 above, and the rainfall 1·21 inches below, their respective averages for the fifty years 1841–1890.

In the chronometer and time-service department the report follows the usual lines, but the Astronomer Royal remarks on the inferiority of the box chronometers and the superiority of the watches submitted for tests during the period covered by the report. Of fifty-nine chronometers sent in, thirty-three were rejected because they failed to attain the minimum standard of constancy. This is a larger number of rejections than in any previous year, although the number submitted was smaller than usual.

In concluding the report, the Astronomer Royal directs attention to the serious menace to the continued efficiency of the observatory on its present site involved in the establishment in the immediate neighbourhood of large generating stations for the supply of electric power to distant districts. The most serious danger at present arises from the new power station erected by the London County Council, which is situated directly north of the observatory. Not only will the high chimneys actually prevent stars from being seen when near the northern horizon, but the heated gases arising from the buildings may seriously affect the accuracy of any results obtained. Again, the new station is but half a mile from the observatory, and the running of the engines, although their number is not yet complete, produces serious tremors on the mercury reflecting surface, on the steadiness of which the accuracy of the astronomical results is critically dependent. At present the instruments employed in the magnetic pavilion have shown no disturbance, but it is greatly to be feared that the contemplated increase of the electrical plant will also have a serious effect on the work of this department.

THE ROYAL SOCIETY OF EDINBURGH AND THE NATIONAL GALLERIES OF SCOTLAND BILL.

On Friday last, June 1, the Secretary for Scotland received an important deputation of the Royal Society of Edinburgh regarding the claims of science in the readjustment of grants in aid and allocation of national buildings as contemplated in the National Galleries of Scotland Bill recently introduced in Parliament.

The chief point discussed was the position of the society in regard to its present occupancy of part of the Royal Institution, Princes Street. The deputation, which was very representative of science in Scotland, was introduced by Sir J. Batty Tuke, M.P. The claims of the society were presented by Lord M'Laren, vice-president; Mr. J. W. Gulland, M.P.; Principal Sir William Turner, of Edinburgh University; Principal Mackay, Dundee; Prof. Cash, Aberdeen; Prof. Gray, Glasgow; and Prof. Chrystal, secretary of the society. It was pointed out that in the National Galleries Bill, which contemplates devoting the Royal Institution, as well as the present National Gallery building, entirely to art, no provision is made for the Royal Society, which has occupied the west wing of the Royal Institution since that building was constructed seventy years ago, and for which, indeed, the building was originally designed. The deputation suggested the introduction of a clause safeguarding the position of the society, so that it shall not be dispossessed until equally good and convenient rooms have been obtained elsewhere out of public money. It will be impossible to carry on the important work of the society, especially as regards the publication of valuable and expensive memoirs, without this guarantee. Not only so, but it was urged that the Royal Society of Edinburgh should be placed on the same footing as the Royal Society of London and the Royal Irish Academy, both of which sit rent free in Government buildings, and receive grants to the extent of 1000*l.* and 1600*l.* respectively. The Royal Society of Edinburgh receives a grant of 300*l.*, which, however, is nearly all paid back to the Board of Manufactures in the form of rent. The Royal Society of London and five other scientific societies are accommodated in Burlington House next door to the Royal Academy, and it is hoped that a similar principle will be applied in Edinburgh.

The Secretary for Scotland expressed his hearty sympathy with all that had been said as to the importance of scientific work and the national character of the work done by the Royal Society. The National Galleries Bill introduced by the present Government is practically the Bill of last session with some minor alterations. The whole question has been gone into very carefully, and the conclusion is to put the National Gallery into the south building, and give to the Royal Academy the Royal Institution, part of which is at present occupied by the Royal Society. The accommodation for the National Gallery and for the Academy will thus be doubled, and ample scope will be given for future development. It is not possible to house the Royal Society and the Royal Academy in the same building. The decision has been come to after review of all the circumstances, and it carries with it the obligation to find accommodation consistent with the necessities and prestige of the Royal Society. It is the desire and intention of the Government to meet the reasonable demands of the Royal Society in a liberal spirit; and the Secretary for Scotland suggested that the Royal Society should consider the new situation which has been created, and should formulate some scheme for the consideration of the Government.

THE DISCOVERY OF MAGNETIC DECLINATION.

The *Meteorologische Zeitschrift* for April contains an interesting article by Prof. G. Hellmann on the knowledge of the magnetic declination before the time of Christopher Columbus. Some years ago Prof. Hellmann pointed out that, independently of the discovery by Columbus, the variation must have been known on the Continent, from the construction of many pocket sundials provided with magnetic needles for adjusting the instruments to the astronomical meridian, and showing the declination by a line on the floor of the compass-box.

Dr. A. Wolkenhauer recently discovered three such sundials dating from before the time of Columbus. One of these, which is in the Ferdinand Museum at Innsbruck, and

Fig. 1.—Pocket sun-dial with compass and variation line. Date, about A.D. 1451.

was probably made at Nuremberg, is shown in the accompanying photographs by Hofrath von Wieser. The glass shade and magnetic needle have been removed so that the lines on the bottom of the box might be more plainly shown. The lid or flap, which has also been removed, and which adjusts the gnomon when opened, shows the date of construction, viz. 1451, the figures 4 and 5 being in the old form (see also the hour numbers of the dial).

The rim of the compass-box shows the four cardinal points:—M. (Meridies), Oc. (Occidens), S. (Septentrio), Or. (Oriens). On the floor of the compass-box is cut the northerly-pointing bifurcated line of deviation of the magnet, showing about 11° easterly variation. This line is of the same depth and thickness as the hour lines, and a careful examination of the instrument shows that it must have been originally done by the maker. It can easily be recognised, however, that the three other marks west of the original line (two of which have arrow-heads) were roughly inserted at a later time, when probably the declination had become westerly. The short, thick stroke lying 4°–5° west of the N.-S. direction has been scratched the deepest. The magnetic variation was apparently probably known before the beginning of the fifteenth century, but by whom and where it was discovered still remain an open question.

IRISH CAVE EXPLORATIONS.

OUR knowledge of the Irish fauna in Neolithic and early historic times has been greatly extended by recent researches into the cave remains of Ireland. These have been carried out during the past few years by a committee, under the auspices of the British Association and of the Royal Irish Academy. Two reports on these investigations have been published in the Transactions of the latter. The first dealt with the exploration of the caves of Kesh, in the county Sligo, and the second, which has just been issued, with that of the county Clare caves. The committee is now at work further south, in the county Cork.

The Clare caves, which are situated about thirty miles from the sea coast, among beautiful surroundings, in a district of crags and lakes, lie in the lands of Edenvale and Newhall. Our illustration shows the entrance to two of these caves (marked A and B) in a steep ridge of rock overlooking an ancient track, known as the Pilgrims' Road, which leads from Ennis to Killone Abbey and the Holy Well. The others lie barely a mile to the west of these. All the caves have been formed by the solvent action of water on the limestone in which they occur. Several of them are of great extent, with complicated ramifications. They are mostly about 100 feet above sea-level. They differ from many of the great English caves in the absence of a well-marked stalagmite floor, and of their early cave-fauna, including the rhinoceros, hippopotamus, cave-bear, hyæna, &c. The deposits are composed, as a rule, of two easily distinguishable strata. The upper one, generally consisting of brown earth, contains charcoal associated with the bones of domestic animals, while the second is often of a very tenacious nature, and includes many remains of the bear and reindeer, Irish elk, and Arctic lemming.

Photo.] [*R. Welch.*

FIG. 1.—View showing entrances of Bat's Cave (A) and Elder-Bush Cave (B), Newhall.

Of particular interest is the occurrence of the Arctic fox and of the wild cat. The former of these is exceedingly rare in England, and had not been known to occur in Ireland, while as to the latter, it has been held as doubtful whether it ever inhabited Ireland. Several jaws and teeth were found, however, which agreed, not with the Scottish wild cat, but with that commonly met with throughout the African continent, and popularly known as the Caffer cat.

More than 2000 bones of birds were obtained, comprising fifty-eight species, the most noteworthy of which is the crane. The Welsh traveller, Giraldus Cambrensis, stated that when he visited Ireland in the twelfth century cranes were to be met with in flocks, and it is of interest that this account of their presence has been verified by the discovery of these remains.

The occurrence of a shed antler of the Irish elk, and of long bones of this species and of the reindeer, which seemed to show signs of having been artificially fractured, indicate the possible contemporaneousness of man with these deer, but the evidence in this case is not conclusive. The bear, however, was clearly coexistent with man, and probably lingered on in Ireland long after the Irish elk and the reindeer had become extinct. A knee-cap of a large bear, showing the incisions of a knife, was found in one of the caves, and other bear bones were obtained from the upper layer along with charcoal and the remains of domestic animals. Unfortunately all the cave deposits had been greatly disturbed by burrowing animals, such as badgers and foxes, which inhabited them chiefly in recent times.

Some of the caves show traces of human occupation of long continuance in early times, while others may have been used as shelters for short periods. Scrapers and flint flakes, bone pins, and stone implements occurred, while a gold bracelet, and another, richly decorated, of bronze, were found. Of bronze, also, was a buckle engraved with an interlaced pattern and plated with silver. One of the most remarkable of the objects discovered was a lamp, the receptacle being hollowed out of a round stone, not carved in any pattern, but with deep grooves round the sides. Of these and other objects the plates illustrating the report give a good idea. Together with the implements, numbers of human bones were found, although there is no evidence that the caves had ever been used as places of burial. The bones revealed nothing which might lead us to suppose that they belonged to a different race from that inhabiting Ireland at the present time; but their study elicited the fact that some of them belonged to individuals who habitually assumed the squatting position common to all primitive peoples.

R. F. SCHARFF.

NEW PILOT CHARTS.

IN these days of perpetual and feverish haste, which is characteristic of life at sea as well as on shore, the desirability has been realised of introducing modifications in the method of conveying practical information for the use of seamen. Formerly, men had more leisure to wade through the bulky volumes known as sailing directions when they wished to clear up any point in doubt. Now, with less time to spare, the demand is for the concentrated essence rather than the minute details of the facts, and this is one of the objects in view in the production of the several pilot charts originated on both sides of the Atlantic within recent years. Many subjects have to be dealt with, and the space is strictly limited, so that the mariner has before him on his chart-room table all the essential features of the particular subjects.

Two pilot charts are published by the Deutsche Seewarte at Hamburg, one for the North Atlantic and Mediterranean area, issued monthly, the other for the North Sea and Baltic region, issued quarterly. They are elaborately and excellently got up, and in the quality of their varied contents afford further evidence of that thoroughness characteristic of German investigators. The face of each Atlantic chart (36 inches by 27 inches) is covered with information of immediate concern in navigating a ship—the mean direction and force of the prevailing winds in every 5° square; the northern and southern limits of the trade winds; the paths and the intensity of storm systems; the regions of mist and fog; the dust atmosphere off Africa; the tropical rain area; the set and velocity of ocean currents; ice; derelicts; steamship and sailing-ship routes and great circle tracks; copious remarks bearing on all these subjects; variation curves; and illustrations of the storm-warning signals adopted by countries on both sides of the ocean. The whole of the back is devoted to articles, with or without illustrations, discussing subjects of general interest to the navigator, and not necessarily limited to the North Atlantic area. A special investigation of the winds, currents, and air and sea temperatures experienced along the Mediterranean steamship routes is being carried out at the Seewarte, and the results are now appearing month by month on the pilot chart.

The issue for last February contains a very complete work on the handling of ships in tropical hurricanes Atlantic, Indian and Pacific Oceans, the Arabian and China Seas. The April number gives an account of a very severe Atlantic storm, the maximum violence occurring on the rise of the barometer; a still longer article deals with water-spouts. The May chart gives the true bearing and the compass bearing at about three hundred positions round the coasts of the British Isles. The North Sea-Baltic publication is equally complete, each quarterly issue containing one general chart for the region and others for the several months of the quarter, together with an abundance of letterpress dealing with a great variety of subjects, such as the investigation of the fisheries and the physical condition of the waters of the region, the surface currents of the Kattegat and Sound, ice, and tidal streams.

With five years' experience in the preparation of the monthly North Atlantic pilot charts, our Meteorological Office has now commenced the publication of a similar series of "Monthly Meteorological Charts of the Indian Ocean North of 15° South Latitude, and Red Sea." The area covered by the map extends from 30° N. to 15° S., between the meridians of 30° and 100° E. The first number, issued in London on May 9, is for the month of May. Presumably future issues will be well in advance of the month to which they relate, so as to be in the hands of mariners navigating the Indian Ocean during the month. Generally, the chart presents the same features as the North Atlantic one. For each ocean space of 5° of latitude by 5° of longitude the frequency of winds of light, moderate, or gale force is shown for the sixteen even points of the compass, the observations upon which the results are based covering a period of fifty years. Apparently through inadvertence a pecked line intended to indicate the northern limit of the south-east trade has been omitted. Tracks of some cyclonic storms are given in red. It is left to the sailor to assume whether the date given is at the commencement or end of the tracks, there being no directing arrow heads. The set and velocity of the ocean currents are shown in blue, and in a lighter blue the variation curves for 1907. Use is made of the land spaces for supplying a variety of information by means of letterpress and inset charts.

A small chart of the whole area gives, for the month, the average distribution of barometric pressure over the sea, and the mean temperature of the air and of the water. An enlarged map of the Guardafui and Ras Hafún district shows the currents, sea temperatures, and misty weather in this dangerous locality, and suitable notes accompany the map. Over Arabia appear remarks on the various air and water elements of the Red Sea and Gulf of Aden. On the back of the sheet are given complete summaries of the elaborate storm and weather signals of the Bay of Bengal and of the Húgli River storm signals, which are far more precise than those in use in any other part of the world. A map of the southern Indian Ocean, from the equator to 40° S., and 30° to 120° E., is used for reproducing the late Dr. Meldrum's monthly tracks of cyclones between 1848 and 1885. There are notices to captains relating to the collection of meteorological observations, to the necessity for accurate determination of the errors of barometers in use, and to the compass adjustment marks at Kalpi anchorage.

Altogether the new publication gives promise of supplying a much-needed want in a simple and easily accessible form for a part of the ocean about which there has hitherto been but little information. The monthly variations in the circulation of the waters of the Arabian Sea and of the Bay of Bengal will alone well repay careful study, while a more accurate knowledge of the different winds of the region covered by the chart cannot fail to be of the greatest practical benefit to shipmasters and their officers.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—The electors to the Linacre professorship of comparative anatomy will proceed to an election next month. Candidates are desired to send in their names so as to reach the registrar's office not later than Saturday, July 7. The Linacre professor is by virtue of his office a fellow of Merton College. He is entitled to receive from the college a stipend of 700*l*. a year in addition to the emoluments of a fellowship, which amount at present to 200*l*. a year.

Cambridge.—Mr. E. S. Roberts, Master of Gonville and Caius College, has been elected Vice-Chancellor for the ensuing academical year.

Mr. L. Noon, Trinity College, has been elected to a John Lucas Walker studentship in pathology.

The assessment to be paid by the colleges to the University in the present year has been fixed at 30,038*l*., or 13*l*. per cent. on the college incomes.

The Chancellor, His Grace the Duke of Devonshire, has made a gift of 500*l*. to the special fund now being raised on behalf of the University library.

Mr. C. L. Boulenger, King's, has been nominated to the University table at the Naples Zoological Station; and Mr. K. Lucas, Trinity, to the table at the Plymouth Marine Biological Laboratory.

The special board for mathematics has made some minor alterations in the proposals for the re-modelling of the Mathematical Tripos, parts i. and ii., but it is proposed to submit unchanged to the Senate the principles of the original report.

Ten candidates have been successful in the special examination in agricultural science and the first examination for the University's diploma in agriculture.

Mr. W. A. Cunnington, Christ's, for a dissertation on "Tanganyika," and Mr. C. Shearer, Trinity, for a dissertation on "The Development of Larval Nephridia," have been approved as advanced students for the certificate of research.

Prof. Bradbury, Prof. Osler, Dr. S. West, and Prof. Rose Bradford have been appointed examiners in medicine; Dr. Rivers Pollock and Prof. Spencer, examiners in midwifery; and Dr. Kellock, Prof. Barling, Mr. Stanley Boyd, and Mr. Dunn, examiners in surgery for the ensuing academical year.

A sum of 6000*l*. from the benefaction fund, raised by the University Association, has, with the approval of the Chancellor, been contributed to the cost of the botany and medical school buildings.

The name of "Frederick James Quick, of Trinity Hall," founder of the Quick professorship of biology, has been added to the list of benefactors in the Commemoration Service.

A Royal Commission has been appointed for the purpose of holding an inquiry into Trinity College, Dublin, and the University of Dublin. The terms of reference of the commission are as follows:—"To inquire into and report upon the present state of Trinity College, Dublin, and of the University of Dublin, including the revenues of the College and of any of its officers and their application, the method of government of the University and of the College, the system of instruction in the College and the teachers by whom it is conducted, the system of University examinations, and the provision made for post-graduate study and the encouragement of research; and also to inquire and report upon the place which Trinity College, Dublin, and the University of Dublin now hold as organs of the higher education in Ireland, and the steps proper to be taken to increase their usefulness to the country." Among the commissioners are Sir Edward Fry (chairman), Sir A. W. Rücker, F.R.S., and Prof. D. J. Coffey.

According to the *Reichsanzeiger*, the number of students who took the "Doktor-Ingenieur" degree of the technical Hochschulen at Berlin, Hanover, and Aachen during the last winter semester was seven in Berlin, five in Hanover, and four in Aachen, while the number who took this degree during the two semesters from March, 1905, to

March, 1906, at the Dresden Technische Hochschule was seventeen; of these thirty-three we find that eight passed the *viva voce* examination with distinction, whilst the ages of the candidates varied from twenty-three to thirty-nine years. As a reason for this small number of the students who eventually take the degree, it is said that the great majority of the students, after having passed through their eight semesters of stiff study and obtained the coveted diploma, qualifying them to style themselves "Dipl. Ing.," have frequently neither the desire nor the means for the extra semester's study and research necessary for the doctor's degree.

THERE is no diminution in the generosity shown by American citizens towards higher education. *Science* announces that Columbia University has received 100*l*. for a mathematical prize, given by Mrs. Louise T. Hoyt. Mr. Edward S. Harkness has given 540*l*. to the morphological museum at the College of Physicians and Surgeons, and Mr. Archer M. Huntington 200*l*. to support a lectureship in geography. In April, 1905, Mr. Andrew Carnegie offered Morningside College, Sioux City, Iowa, 10,000*l*. on condition that they raised 30,000*l*. On April 3, 1906, his conditions for the gift were satisfied, and Mr. Carnegie's cheque has been received. Mr. Carnegie has also given the sum of 10,000*l*. to Drury College, at Springfield, Missouri, on condition that the college increases its resources by the sum of 40,000*l*. About one-third of this sum has been raised since January 1. Mr. R. Y. Cummings has given 4000*l*. to the Field Museum of Natural History to defray the expenses of an ethnological study of the native tribes of the Philippine Islands.

ALBION COLLEGE is now building a new biological laboratory, which is expected, we learn from *Science*, to be completed in time for the opening of the college year in September. Mr. Andrew Carnegie has promised 4000*l*. to the endowment fund of the college on condition that 16,000*l*. additional is raised for the purpose. Mr. Carnegie has also given Kenyon College 5000*l*. to aid poor students. A new scholarship of 1000*l*. has been given to Barnard College, Columbia University, by Mrs. George W. Collord in memory of her brother. By the will of Roland Hayward, of Milton, Mass., the museum of comparative zoology of Harvard University will receive the testator's collection of Coleoptera.

A CLAUSE in the Education Bill before Parliament will, if it eventually become part of the Act, abolish the Teachers' Register. There is a strong feeling among teachers in secondary schools and others that such a course would be very prejudicial to the progress of secondary and higher education, inasmuch as it would discourage the movement to secure adequate training for secondary-school teachers. A meeting of the heads of training colleges for secondary-school masters and mistresses in all parts of the country was held at Bedford College, London, on May 26, to consider the proposals of the Government, and after discussion numerous resolutions were adopted unanimously. These resolutions declared that, as a result of the proposal, public confidence in the stability of the Board of Education has been shaken seriously; that a part of the present register fulfils a purpose that is useful and not otherwise provided for; that grants and other administrative aids to the training of secondary-school teachers, as promised by the Board of Education, do not form a substitute for a register. The recognition of a profession, one resolution insists, with powers over entrance to its ranks, is an essential element in creating a respected and permanent profession; and another lays it down that in view of the difference of conditions at the various centres of training and of the necessity for experiments in the training of teachers, the Board of Education should give as much liberty as possible in the regulations under which the preparation for diplomas is conducted.

THE current number of the *University Review* contains a vigorous article by Mr. H. P. Biggar on the establishment of a graduate school at Oxford. One of the chief aims of a university should be, the article insists, the extension of the bounds of knowledge in each department of learning by masters who are capable of making fresh discoveries therein. This object is constantly before the minds of the authorities of German and French universities. In both these countries the graduation of students is dependent upon their success in prosecuting research, and from France and Germany instruction in research has spread to the United States. Since 1876, Princeton, Columbia, Chicago, Cornell, and other American universities have found themselves bound to establish graduate schools where training may be obtained in research, and from the United States post-graduate studies have spread to Canada. With us, however, graduate studies are practically unknown. At Oxford, for instance, which Mr. Biggar takes as an example, because it is there alone that Rhodes scholars may study, the University ceases to enforce any test of proficiency beyond the degree of Bachelor of Arts. The B.A. has but to continue to pay certain fees to his college for about three and a half years after taking his degree, when he may come up, pay some 20*l*., receive the degree of Master of Arts, and become a member of Convocation. What is wanted, Mr. Biggar maintains, is to establish at Oxford a proper graduate school, that is merely the reinforcement of a thesis, either for the M.A. or for the doctor's degree. The important part is that the increase of knowledge should be looked upon as one of the main ends to be kept in view. Then, perhaps, the Rhodes scholars will discontinue to experience the disillusionment which awaits many of them, who come hoping to find themselves among *the makers of new knowledge*! and participating in the glorious work.

THE distinguished representatives of the University of Paris and the Collège de France, together with guests from nine other French universities, arrived in London on June 4, and have during the week been entertained by the University of London and the Modern Language Association. The visitors were met at Victoria Station by Sir Edward Busk, Vice-Chancellor of the University of London; Sir Arthur Rücker, principal of the University; and many members of different faculties of the University and of the Modern Language Association. In the evening of June 4 the French guests were entertained at an informal dinner. Sir Walter Palmer, chairman of the London University organisation committee, in proposing in French the toast of "Our Guests," said that the visit is a unique fact in the annals of university life, which will long remain imprinted on our hearts as a new phase in the scientific and literary development of the two nations represented. What could be of happier augury than so distinguished an assembly of men of letters and of science leaving their country and paying a visit to their colleagues in order to draw closer still the bonds existing between the arts and the sciences of the two countries? M. Bayet, director of higher education at the Ministry of Public Instruction, responding in French, remarked that if there is a domain in which the *entente cordiale* has its place it is the domain of letters, science, and art. It has long had its place there, for if we reascend the current of the centuries we find that this *entente cordiale* has existed almost always between England and France. We are creditors and debtors of each other. Frenchmen, he said, salute the profound influence which England has exerted upon them in the domain of letters, science, and art. They know the English writers, poets, and philosophers, they love them, they have drawn inspiration from them, and in their hearts they associate themselves with the cult of great writers and thinkers. M. Lippmann, who responded for the faculty of science of the University of Paris, spoke in English, and said science is not bounded by the Channel nor has it a local habitation. There is but one geometry throughout the world. The laws of nature reach beyond the stars. For that reason the guests feel at home in any place among the brotherhood of scientific men. He continued, it is a happy dispensation that a university should have been founded within the precincts of this huge city. London is gigantic in size, wealth, and might; its shipping is unrivalled, its commercial activity unexampled; but the greater the pressure of business, the heavier the load of accumulated wealth, the more needful it is to augment the power of the priceless element which is the soul of a university, the more so as the experimental work done in laboratories and in experimental research of any kind is the prime source of industrial progress, as well as an antidote to fortune.—On Tuesday the visitors were received at the Foreign Office in order that Lord Fitzmaurice and Mr. Lough, M.P., might welcome them officially on behalf of the Government. At the conclusion of the reception they were driven to the University of London, where luncheon was served. Addresses were afterwards delivered by the Vice-Chancellor (Sir Edward Busk), M. Liard, Sir Arthur Rücker, and Prof. M. E. Sadler, and a visit was made to the new physical and chemical laboratories of the Royal College of Science. In the evening several receptions were held in honour of the guests.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, May 9.—Mr. Aubrey Strahan, F.R.S., vice-president, in the chair.—The eruption of Vesuvius in April, 1906: Prof. Giuseppe **de Lorenzo.** After the great eruption of 1872 Vesuvius lapsed into repose, marked by merely solfataric phenomena, for three years. Strombolian activity followed, varied by lateral outpourings of lava in 1885, 1889, 1891, 1895, &c., and by outbursts from the principal crater in 1900 and 1904. Fissuring of the cone and slight outpourings of lava began in May, 1905, and continued until April 4, 1906, when the first great outburst from the principal crater occurred, accompanied by the formation of deeper and larger fissures in the southern wall of the cone, from which a great mass of fluid and scoriaceous lava was erupted. After a pause the maximum outburst took place during the night of April 7 and 8, and blew 3000 feet into the air scoriæ and lapilli of lava, as well as fragments derived from the wreckage of the cone. The south-westerly wind carried this ash to Ottajano and San Giuseppe, which were buried under 3 feet of it, and even swept it on to the Adriatic and Montenegro. At this time the lava which reached Torre Annunziata was erupted. The decrescent phase began on April 8, but the collapse of the cone of the principal crater was accompanied by the ejection of steam and dust to a height of from 22,000 feet to 26,000 feet. On April 9 and 10 the wind was north-easterly, and the dust was carried over Torre del Greco and as far as Spain; but on April 11 the cloud was again impelled northward. The ash in the earlier eruptions was dark in colour, and made of materials derived directly from the usual type of leucotephritic magma; but later it became greyer, and mixed with weathered clastic material from the cone. The great cone had an almost horizontal rim on April 13, very little higher than Monte Somma, and with a crater which possibly exceeds 1000 feet in diameter; this cone was almost snow-white from the deposit of sublimates. Many deaths were due to asphyxia, but the collapse of roofs weighted with dust was a source of much danger, as was the case at Pompeii in A.D. 79. The lava-streams surrounded trees, many of which still stood in the hot lava with their leaves and blossoms apparently uninjured. The sea-level during April 7 and 8 was lowered 6 inches near Pozzuoli and as much as 12 inches near Portici, and had not returned to its previous level on April 18. The maximum activity coincided almost exactly with the full moon, and at the time the volcanoes of the Phlegræan Fields and of the islands remained in their normal condition. The author believes that this eruption of Vesuvius is greater than any of those recorded in history, with two exceptions—those of A.D. 79 and of A.D. 1631.—The Ordovician rocks of western Caermarthenshire: D. C. **Evans.** The ground dealt with is practically identical with that examined by the late Thomas Roberts, whose notes were published in 1893. It extends from the River Cywyn on the east to the Tave on the west, and from the base of the Old Red Sandstone on the south to the top of the Dicranograptus-Shales on the north.

Zoological Society, May 15.—Dr. J. Rose Bradford, F.R.S., vice-president, in the chair.—Descriptions of the two species of water-mites (Hydrachnidæ) collected by Mr. W. A. Cunnington in Lake Nyasa during the third Tanganyika expedition, 1904–5: J. N. **Halbert.**—A collection of mammals made by Mr. W. Stalker in the northern territory of South Australia, and presented to the National Museum by Sir William Ingram, Bart., and the Hon. John Forrest: O. **Thomas.** The collection included sixteen species, of which the two following were of special interest: *Mus forresti*, sp.n. Size, medium. Colour, drab-grey above, white below. Teeth with their laminæ peculiarly twisted, the first molars with large cingular ledges. Head and body, 104 mm.; tail, 72 mm.; hind foot, 19 mm. Type, B.M. No. 6.3.9.39. *Phascogale ingrami*, sp.n. Size, minute; the teeth and feet smaller than in any known Australian marsupial. Head peculiarly flattened. Head and body, 80 mm.; tail, 60 mm.; hind foot, 10 mm. Type, B.M. No. 6.3.9.77.—The skull of a young ribbon-fish (Regalecus): Prof. W. B. **Benham** and W. J. **Dunbar.**—Descriptions of two species—one of them new—of hair-worms of the family Gordiidæ: Dr. von **Linstow.** The specimens were obtained in Korea by Mr. Malcolm Anderson, who was making collections of the fauna of eastern Asia for the Duke of Bedford.—Descriptions of a new lizard, a new snake, and a new toad collected in Uganda by Mr. E. Degen: G. A. **Boulenger.**—The gestation and parturition of certain monkeys that had bred in the society's menagerie in the spring of the present year: R. I. **Pocock.**

Faraday Society, M y 15.—Dr. F. Mollwo Perkin, treasurer, in the chair.—Behaviour of platinised electrodes: H. D. **Law.** The author desired to find an electrode on which the reduction of the aromatic aldehydes and similar easily reducible compounds could not be effected. Platinised platinum, as being the metal from which hydrogen is liberated at the lowest potential, was tried as the kathode in an acidified alcoholic solution of benzaldehyde. At first energetic reduction took place; the activity of this, however, diminished in successive experiments, and was extremely small after twelve hours' polarisation.—The electrolysis of fused zinc chloride in cells heated externally: Julius L. F. **Vogel.** The dehydration of zinc chloride by evaporating under reduced pressure, and the electrolysis of the salt in a fused state in externally heated cells were investigated by Dr. O. J. Steinhart and the author jointly on behalf of the Smelting Corporation, Ltd. Further investigations were made after the United Alkali Company had joined the Smelting Corporation in testing the process, and details are given in the paper of the work as carried out under the joint supervision of the author's firm and the chemical staff of the United Alkali Company. The author describes how the process was carried successfully to a stage when continuous electrolysis was carried on for eleven days and nights, and three cwt. of pure zinc was produced. On the failure of the Smelting Corporation the work was suspended, and finally abandoned, although further elaborate investigations were undertaken by the United Alkali Company utilising cells heated internally by the current.

Royal Microscopical Society, May 16.—Dr. D. H. Scott, F.R.S., president, in the chair.—Some observations recently made on the parasites of malaria and the phagocytic action of the polymorphonuclear leucocytes: Dr. **Bernstein.** The subject was illustrated by drawings showing the results of observations made during the examination of blood taken from a patient suffering from malarial fever. The observations were made at intervals of a few minutes during a period of five hours. A crescent form of the parasite was seen to become engulphed by a leucocyte, in which it was soon surrounded by vacuoles and was ultimately destroyed, only the pigment granules remaining; other leucocytes afterwards approached and absorbed some of the granules. The blood film was stained, and the preparation, showing the pigment granules in the polymorphonuclear leucocytes, was exhibited under a microscope at the meeting.

Chemical Society, May 17.—Prof. R. Meldola, F.R.S., president, in the chair.—The relation between absorption spectra and chemical constitution, part vi., the phenylhydrazones of simple aldehydes and ketones: E. C. C. **Baly** and W. B. **Tuck.** A spectroscopic investigation of the phenylhydrazones of formaldehyde, acetaldehyde, propylaldehyde, acetone, and diethylketone shows that these exist in two forms, an unstable true hydrazone and a stable azo-form. The absorption spectra of the hydrazones of the three nitrobenzaldehydes show that the colour of these substances is not due to their existence in the azo-form.—The rusting of iron: J. T. **Nance.** The "rusting" of iron in solutions of ammonium chloride is probably due to the action of hydrogen ions formed by hydrolysis of the salt.—Aromatic compounds obtained from the hydroaromatic series, part ii., the action of phosphorus pentachloride on trimethyldihydroresorcin: A. W. **Crossley** and J. S. **Hills.**—Studies of dynamic isomerism, part v., isomeric sulphonic derivatives of camphor: T. M. **Lowry** and E. H. **Magson.**—The densities of liquid nitrogen and liquid oxygen and of their mixtures: J. K. H. **Inglis** and J. E. **Coates.** The results showed that a slight contraction took place on mixing the two liquids. It was found that the solubility of nitrogen in oxygen obeys Henry's law, but that the solubility of oxygen in nitrogen does not obey the simple form of that law, since oxygen dissolved in nitrogen is associated to the extent of about 9 per cent.—Glutaconic and aconitic acids: H. **Rogerson** and J. F. **Thorpe.**—The chemistry of organic acid "thiocyanates" and their derivatives: A. E. **Dixon.**—The molybdilactate and the tungstilactate of ammonium: G. G. **Henderson.** Molybdic and tungstic anhydrides are dissolved, the latter with some difficulty, when heated on the water-bath with solutions of ammonium lactate, the products being ammonium molybdilactate, $MoO_2(C_3H_4O_3NH_4)_2$, and ammonium tungstilactate, $WO_2(C_3H_4O_3NH_4)_2$, respectively. Descriptions of these salts are given.

Society of Chemical Industry (London Section), May 21.—Mr. A. Gordon Salamon in the chair.—The electrochemical problem of the fixation of nitrogen: Prof. Philippe A. **Guye.** Among the many investigations undertaken to solve this problem, two directions have led to industrial methods, the one, calcium cyanamide, the other, electrochemical nitric acid. The principal technical details of the manufacture of calcium cyanamide are given, and it is pointed out that its cost price depends upon that of calcium carbide. From this it is concluded that a kilogram of nitrogen fixed as calcium cyanamide will cost a little more than ammonia salts and Chili saltpetre, if the excess of calcium carbide obtained in carbide works not available for the development of acetylene is used. This conclusion seems confirmed by some agricultural tests made with this new compound of nitrogen of which the value, relative to Chili saltpetre, is not definitely fixed. Passing to electrochemical nitric acid, the author summarises the principles of its preparation, and although these are very simple, the application has presented serious difficulties, which, however, now appear to be solved by the experiments carried out in Norway. The absorption of the nitric acid by sulphuric acid is insisted on, as this allows concentrated nitric acid to be directly obtained, which is of greater commercial value than nitrate of lime, and consequently of more interest to a new industry. Analysis of the cost of electrochemical nitric acid leads to the conclusion that a kilogram of nitrogen is fixed slightly cheaper as nitric acid than as calcium cyanamide. In concluding, the author discusses the exterior economic factors which may hasten the development of the nitrogen industries. Among these the direct synthesis of ammonia from nitrogen and hydrogen, and the recovery of the nitrogen of coal in the ammoniacal form by the methods of L. Mond are mentioned. These processes, combined with the production of electrochemical nitric acid, will in all probability solve the problem of obtaining electric energy cheaply by motors utilising the power of coal.

Dublin.

Royal Dublin Society, April 24.—Prof. J. A. McClelland in the chair.—Entoptic vision, part iv., Haidinger's brushes and other entoptic phenomena: Prof. W. F. **Barrett,** F.R.S. The term entoptic vision may be employed to include the observation of all those phenomena the cause of which is situated within the eyeball. In previous papers on this subject the author has shown how obscurities in the path of a homocentric pencil of rays within the eye may be self-detected, delineated, and measured with great ease by means of the entoptiscope, a simple instrument devised by the author. Obscurities due to incipient cataract can be detected, and its progress watched and the effect of any possible remedy examined. In the present paper the entoptic phenomena are studied, delineated, and submitted to exact measurement, such as (1) the so-called Haidinger's brushes, or coloured polarised fasciculi seen when a brightly illuminated surface is looked at through a Nicol's prism, and the seat of which has been the subject of considerable discussion; (2) the moving corpuscles, like darting fire-flies, seen when a bright sky is looked at through a cobalt blue glass. These are depicted and measured in the paper, and the result leaves little doubt that they are really due to the movement of blood corpuscles in the vessels of the retina, the curved streaks of light they leave behind being due to the retention of the image of a quickly-moving body. Other entoptic phenomena are also discussed.—The absorption of β radiation by matter: Prof. J. A. **McClelland** and J. E. **Hackett.** It is important to know the true coefficient of absorption of β rays for different substances. There are really no data on the subject, as the coefficient usually measured depends to a large extent upon the power of the substance to emit secondary β rays. This coefficient gives, therefore, little information as to the actual stopping power of different forms of atoms. The present paper describes a method of determining the *true* absorption coefficient.

Royal Irish Academy, April 23.—Dr. F. A. Tarleton, president, in the chair.—Magneto-optic rotation: F. E. **Hackett.** The author examines the two dispersion formulæ deduced by Drude for the magneto-optic rotation, and brings forward a method to decide between them. The analysis consists in deducing from the constants of the formula, based on the hypothesis of rotating ions, the quotient of the area of the ionic orbit by the period of the ion for the absorption bands of carbon disulphide and creosote. The radii of the ionic orbits thus obtained are 100 times the ordinary molecular radii. From this result it is argued that the theory of rotating ions cannot account for more than one-thousandth of the rotation observed in these substances. A similar analysis applied to the constants of the Hall effect formula leads to values of ϵ/m of the same order as are obtained for electrons. Similar results are shown to hold in general for diamagnetic substances. It is then concluded that the theory based on the Hall effect gives a sufficient explanation of the rotation in diamagnetic substances.—The total solar eclipse of August 30, 1905: A. L. **Cortie.** The observations recorded in this paper were made at Vinaroz, on the Mediterranean coast of Spain. The results were:—(1) the corona was of the maximum type; (2) there were numerous prominences, especially one great group on the east limb of the sun; (3) the lower corona was much disturbed over this group, with a marked structure of arches and interlacing rings; (4) a well-marked vortex-ring with a white centre was connected with the prominences; (5) a ray, of presumably dark matter, and a group of plumes, marked the south-east quadrant; (6) the dark ray and plumes coincided in position with the sun-spot regions, and were possibly connected with the area disturbed by the great February spot; (7) some straight bright rays marked the south-west quadrant, also in the region of the spot-zones; (8) the general trend of the streamers was north and south, the largest streamers being placed almost at the south pole; (9) the inner corona was a ring of intense brilliancy, comparable to the full moon; (10) the streamers seemed in general to mark the regions of prominences more than those of spots.—Sixteen years' observations on the relation of temperature and rainfall to the spread of scarlatina, measles, and typhoid fever: R. Sydney **Marsden.** Weekly returns of cases of these diseases and the corresponding weekly variations of temperature and rainfall had been recorded for the years 1890–1905 at Birkenhead, and curve diagrams had been worked out to show the relation of the diseases to amount of rainfall and temperature as these varied above or below their average normal amount. Atmospheric temperature was found to have no effect on the spread of these diseases. As regards rainfall, this was shown to have no influence whatever as regards measles, but in the case of scarlatina the number of cases increased after deficient rainfall and decreased after rain; the number of *cases* increases after a series of dry years.

Newsholme has shown diphtheria to be affected in a similar manner. Dr. Marsden asks: Is it possible that scarlatina and diphtheria are "allotropic" forms of the same disease? In the case of typhoid, the number of cases occurring seems to be independent of whether it is a wet or dry year, but there seems to be a slight tendency for the number of cases to fall after rain.

PARIS.

Academy of Sciences, May 21.—M. H. Poincaré in the chair.—The president announced the loss by death of M. Bischoffsheim.—The discontinuity of the specific heats at saturation and Thomson's curves: E. H. **Amagat.** Simple relations between the dynamical reactions of muscle and the energy which produces them: A. **Chauveau.** Geometrical loci of centres of gravity: Haton **de la Goupillière.**—The intestinal origin of tuberculous tracheo-bronchial adenopathy: A. **Calmette**, C. **Guérin**, and A. **Déléarde.** The work communicated in the present paper has an important bearing on the question of the spread of tuberculosis by milk. It has been shown experimentally in the case of animals, and clinically in twenty-four cases of children, that whenever tuberculous infection is manifested by tracheo-bronchial adenopathy, tuberculous bacilli exist in the mesenteric ganglions, even when the latter appear to be healthy. These bacilli make their way into the system by the intestine.—Geodesic and magnetic work in the neighbourhood of Tananarive: Ed. El. **Colin.** The magnetic elements are given in tabular form for forty-nine stations round Tananarive.—A magnetic collimator which transforms a binocular into an instrument for taking bearings: A. **Berget.** A compass with a collimating lens and a system of totally reflecting prisms is fitted to one of the telescopes of the binocular, allowing the position of the needle of the compass to be read off to about 0·25 of a degree if held in the hand, or more closely if a support is used. The right-hand telescope is directed at the object the position of which is to be examined; the magnetic azimuth is read off directly at the same time in the left limb of the binocular.—The correlation between the variations of the absorption bands of crystals in a magnetic field and the magnetic rotatory polarisation: Jean **Becquerel.**—The sulphides, selenides, and tellurides of tin: H. **Pélabon.** The effect of the gradual addition of sulphur to tin on the melting point has been studied, and the relation between the percentage of added sulphur and the melting point given in the form of a curve. The corresponding curves for selenium and tellurium are also given.—The direct oxidation of cæsium and some properties of the peroxide of cæsium: E. **Rengade.** Oxygen, even when well dried, attacks cæsium energetically at the ordinary temperature. At $-40°$ C. the metal blackens, but there is no incandescence; at $-80°$ C. the action is very slow, and it is only after some minutes that the metal commences to tarnish. The action of an excess of oxygen gives cæsium peroxide, Cs_2O_4, a yellow oxide, easily dissociated at high temperatures. Water acts on it at ordinary temperatures, giving the hydroxide CsOH, oxygen, and hydrogen peroxide. Gently heated in carbon dioxide, cæsium carbonate and oxygen are produced. Dry hydrogen commences to reduce the peroxide at about 300° C.—New methods of preparing some organic compounds of arsenic: V. **Auger.** Methylarsinic and cacodylic acids can now be obtained commercially at a moderate price, and with these substances as starting points the author shows how various arsenic compounds can be readily prepared, including methylarsine iodide, CH_3AsI_2; methylarsine oxide, CH_3AsO; methylarsine chloride, CH_3AsCl_2; cacodyl chloride, $(CH_3)_2AsCl$; cacodyl, $As_2(CH_3)_4$; and tetramethylarsonium iodide, $(CH_3)_4AsI$.—Researches on diazo-compounds. The transformation of azo-orthocarboxylates into c-oxyindazylic compounds: P. **Freundler.**—The gases from thermal springs. The determination of the rare gases: general presence of argon and helium: Charles **Moureu.** Analyses are given of the gases from forty-three springs of mineral waters. Argon has been recognised in the whole of the forty-three samples examined, and helium in thirty-nine. It is possible that helium is also present in the remaining four, but in proportions so small that its presence is masked by the argon spectrum.—The elasticity of organic tissues: Ad. **Goy.** The apparatus described allows of six determinations being carried out nearly simultaneously on separate samples of muscle, the latter being surrounded by a fluid appropriate to its preservation. Drying in the course of the measurements is thus avoided.—The regenerator of fibrin and comparative estimations of this substance in different vascular territories of the dog after defibrination: M. **Doyon**, A. **Morel**, and N. **Kareff.**—A reaction of the oxydase type presented by the halogen compounds of the rare earths: E. **Fouard.** The oxidation of hydroquinone was determined in the presence of equimolecular solutions of the chlorides of thorium, cerium, lanthanum, neodymium, praseodymium, and samarium. The presence of the salts increased the rate of oxidation, samarium being the most active in this respect. The action is comparable to an oxydase.—The effect of adrenalin on the amount of glycogen in muscle: Mme. Z. **Gatin-Gruzewska.** The injection into a rabbit of a solution of adrenalin (containing 1 mg.) caused the total disappearance of the glycogen both in the liver and muscles. When the effect of the injection has passed off, the animal, if fed, has not lost the power of producing glycogen.—The identity of *Hemipygus tuberculosis* and *Hemicidadis crenularis*: M. **Seguin.**

CALCUTTA.

Asiatic Society of Bengal, May 2.—The relative proportion of the sexes in *Helopeltis theivora*: H. H. **Mann.** Hitherto no careful investigations have been made as to the relative number of males and females in any species of Heteropteron, but the fact that *Helopeltis theivora* is a serious pest of tea has given the chance for ascertaining details in its case. The paper summarises the result of daily catching of the insects for three years, and it is concluded that (1) the females are always much more numerous than the males; (2) the proportion of males increases as the conditions of life become more difficult.—Notes on the freshwater fauna of India, No. 5, some animals found associated with *Spongilla carteri* in Calcutta: Dr. N. **Annandale.** Several animals have been observed to use the dead skeleton of the sponge as a shelter for themselves or for their eggs, while an Oligochæte worm (*Chaetogaster spongillae*, sp.nov.), two chironomid larvæ, a coleopterous larva, and a larva of the neuropterous genus Sisyra appear to have a more intimate connection with the living organism. The advantage of this connection is in some cases reciprocal.—The life-history of an aquatic weevil: Dr. N. **Annandale** and C. A. **Paiva.** A general account of the mode of life and metamorphosis of a weevil which feeds on and lays its eggs in the submerged parts of the water-plant Limnanthemum.—A new goby from fresh and brackish water in Lower Bengal: Dr. N. **Annandale.** An account of a minute fish of the genus Gobius, which appears to have escaped notice owing to its retention of juvenile characters.—Preliminary note on the rats of Calcutta: Dr. W. C. **Hossack.** The author shows that the subject of rats has become of practical importance owing to the part they play in the propagation of plague. He names and gives chief characters of the four varieties found in Calcutta. He shows that colour is very variable and not a trustworthy distinction, and gives a table of the principal measurements of the four varieties found.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part i. for 1906, contains the following memoirs communicated to the society:—

December 23, 1905.—The calculation of chemical equilibrium from thermal measurements: W. **Nernst.**—Determination of the velocity of propagation and absorption of earthquake waves which have traversed the antipoint of the original focus: G. **Angenheister.**—Comparison of the seismic diagrams, from Upsala and Göttingen, of earthquake waves which have encircled the globe: F. **Akerblom.**

January 13.—The equilibrium of the sun's atmosphere: W. **Schwarzschild.**

February 3.—The number and dimensions of the taste-buds in the circumvallate papillæ of man at various periods of life: F. **Heiderich.** The action of luminous rays upon living cells: E. **Hertel.**—Electric phenomena accompanying the disintegration of ammonium: A. **Coehn.** (March 3.—A second communication on the same subject.)

February 17. Researches from the Göttingen University Chemical Laboratory, xv.:—(1) The process of isomerisation in oximes; (2) isomeric forms of cyclodimethylhexylamine; (3) the simplest methene-hydrocarbons of the various ring-systems and their transformation into alicyclic aldehydes: O. **Wallach.**—Contributions to the theory of vortex-rings: J. **Weingarten.**

DIARY OF SOCIETIES.

THURSDAY, JUNE 7.

ROYAL SOCIETY, at 4.30.—On the Osmotic Pressures of some Concentrated Solutions: Earl of Berkeley and E. G. J. Hartley—On the Regeneration of Bone: Sir William MacEwen, F.R.S.—The Effects of Self-induction in an Iron Cylinder: Prof. E. Wilson.—An Account of the Pendulum Observations connecting Kew and Greenwich Observatories, made in 1903: Major G. P. Lenox-Conyngham.

ROYAL INSTITUTION, at 5.—Man and the Glacial Period: Prof. W. J. Sollas, F.R.S.

LINNEAN SOCIETY, at 8.—On Two New Species of Populus from Darjeeling: H. H. Haines.—Biscayan Plankton, part viii., The Cephalopoda: W. E. Hoyle.—Part ix., The Medusæ: E. T. Browne.

CHEMICAL SOCIETY, at 8.30.—Ammonium Selenate and the Question of Isodimorphism in the Alkali Series: A. E. H. Tutton.—An Improved Beckman Apparatus for Molecular Weight Determination: J. M. Sanders.—Resolution of Lactic Acid by Morphine: J. C. Irvine.—The Vapour Pressures of Binary Mixtures, part i., The Possible Types of Vapour-pressure Curves: A. Marshall.—Action of Sodium on αα-Dichlorpropylene: I. Smedley.—Thiocarbamide as a Solvent for Gold: J. Moir.—The Action of Sulphur Dioxide and Aluminium Chloride on Aromatic Compounds: S. Smiles and R. Le Rossignol.

FRIDAY, JUNE 8.

ROYAL INSTITUTION, at 9.—Studies on Charcoal and Liquid Air: Sir James Dewar, F.R.S.

PHYSICAL SOCIETY, at 8.—On the Solution of Problems in Diffraction by the Aid of Contour Integration: H. Davies.—The Effect of Radium in Facilitating the Visible Electric Discharge *in vacuo*: A. A. Campbell Swinton.—Mr. J. Goold's Experiments with a Vibrating Steel Plate, exhibited by Messrs. Newton and Co.—Fluid (liquid) resistance: Col. de Villamil.

ROYAL ASTRONOMICAL SOCIETY, at 5.—The New Reduction of the Meridian Observations of Groombridge: Lewis Boss.—On Mr. Cowell's Discussion of Ancient Eclipses of the Sun: Simon Newcomb.—The Physical Condition of Mars: R. Crawford.—*Promised Papers:* Results of Micrometer Measures of Double Stars made with the 28-inch Refractor in the Year 1905: Royal Observatory, Greenwich.—Errors of Jupiter from Photographic and Transit Circle Observations: Royal Observatory, Greenwich.—A Simple Method of obtaining an Approximate Solution of Kepler's Problem (an Instrument will be shown by which the Solution is Effected): A. A. Rambaut.—Solar Parallax Papers, No. 4; the Magnitude Equation in Meridian Circle Right Ascensions of the "Étoiles de Repère": A. R. Hinks.—Spherical Slide Rule: W. B. Blaikie.—Discussion on some of the Results of Observations of the Solar Eclipse of 1905 August 30.—Contributions are promised by Prof. H. H. Turner and Mr. H. F. Newall.—Mr. Newall promises a Paper, Notes on Polarisation Phenomena in the Solar Corona.

GEOLOGISTS' ASSOCIATION, at 8.—The Higher Zones of the Upper Chalk in the Western Part of the London Basin: H. J. Osborne White and Ll. Treacher.

MALACOLOGICAL SOCIETY, at 8.—Mollusca of the *Porcupine* Expeditions, 1869-70, Supplemental Notes, part iii.: E. R. Sykes.—Notes on the Dates of Publication of the "Mineral Conchology" and "Genera Rec. Foss. Shells": E. R. Sykes.—Description of *Oliva ispidula*, L., var. *longispira*: F. G. Bridgman.—On *Chloritis heteromphalus*: H. A. Pilsbry.

MONDAY, JUNE 11.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Geography of the Indian Ocean: J. Stanley Gardiner.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Recent Progress in the Cement Industry: Bertram Blount.—On Purifying and Stabilising Guncotton: Dr. R. Robertson.

INSTITUTE OF ACTUARIES, at 5.—Fifty-ninth Annual General Meeting.

TUESDAY, JUNE 12.

ANTHROPOLOGICAL INSTITUTE, at 8.15.—Two Years among the Akikuyu of British East Africa: W. Scoresby Routledge.

MINERALOGICAL SOCIETY, at 8.—On the Occurrence of Axinite in the Area South of Bodmin, in Cornwall: G. Barrow.—Cassiterite Pseudomorphs from Bolivia: R. Pearce.—Notes on Skiodromes and Isogyres: Dr. J. W. Evans.

WEDNESDAY, JUNE 13.

GEOLOGICAL SOCIETY, at 8.—Recumbent Folds produced as a Result of Flow: Prof. W. J. Sollas, F.R.S.—The Crag of Iceland—an Intercalation in the Basalt-Formation: Dr. Helgi Pjetursson.

VICTORIA INSTITUTE, at 4.—Wonders and Romance of Insect Life: Frederick Enock.

THURSDAY, JUNE 14.

ROYAL SOCIETY, at 4.30.—*Probable papers:* The Experimental Analysis of the Growth of Cancer: Dr. E. F. Bashford, J. A. Murray, and W. H. Bowen.—On the Electrical and Photographic Phenomena manifested by certain Substances that are commonly supposed to be Ætiologically Associated with Carcinoma: Dr. W. S. Lazarus-Barlow.—The Bone Marrow; a Cytological Study forming an Introduction to the Normal and Pathological Histology of the Tissue: Dr. W. E. Carnegie Dickson.—On the Relation of the Liver Cells to the Blood Vessels and Lymphatics: P. T. Herring and S. Simpson.—(1) Note on Lipase; (2) The Hydrolytic Action of Acids in Presence of Salts: Prof. H. E. Armstrong, F.R.S.

MATHEMATICAL SOCIETY, at 5.30.—Exhibition of Models of Space-filling Solids: W. Bailey.—The Algebra of Apolar Linear Complexes: Dr. H. F. Baker.

INSTITUTION OF MINING ENGINEERS, at 11 a.m.—Address by the President.—The Commercial Possibilities of Electric Winding for Main Shafts and Auxiliary Work: W. C. Mountain.—Electrically-driven Air-compressors, combined with the working of the Ingersoll-Sergeant Heading-machines, and the subsequent working of the Busty Seam: A. Thompson.—Practical Problems of Machine-mining: Sam Mavor.—The Strength of Brazed Joints in Steel Wires: Prof. Henry Louis.—Bye-product Coke and the Huessener Bye-product Coke Ovens: J. A. Roelofsen.—Considerations on Deep Mining: George Farmer.

FRIDAY, JUNE 15.

INSTITUTION OF MINING ENGINEERS, at 10.30 a.m.—Rescue Apparatus and the Experience made therewith at the Courrières Collieries by the German Rescue Party: G. A. Meyer.—A New Apparatus for Rescue-work in Mines: W. E. Garforth.—A Rateau Exhaust-steam-driven Three-phase Haulage Plant: William Maurice.—Development of Placer Gold-mining in the Klondike District, Canada: J. B. Tyrrell.—Mining Education: Prof. J. W. Gregory.—The Capacity-current and its Effect on Leakage Indications on Three-phase Electrical Power-service: Sydney F. Walker.—Petroleum Occurrences in the Orange River Colony: A. R. Sawyer.

NATIONAL ASSOCIATION FOR THE PROMOTION OF TECHNICAL AND SECONDARY EDUCATION, at 3.—Annual General Meeting.

CONTENTS.

PAGE

THURSDAY, JUNE 14, 1906.

THE RESPIRATORY SYSTEM OF VERTEBRATES.

Lehrbuch der vergleichenden mikroskopischen Anatomie der Wirbeltiere. Edited by Dr. Albert Oppel. Part v., Parietal Organ. By Dr. F. K. Studnička. Pp. vi+254. Price 8 marks. Part vi., Atmungsapparat. By Dr. Albert Oppel. Pp. x+824. (Jena: Gustav Fischer, 1905.) Price 24 marks.

If any interruption should overtake the present rapid growth of scientific knowledge it will not be in the acquisition of new facts that the breakdown will occur, but in the systematisation of facts already acquired by present and past generations of workers. The task of systematisation, so necessary for further progress, is in the hands of the writers of text-books, but, unfortunately, the fate which presides over that world wherein men of science live and move has ordained that the financial success of a text-book is in inverse proportion to its scientific value. The general student can command with ease both author and publisher, but the specialists, for whom a text-book is a first necessity, find it almost impossible to obtain either author or publisher. It is the good fortune of those specialists who are actively investigating the finer structure of the vertebrate body to find that, thanks to the untiring industry of Prof. Oppel and the enterprise of Herr Gustav Fischer, the text-book they so much needed has now been provided for them. In bringing to a conclusion the sixth part or volume of this great task, Prof. Oppel modestly consoles himself with the hope that the work, to which he has devoted twelve years of his life without reward or fee, may prove of use to others. It is in no niggardly spirit that we in England must acknowledge the service he has rendered us.

Within the sixth volume Prof. Oppel has compressed the results of two centuries of inquiry into the minute structure of the breathing organs of vertebrate animals. The facts are drawn from more than 900 separate publications as well as from his own researches, and deal with the respiratory system of more than 500 species of vertebrate animals. A close examination of the great mass of evidence which has been thus brought together leaves one convinced that, however unlike they may seem, the gill of the fish and the lung of the mammal serve not only the same functional purpose, but are, indeed, but modifications of the self-same organ. It is now clear that in the evolution of the vertebrates there has been no development of a completely new organ of respiration. By a process which we understand but imperfectly at present, the same organ has been modified to serve the same purpose in fishes, amphibians, reptiles, birds, and mammals. The embryological investigations into the origin of the lungs of the frog by Goette, of the fowl by Kastschenko, of the human embryo by Fol, and the later researches of Weber and Buvignier, leave no room to doubt the truth of that generalisation.

Perhaps no two structures have engaged the speculative fancy of naturalists so much as the swim-bladder of fishes and the air-sacs of birds. As to the first, it cannot be said that the great number of observations which Prof. Oppel has succeeded in massing in his pages takes us perceptibly nearer a conception of the true nature and origin of the swim-bladder and its relationship to the vertebrate lung than were the naturalists of fifty years ago. A theory which regards it simply as a hydrostatic organ for permitting a fish to accommodate itself to any depth of water gives only a very incomplete explanation of its presence and structure. On the other hand, the nature of the air-sacs of birds is now almost completely understood. When the facts grouped together by Prof. Oppel are considered it becomes evident that in the vertebrate lung, be it of a frog, of a lizard, of a bird, or of a mammal, there are three distinct parts which differ in structure and in function. In no vertebrate form have these three parts become so highly specialised and distinctly separated as in birds. The three parts are:—(1) a vascular membrane covered by peculiar epithelium and puckered so as to form alveoli (the respiratory part); (2) an elastic chamber or series of chambers, capable of being enlarged and diminished on inspiration and expiration (the bellows part); (3) a series of non-collapsible tubes for conveying the air to and from the air chambers (the conducting part). In the avian lung the bellows part has become completely separated from the respiratory portion, and forms the air-sacs. Intermediate stages in the process of separation are to be seen in the lungs of reptiles. In the mammalian lung the bellows part is broken up into a series of small chambers throughout the whole organ, which form what we in England have been in the habit of calling infundibula, but which, in the more elaborate terminology of Dr. W. S. Miller, are now demarcated into vestibule, atrium, and air-sac.

The progress of our knowledge of the minute structure of the mammalian lung has been peculiarly slow. In part this has been due to the elaborate nomenclature employed. The same term has been used to designate totally different parts, and the same part has been called by several different names. Prof. Oppel has done us a great service in coordinating the terminology used by different investigators. It is clear from the manner in which Prof. Oppel discusses the question as to the nature of the epithelial covering of the gills that he finds it difficult to break away from the tradition which has come down to us from the older embryologists—that there is a profound morphological distinction between the ectodermal and endodermal layers of the embryo. From the minute manner in which he relates the matter it is evident that he quite enjoyed the prolonged scholastic discussion which was first raised by Aeby—as to whether the branching of the bronchial tree was by a process of dichotomy or monopody.

The fifth volume, which deals with our knowledge of the pineal body, and the pineal eye or parietal organ, was entrusted by Prof. Oppel to the safe hands of Dr. F. K. Studnička. That authority has not only coordinated the results contained in some three hundred papers dealing with this structure, but has added much new and valuable work of his own.

The study of structure by itself and for itself is a most unprofitable occupation, and Prof. Oppel, by including a free reference to function and development, has not only added greatly to the interest, but also to the value of these two volumes.

A. K.

A TEXT-BOOK OF GENETICS.

Vorlesungen uber Deszendenztheorien mit besonderer Berücksichtigung der Botanischen Seite der Frage gehalten an der Reichsuniversität zu Leiden. By Dr. J. P. Lotsy. Erster Teil. Pp. xii+384. (Jena: Gustav Fischer, 1906.) Price 8 marks.

AS the moment is favourable, may it be suggested that the branch of science the rapid growth of which forms the occasion of Prof. Lotsy's book should now receive a distinctive name? Studies in "Experimental Evolution" or in the "Theory of Descent," strike a wrong note; for, theory apart, the physiology of heredity and variation is a definite branch of science, and if we knew nothing of evolution that science would still exist. To avoid further periphrasis, then, let us say genetics.

Prof. Lotsy's lectures are a welcome contribution to genetics. They are expository and critical rather than creative, but there is plenty of room for such a work. Since it must be admitted that to most of us facts appeal "first when we see them painted," such a presentation as this book provides should attract many who would find little to detain them in original records.

There are twenty lectures in this first part, and a second part is promised. After a philosophical introduction, which must be left to the judgment of those versed in such matters, the author proceeds to a careful discussion of the evidence for direct adaptation. Though no Lamarckian in the usual sense, he has a high respect for Lamarck's penetration and breadth of view. In this revindication of a great name, naturalists of the younger generation who have studied Lamarck's writings at first hand will probably sympathise with Prof. Lotsy. In a limited sense the modification produced by environment—biaiometamorphosis, as Prof. Lotsy calls it—is important. No botanist doubts that the forms of plants can be profoundly changed by the conditions to which they are exposed. The normal or habitual form in which we know a species is only one of these modifications. Consequently each experimental proof of the dependence of form on environment has a direct bearing on the genesis of type. But the question of *purposeful* or adaptative modification is quite distinct, and of any transmission of purposeful modification in descent there is no evidence.

The section of the book which gives it its chief value is that in which an account is provided of the new developments in genetics, especially Mendelian analysis and the experiments of de Vries. The consequences of Mendelian segregation are described with great clearness, and are illustrated by some excellent diagrams, of which one (p. 101) is striking and novel. The members of the various generations are shown in a perspective view, drawn approximately to scale, in a way which should do something to remove the supposed obscurity of these phenomena. Both the description of the facts and the critical discussion of the bearing of Mendel's discovery on the earlier or Galtonian method of calculating inheritance are especially lucid and to the point.

The weaker features of this section are such as are almost inevitable in attempts to confine a rapidly growing study within text-book limits. The relative importance of the various elements is continually changing. For example, though due stress is laid on Tschermak's fine series of cases illustrating the influence of hidden factors, or cryptomeres, Cuénot's useful exposition of the part played by double factors in the case of mice seems to have been left out. Having regard to the remarkable developments which have followed, this omission is unlucky. In the same connection it is a matter of special regret to myself that the revised and simplified account of the "walnut" combs in fowls did not reach Prof. Lotsy in time to prevent a reproduction of my former and erroneous idea in his text-book.

By all who are working at genetics the discussion of de Vries' mutations will be read with interest. Till now those remarkable observations have been regarded either with indiscriminate enthusiasm, or with still more unreasoning suspicion. But on those who know that the mutations of Œnothera are not errors of observation, and hesitate to accept them as the single key to the final mysteries of evolution, the question begins to press: What *are* those mutations? Upon this point the teaching of genetic research is clear. Before we can form a definite view as to the nature of any given mutation we must know its gametic relations to the type from which it sprang, and to the sister-mutations. So far, these relations, as expressed by the ratios in which the forms appear, seem to be almost always irregular in the Œnothera cases. Experience, however, has shown that such irregularities, as in the case of Miss Saunders' *Matthiola*, may conceal an underlying regularity which fuller analysis can reveal. For instance, we know that various individuals of a form A may give respectively an F_2 ratio 9A : 7B; or 3A : 1B; or all A; or 27A, 9C, 28B, and so on, and the causation or meaning of these several ratios is clear. May not such complexities be the source of the confusion which apparently besets the Œnothera cases? That is the opinion to which Prof. Lotsy inclines, and the position is for the most part unassailable as yet. All that can be positively asserted is that these mutations are forms arising discontinuously, and that their distinctions are exactly comparable with those that often appear to characterise species. But now that we understand what a medley of phenomena is included in the term "specific difference" it becomes necessary to go further and to ascertain which phenomenon is exemplified in each case. That genetic analysis can alone answer that question everyone now perceives. De Vries' own discussion of his results contains manifest traces of an attempt to incorporate the Mendelian ideas into earlier and pre-Mendelian conceptions, and the result is not always harmonious or convincing. We look to de Vries and the many observers who are now at work on Œnothera to bring the various possibilities to a strict test, case by case, and so complete what has been begun with such astonishing success.

Meanwhile, however, it must be conceded that there are serious difficulties in the way of a purely Mendelian account of the Œnotheras—more perhaps than Prof. Lotsy indicates. Of these one of the most formidable is the behaviour of the form *nanella*, for which other cases afford no parallel. There are, further, the objections de Vries himself has urged in the passages contributed to Moll's exposition of his work—particularly, that no indication of a hybrid origin of his original stock is forthcoming. Again, though the sterile pollen grains are suspicious, I may mention that in a collection of wild Œnotheras (? species) made near Baltimore, I found none which had not some bad pollen grains. Were all these hybrids? it may well be asked. If so, hybrids of what? Our Rubi hybridise freely, but, as Focke showed, there are pure forms with perfect pollen, and hybrid forms with an admixture of bad grains. This test should be made in America on a large scale, to discover whether any Œnothera is "pure" by that criterion.

But again, we know that the production of analytical varieties by a hybrid, and the production of novel forms by a mutating species, must be exceedingly similar and perhaps indistinguishable phenomena. Hybridisation cannot be regarded as the sole source of analytical variation—witness the case of *Primula sinensis* and the sweet pea, where analytical variation is rife, though no hybridisation has taken place. The interrelationship of the two sets of occurrences is still obscure; but by experimental breeding it can in great measure be elucidated, and in the course of that inquiry the meaning of mutation will probably be discovered.

Only salient features of the book have been mentioned; many others must be passed over. *Capsella* has provided (p. 180), as might be expected, good examples of the constancy of *petites espèces*. Time brings revenges, and we must hope that Jordan would have felt satisfaction in the recognition now accorded to his once discredited work, though, by the perversity of things, that work is used to complete and support those views he most detested. Strange, too, would it seem to his opponents to see Jordan's microspecies received as a valuable element in the general doctrine of mutability!

In several minor points the book is open to criticism. The Artemia-Branchipus story should not be repeated even incidentally without words of caution. The pictures even in these half-tone days are below the mark, and such pictures as those of peloric Linaria make one long for decent woodcuts again. The figure of the Norwich canary would surprise the fanciers of that city, and it suggests that the crest is a Norwich character. Lastly there is a profusion of most distracting misprints.

W. BATESON.

TEXT-BOOKS OF PHYSICS.

(1) *Muller-Pouillets Lehrbuch der Physik und Meteorologie.* Edited by Leopold Pfaundler. Tenth edition. First vol. (in two parts). Pp. xiv+801. Illustrations. (Brunswick: F. Vieweg und Sohn, 1905 and 1906.) Price 7 marks and 3 marks 50.

(2) *Cours de Physique de l'École Polytechnique.* By J. Jamin. Troisième supplément. Radiations, Électricité, Ionisation. E. Bouty. Pp. vi+420. (Paris: Gauthier-Villars, 1906.) Price 8 francs.

(3) *Lehrbuch der Physik.* By H. A. Lorentz. Translated into German by G. Siebert. Erster Band. Pp. vi+482. (Leipzig: Johann A. Barth, 1906.) Price 8 marks.

(1) THE preparation of this tenth edition of a well-known text-book has been undertaken by Dr. Pfaundler, in succession to Dr. Wild, whose death occurred soon after the publishers had put the revision in hand. For the present instalment on mechanics and acoustics Dr. Pfaundler is responsible; but for other parts of the four volumes in which the work will be completed the co-operation has been secured of Dr. Lummer (optics and heat), Dr. Kaufmann (magnetism and electricity), Prof. J. M. Pernter (meteorology), Dr. Nippoldt (terrestrial magnetism), Dr. Drucker (physical chemistry), and Dr. Wassmuth (heat conductivity and thermodynamics).

It is intended to maintain the characteristics of the book as being essentially non-mathematical. This plan, of course, very much restricts the treatment of most of the problems dealt with, and in many cases prevents any proof being given of formulæ which are discussed. There is room, however, for a text-book of this kind, as is amply testified by the success of the previous editions. In spite of the limitation in the treatment, the author has succeeded in giving a very comprehensive account of his subject. He is very clear, and takes special pains to be so in cases where difficulties are commonly met with. For example, in connection with *mass* and *weight* he is very precise. The kilogram is a mass, and not a weight; one can only say *it has a weight*, and can call this the kilogram-weight. In stating this he is in agreement with the International Committee of Weights and Measures (Paris, 1901), whose decisions may be considered as representing the common-sense of the scientific world.

The intention is to bring out the remaining volumes quickly. It is expressly hoped that owing to the large number of collaborators, the treatise may be completed before the first volume is out of date.

(2) The second of the volumes under notice is the third supplement to the treatise on physics, commonly known as "Jamin et Bouty." The subject-matters embraced are radiations, électricité, ionisation. It is

more than six years since the second supplement appeared, and in the interval the study of the kathode stream, the phenomena of radio-activity, and in general of everything concerned with the propagation of electricity in gases has given rise to a new conception of electrical conductivity, and of the ultimate constitution of what were once called the "electrical fluids." The faith of scientific men in the non-transmutability of matter has been shaken; even the notion of material mass tends to be absorbed in that of electromagnetic inertia.

This is the state of things as set forth in the preface to this supplement; no surprise need be felt, then, at its large size compared with that of the preceding numbers. The portion dealing with radiations includes amongst other things an account of recent work on the energy of a block body, the pressure of radiation, the laws of dispersion (normal and anomalous), remainder rays, and N-rays. In regard to the last-named subject, we have no wish to be dogmatic; there is certainly some evidence that M. Blondlot has been experimenting with objective, and not entirely with subjective, phenomena, and if this is so, experiments should not cease until the *exact* nature of these phenomena has been established. But when M. Bouty devotes nearly two pages to this subject, and does not even hint that there is doubt, amounting to disbelief, in the minds of most of the leading physicists of the world in regard to this matter, we think that he is hardly doing justice to it.

In electricity, leading sections deal with wireless telegraphy, polyphase currents, the ionic theory, and the work of Nernst. Under the head of ionisation are taken the phenomena of ionisation in gases and radio-activity. The volume concludes with some miscellaneous practical applications of electricity.

Any who are familiar with the main treatise and the previous appendices will know that M. Bouty is a master of lucid exposition; there is no need to commend this volume to them. Those who are desirous of learning, in brief but clear summary, the present state of knowledge in regard to the above supremely important subjects may be recommended to read this appendix.

(3) The third of the above books is the first volume of a course of elementary physics based on lectures delivered to classes consisting largely of medical students. As the reader is assumed to be attending experimental lectures and, if possible, performing experimental work himself in a laboratory, small space is given here to descriptions of experiments and of methods of observation.

The subjects dealt with are mechanics, and the properties of bodies in the solid, liquid, and gaseous states. The sixth chapter consists of thermodynamical considerations in respect to gases. This chapter is undoubtedly very lucid, but we think that its proper place is later on—after calorimetry. The mathematics employed is simple, and the treatment very clear. The name of the author is, of course, a sufficient guarantee of the nature of the book. We look forward to seeing the German translation of the remainder.

REDUCTION OF GEODETIC MEASURES.

The Adjustment of Observations by the Method of Least Squares, with Applications to Geodetic Work. By T. W. Wright, with the cooperation of J. F. Hayford. Second edition. (New York: D. Van Nostrand Co.; London: A. Constable and Co., Ltd., 1906.) Price 3 dollars net, or 12*s*. 6*d*. net.

THIS is a book which in its original form grew out of the experience and requirements of the U.S. Coast and Geodetic Survey. As points of novelty or difficulty arose in the course of the work and were solved by the staff, Mr. Wright collected the decisions and the methods as guides for the treatment of similar cases in the future. The systematic arrangement of these cases, and the discussion of the principles which furnished the solution, provided a mass of materia which has been of great service to the department An opportunity has now arisen for the revision o, this work, and in the belief that the information would be of advantage in many operations connected with scientific engineering, the original author, in collaboration with Mr. J. F. Hayford, chief of the computing division and inspector of geodetic work, has given to this material the form of a treatise.

The book is eminently practical. The authors do not enter into the question whether the principle of least squares suggests the best or the only method for deriving from a mass of imperfect data a result that will command general confidence. They recognise the fact that the method has secured an impregnable place in all inquiries to which it is applicable, and proceed at once to discuss the law of error on the ordinary Gauss-Chauvenet lines. The subject necessarily does not lend itself to any novelty of treatment. The value of the earlier chapters at least lies in the fact that the authors place before us the results of a wide and profound experience. Everywhere they keep in sight the practical treatment, insisting on the importance of arithmetical checks and processes of abbreviation. In this connection one is glad to see Doolittle's system of solution set out in a complete scheme, as well as other processes which have a practical application.

The question of the rejection of discordant observations will always occasion a computer some anxiety The authors have evidently suffered, and the practical rule given here may not be generally accepted, but is valuable as showing, presumably, what is the practice in the U.S. Geodetic Survey. The authors advise that no observation should be retained for which the residual exceeds five times the probable error of a single observation, and that all observations the residuals of which exceed three and a half times the probable error of a single observation should be examined, and rejected, if any of the conditions under which the observation was made were such as to produce any lack of confidence. The conviction is also expressed that an observer's best observations are poorer than he believes them to be, and his poorest better. As a consequence of this the range of weights that observers attach to their observations is too large.

Actual geodetic measures necessarily introduce the problem of conditioned observations, in which no set of values can be assumed to satisfy approximately the observation equations which does not exactly satisfy some *a priori* conditions. This problem may not necessitate any fresh method of treatment, but the applications are somewhat unusual, and, again, it is of very great importance to know what is done in actual practice. The authors have given us a valuable treatise, prepared with care, and generally free from errors. There is some confusion in the numbering of the figures after p. 193, but this, if annoying, is of less importance than any error in the formulæ.

W. E. P.

OUR BOOK SHELF.

Modern Milling Machines. By Joseph G. Horner. Pp. ix+304. (London: Crosby Lockwood and Son, 1906.) 12*s.* 6*d.* net.

A MODERN machine shop in any large works would be very incomplete indeed without a full complement of milling machines. The proportion of this class of machinery very largely depends upon the class of work dealt with. For instance, in a sewing-machine, cycle, or motor-car factory the milling machine would predominate, being in many specialised forms, each machine designed for some particular function. On the other hand, in a general engineering establishment any milling machines installed would be of the universal type, and capable of dealing with many different operations, such as the universal machines made by Brown and Sharpe, of U.S.A., and many others.

It is only during recent years that milling machinery has come prominently to the front, principally due to the fact that designers of such machines have grasped the fact that they must be made of ample weight with large bearing and wearing surfaces, so as to ensure steady running without spring of the machine and consequent vibration. Another very important consideration is the possibility of obtaining suitable material for the cutters used. The cost of making a milling cutter is infinitely more than the value of the cast steel used. It is evident, therefore, that when once completed the cutter should have a long life. This desideratum has been rendered possible by the introduction of high-speed tool steel, the results obtained being of a most satisfactory nature, particularly those from the "Air-hardened" steel manufactured by Edgar Allen and Co., of Sheffield. The cost of the material, therefore, is a secondary consideration.

In the volume under notice the author describes very fully many different types of machines, and probably one of the best chapters is that dealing with the design and manufacture of the cutters. The power required very largely depends on the design of cutter used, other things being equal; to use a cutter in any degree dull is also poor economy.

Another valuable assistant to the milling machine and its cutters is the introduction of special cutter grinding machines, which, I believe, emanated from the Brown and Sharpe Manufacturing Company. Many of these machines are described and illustrated, the author having gone very fully into the subject. This is as it should be, since a good cutter is of the utmost importance in milling work.

Chapter xi. is too short, though very interesting; it deals with the subject of feeds and speeds. On these constant worries of a machine-shop manager our author has much to say, and sensible advice to give, and we cordially agree with him where he points out how easy it is to get wonderful results by means of a sharp tool running for short periods by comparison with work done under ordinary shop conditions. Such work, as a rule, does not pay.

We can recommend this volume to all interested in machine-shop practice. The machines dealt with are of the latest type, and much useful information will be found scattered through its pages.

N. J. L.

Lectures on the Method of Science. Edited by T. B. Strong, Dean of Christ Church. Pp. viii+249. (Oxford: Clarendon Press, 1906.) Price 7*s.* 6*d.* net.

THESE lectures formed part of a course on scientific method delivered at the University Extension summer meeting at Oxford last August. The discourses are intended to illustrate the forms taken by scientific method in various departments of research. Prof. Case deals with scientific method as a mental operation; Prof. Francis Gotch, F.R.S., treats of various aspects of the method; Prof. C. S. Sherrington, F.R.S., describes the scope and method of physiology; the lecture by the late Prof. Weldon discusses inheritance in animals and plants; Dr. W. McDougall explains the psychophysical method; Dr. A. H. Fison applies the method to the question of double stars, Sir Richard Temple to the evolution of currency and coinage, Prof. W. M. Flinders Petrie, F.R.S., to archæological evidence, and the Rev. Dr. Strong to history.

From the nature of the case, the arguments are such as to appeal to persons of general culture rather than to specialists. If Oxford were as energetic in the prosecution of scientific research as she is in popularising knowledge by means of extension lectures, men of science would probably be disposed to think her activities better and more suitably directed. The omission of an index can never be justified in the case of a scientific book, but that a work devoted to scientific method should be deficient in this respect is an irony which cannot be overlooked.

The Secrets of Dog-Feeding. By "Great Dane." Pp. ix+58. (Southampton: Toogood and Sons, 1906.)

THE mere fact that this little work has reached its second edition within less than a year of the date of its first appearance may be taken as a sufficient guarantee that it has obtained the verdict of approval from dog-owners, and is therefore a success. The author is of opinion that the nature of the food is a matter of prime importance in the case of valuable, highly-bred dogs, and one which too often receives but insufficient attention on the part of their masters. While advocating a mixed diet, he deprecates the use of green vegetables, which has of late years come much into fashion among many dog-owners; and he adds that to a dog which has been kept largely upon farinaceous food the change to a meat diet in later years will often produce highly satisfactory results. The constituents of nearly all the foods referred to are given, so that readers can judge for themselves as to their nutritious value.

R. L.

In My Garden. A Little Summer Book for Nature Lovers. Pp. 72. (Wellingborough: The Lavender Press; London: Philip and Tacey, Ltd., 1906.) Price 1*s.* net.

THIS dainty little memorandum book, with its blank pages for notes on experiments in gardening and other observations of natural objects, will please all students of country life. The well-selected quotations and the hints on table decoration should appeal to a wide circle of readers.

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.*]

Inheritance of an Abnormality.

A CASE of the heredity of an abnormality of the hand may be of interest to some of your readers.

A father and a mother with normal hands had a family of three sons and seven daughters. The eldest son had an abnormality of each hand, the second and third fingers being apparently jointed to the same bone, and the third daughter has a different abnormality, both hands being affected. The accompanying skiagram, kindly taken for me by Mr. J. J. Blake, of Onslow Road, Richmond, will show the character of this abnormality. All the remaining children had normal hands.

FIG. 1.—Abnormal hand of third daughter.

The eldest son had two children without abnormalities, and the second son three children that were normal. The eldest daughter had one son and two daughters normal; the son has two normal children, the first daughter one child abnormal, and the second daughter two children normal.

Returning to the third daughter with the abnormal hands, all her eight children are normal; the fourth daughter has two normal children; the fifth daughter has two children abnormal and five normal; the sixth has three normal, and the seventh five normal children.

There is no tradition of abnormalities in any of the relations of the father or mother. It may be mentioned that the husbands of the eldest and fifth daughters, some of whose descendants are abnormal, are first cousins (not first cousins of their wives).

The following scheme may make the relationship more clear (N signifies normal; A, abnormal; and *c*, children):—

Father and Mother, both N.

Sons			Daughters						
1 A.	2	3	1	2	3 A.	4	5	6	7
2*c*. N.	3*c*. N.		son, 1*, 2*		8*c*. N.	2*c*. N.	2*c*. A. 5*c*. N.	3*c*. N.	5*c*. N.
			2*c*. N., 1*c*. A., 2*c*. N.						

* Daughters.

May 30. HERBERT MCLEOD.

Thermometer Scales.

A DECIDED disadvantage of the centigrade scale in meteorology is the use of negative numbers for temperatures below freezing point. In taking out means of months where negative numbers occur the labour is doubled, and other additional sources of error have to be avoided.

The Fahrenheit scale is not so liable to this trouble, but there are other objections to its use. Both of these scales might be superseded by a scale starting from absolute zero, on which the temperature of melting ice is 350°. Such a scale is compared in the following table:—

	° C.	° F.	° Positive
Absolute zero	−273 ...	−459 ...	0
Mercury melts	− 39 ...	− 38 ...	300
Ice melts	+ 0 ...	+ 32 ...	350
Very hot weather ...	+ 39 ...	+102 ...	400
Water boils	+100 ...	+212 ...	478

The great advantage of this positive scale in meteorology is that temperatures, except the most unusual, fall between 300° and 400°, so that temperature columns might be headed "300° plus." On this scale water, under a pressure of 31·3 inches, boils at 480°, so that the most important temperatures in physics are easy to remember.

R. T. A. INNES.

Government Observatory, Johannesburg, May 12.

Solar and Lunar Halos.

AN interesting halo round the sun was seen a few miles from here, on Dartmoor, from 7.30 p.m. to sunset on June 7. The halo consisted of a double circle, the inner one having an angular radius of about fifteen to twenty degrees, with concentrations of light at the top and at the right extremity—the bottom of the ring was below the horizon, and the left extremity hidden by clouds—and a concentrated ray from the sun to the top of the circle. The outer circle was double the diameter of the inner one, and much fainter. A similar halo round the moon (with the exception of the outer circle) was observed the same evening. ROWLAND A. EARP.

The Laboratory, Buckfastleigh, Devon, June 12.

THE ROYAL SOCIETY OF EDINBURGH AND THE GOVERNMENT.

THE great deputation on behalf of the Royal Society of Edinburgh, which waited on the Secretary for Scotland at the Scottish Office in Parliament Square in Edinburgh on June 1, stated a strong case in favour of more liberal treatment of the society by the Government. As one speaker expressed it, they were met there on Scottish soil, indeed at the very heart of the ancient metropolis of the kingdom of Scotland, to confer with their own Secretary of State, and to urge the claim of a society which has been identified with scientific progress in Scotland during the nineteenth century to remain in its old home, and receive some small assistance in producing its Transactions and Proceedings. It must be admitted that this appeal met with only a very disappointing response.

The Royal Society was the heir and successor of a previous society which was established in 1731, and therefore has been practically contemporary with the great scientific illumination which had its beginning in Newton's "Principia." After an existence of about half a century the society was established, in 1826, in the Royal Institution on the Mound in Princes Street, the building in the form of a classic Greek temple, which with the unfinished national monument on the Calton Hill—the Edinburgh Parthenon—and some other public buildings on classic models, affords the outward and visible part of the claim of Edinburgh to be called the Modern Athens. Of the real distinction of the city, its eminence in the arts, science, and letters, the Royal Society has undoubtedly contributed a very considerable part. Never a scientific society only in the purely technical sense of the present day, and never imposing any arbitrary restriction on its fellowship, it has had on its roll and among its presidents and office bearers all the authors, jurists, philosophers, mathematicians, and physical investigators whom Scotland has produced during the eventful period of the society's existence.

Though, like others that might be cited, the Royal Society of Edinburgh has been from time to time perhaps a little too closely identified with the city in which it has had its headquarters, it has always been a national institution. Its library, which is rich in scientific periodicals, has been consulted by men from all parts of Scotland, and its rooms have been a rallying place for Scottish workers, especially in later years for the younger generation of biologists, mathematicians, and physicists. It was never more active than at present, and is in danger of being ruined by its very success, for the problem of providing for the expense of the publication of the many excellent memoirs which have been received of late for its Transactions has seriously embarrassed the council. This point should be carefully borne in mind in considering the reply of the Scottish Secretary to the deputation. The demand made was not merely that the society should not be dispossessed of its rooms without full compensation (though this was the immediate reason for the deputation), but that it should be treated with regard to publications in a small degree at least as the Royal Society of London and the Royal Irish Academy are treated.

As was explained in our last week's issue, the proposal of the Government is to provide the Royal Scottish Academy with a separate house in which, like the Royal Academy at Burlington House, it may annually exhibit its pictures and sculpture to the general public, and—incidentally, of course—to the patrons of Art. Hitherto this Academy has shared the rooms provided for artistic purposes in the National Gallery building also on the Mound; and competent judges, even within the Academy itself, have deemed the provision sufficient. Some of their chief men have even dared to suggest that what was wanted was not so much an extension of space as an elevation of the standard of selection! Nevertheless, the bitter cry of the artists for some time has been for a house of their own; and this the Government has now determined to provide, not by erecting a suitable new building from public funds, but by the cheaper method of evicting the Royal Society of Edinburgh from the rooms which were arranged for it in a building erected mainly for its accommodation. When the decision was announced to the Royal Society it was accompanied by a statement of the willingness of the Government to do something to "help" the Society in the difficulty thus created for it by no fault of its own. Though Mr. Sinclair has now gone a good deal further, and admitted that the Government will be under an obligation to do something substantial, he still merely speaks of "help," and urges the Society to trust to the "liberal spirit" in which the Government is sure to view its necessities!

Now this is all very well, but, as Mr. Sinclair knows, it is not exactly business. The Government of the day has always been lavish of assurances of its high consideration to the men of science who have applied to it in the past, whether for the Royal Society of Edinburgh, the Ben Nevis Observatory, or anything else, but for science in Scotland at least it has consistently refused to do anything whatever beyond continuing the small dole it has hitherto given. The society is not justified, therefore, in being too trustful. It is being dispossessed, and its claim for compensation should either be recognised by a clause in the Bill now before Parliament or acknowledged by being made the subject of a definite pledge by the responsible Minister.

Another assurance asked for by the society and no less essential remains to be given. Time is needed in which to find the best possible premises, to fit them up, remove the library, and arrange for the meetings, without interruption of the society's work. At present the council has only a legal right to two years' notice, and a definite promise that this much too narrow limit of time will not be insisted on is most important. As it is, the insistence of the Scottish Secretary on the necessity for promptitude of decision and action by the society is ominous.

With regard to the promise of "help" towards the erection, or provision otherwise, of new rooms, it is to be observed that the society has no funds to contribute to the erection or purchase of a building. Every penny left after providing for a very modest budget of ordinary expenses goes to the publication of scientific papers. The dole of 300*l.* made by Government is actually paid back to the Board of Manufactures as rent for the rooms in the Royal Institution. For publications the Royal Society of Edinburgh receives nothing; the Royal Society of London receives 1000*l.* per annum for publications; the corresponding body in Ireland—the Royal Irish Academy—lives in its own house, which was given it by the Government, and enjoys a grant of 1500*l.* a year. [Moreover, the houses in London and Dublin are maintained by the Board of Works, which means a further yearly contribution not made to the Edinburgh society.] The request of the deputation that some small annual grant should be made for publications was ignored in the Secretary's answer. That answer, it is to be observed, was written out beforehand, and read as soon as Prof. Chrystal had summed up for the Society, so that even the usual form of taking the representations made into consideration was omitted. In fact, except as regards the admission of the claim of the society to some compensation for disturbance, the statements and claims of the deputation went the way of most representations made to Scottish Secretaries, whether at home at Parliament Square or on the alien soil of Dover House.

The British Science Guild has not been established too soon. The Government and Mr. Sinclair may have as generous intentions as the friends of the artists in the Edinburgh Press urge the Royal Society to believe—and we may say that nobody doubts that the intentions of both are good—but it will be the duty of the council to obtain the necessary guarantees for the continued usefulness, if not for the existence, of the society. If necessary the British Science Guild will no doubt lend its powerful aid.

ARCHÆOLOGY IN THE ISLE OF MAN.[1]

THESE notes form a useful handbook to the geology and antiquities of the Isle of Man, and those responsible for persuading the authors to reprint and amplify their scattered notices have conferred a benefit on the public. Although the little volume runs to little more than 100 pages, it includes a good survey of both branches of the subject, and emphasises the interest of the island in the two aspects of its remoteness in some respects from its neighbours and as a meeting place of the arts of the Celt and the Northman. The evidences of man's presence in the island naturally begin with the Neolithic period, the climatic conditions of the Pleistocene age effectually preventing him from reaching so far north; but from Neolithic times onwards the story of the island can be traced by its archæology. Flint appears only to exist in the form of nodules washed from the Boulder-clay, and the "factories" of flint implements are always on actual deposits of Boulder-clay. Some of the implements figured are, as the authors admit, of very rude make, as well as of very curious types (Fig. 4).

It is perhaps hardly surprising that signs of dwellings are not found near these Neolithic "floors" or factories. Stone-age man, here as elsewhere, chose his dwelling for reasons of security or shelter from the weather rather than from the proximity of a good store of flint nodules. Dwellings in the form of hut circles have, however, been found in fair numbers, and though it is by no means improbable that they date from Neolithic times, the authors are justly cautious in dogmatising on their age. No type of exploration is more difficult than that presented by the ordinary hut circle, and often the principal evidence is that of analogy. Such remains, moreover, share with stone circles the danger of having been disturbed by treasure seekers, with the result that stratigraphical deductions cease to be of value. It cannot be too often insisted upon that the class of exploration that produces the fewest objects of intrinsic value, viz. those of prehistoric times, should be excavated with most care and attention to detail. The reason is a simple one. The elucidation of the problems of early man depends solely upon such explorations, for no other documents can possibly exist to help in the solution of the puzzle. In later historic times the helps to knowledge are endless. Both Mr. Kermode and Dr. Herdman clearly recognise the importance of careful work, but, like most students of the earlier periods, they will doubtless admit the need of this warning to the unwary or careless explorer.

Apart from the interest to those who study the Manks antiquities as part of the general archæological scheme, this little book can scarcely fail to have a good effect in the island itself. It is to be hoped that all the relics that may come to light in future will be deposited in Castle Rushen, where they will be available for comparison and study. It is sad to read of such things going astray when a little tact or trouble might have preserved them.

[1] "Illustrated Notes on Manks Antiquities." By P. M. C. Kermode and W. A. Herdman. Pp. 108. (Liverpool: Tinling and Co., Ltd., 1904.)

The Bronze age in the Isle of Man was evidently a time of considerable communication with the mainland. The types of urns, as well as the fact that all the stone axes are of foreign material, show that trade must have been fairly brisk. The urn shown in Fig. 23 is, for instance, nearly related to the Scottish urns of the same time. This fact has, of course, an important bearing on the relative date of this and other periods when such communication existed. If the same types of funeral furniture are found here as on the mainland, it not only shows intercommunication, but also, as a necessary consequence, proves the contemporary existence of the same burial customs in the two places. Thus although it may well be that the remoteness of the island prevented its inhabitants from being quite as advanced as the continental dwellers, yet the difference in time can only have been slight. The authors seem to lay rather more stress than the facts justify upon the retarding effect of the inaccessibility of the island. It is probable that the civilisation was relatively further behind the rest of England during the eighteenth century, for instance, than it was in the Bronze age. The similarity of stone implements in parts of the world widely separated is not always easy to explain, though the similarity of need has a good deal to do with it. But an elaborated and more complex object, such as an ornamented pottery vase, can scarcely be reproduced in all its details without some relations between the two makers. Commonplace though such an observation may be, it is very necessary to bear such facts in mind in discussing an island civilisation like that of the Isle of Man, or even of Britain.

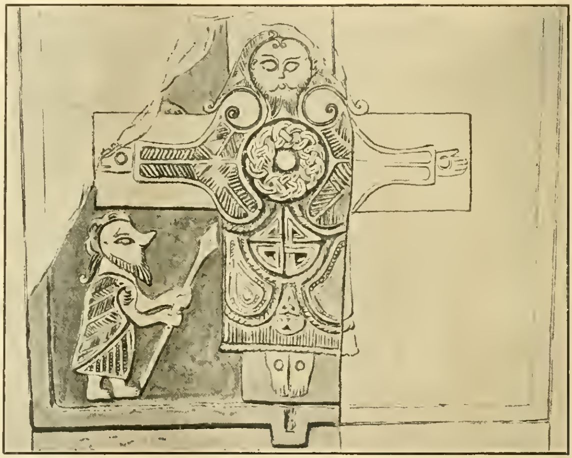


FIG. 1.—Cross from Calf of Man. From "Illustrated Notes on Manks Antiquities."

The most characteristic, and in some respects the most interesting, antiquities of the island are the Scandinavian and Celtic carved stones of Christian times. It is very useful to note how the Northmen appreciated the delightful complicated designs of their Celtic forerunners. The respective shares of Scandinavian and Celt in the motives of these curious monuments, and even in the finest Celtic manuscripts, have never been adequately elucidated. The genius of the two races in the treatment of ornament differed so widely that in some pages of the "Book of Kells," for example, the two can be separated as easily as if they were of different colours. It is odd to find that Mr. Kermode describes the interesting crucifixion shown on p. 72 and here reproduced as "an example of pure Byzantine art." To our eyes it is nearly pure Celtic, and has no relation, artistically, to any Byzantine crucifixion we have ever seen. The statements, however, throughout the "Notes" are in general accurate and restrained, and there is an entire absence of the wild local enthusiasm so often found in books of this particular character. The "Notes" may be commended as likely to be of great use to anyone visiting the island or studying its antiquities.

MOLLUSCAN MORPHOLOGY.[1]

THIS fifth volume of the important "Treatise," edited by Prof. Ray Lankester, deals with the Mollusca, and is the work of the one biologist capable of doing this group most justice, namely, Dr. Paul Pelseneer. Like its predecessors in the series it treats of the subject almost exclusively from the morphological standpoint, just such a sufficiency of systematic matter being added as to justify the title, while it is, of course, very far from being, and indeed does not pretend to be, a manual on the phylum.

Some delay has occurred in its appearance, owing to the need of translation and revision for the press, which has been carried out by Dr. Gilbert Bourne.

FIG. 1.—*Stenogyra mamillata*, left side view, with four embryos in the oviduct. *em*, embryo. From "A Treatise on Zoology."

The work itself is an expansion of Dr. Pelseneer's similar contribution to Blanchard's "Traité de Zoologie." The translation is remarkably well done, and save in some of the opening sentences it is hard to realise that it was not written in English. Not but that there are small slips such as "biannual" for "biennial." The revision, we suspect, has largely consisted in the importation of new terms, so dearly beloved of a certain school of biologists, that do not altogether make for clearness, and are foreign to the lucid style customary in the author's other writings. The opening paragraph on the "general description and external characters" of the Mollusca (p. 3) is a case in point. While the statement (p. 20), "It has been shown that in the Cephalopoda hyperpolygyny is the rule, and in certain Atlantæ and American Unionidæ, hyperpolyandry," inspires the not hypercritical comment that, without hyperbole, it is hypertechnical. Certainly a glossary will be indispensable to the work.

One is glad to observe that that mythical monster, the "Archi-" or "Schematic Mollusc" has dwindled to a shadow of its former self, and now survives solely in a diagrammatic figure as a "scheme of a primitive mollusc" (Fig. 19). For, as Verril pointed out in 1896 (*Amer. Journ. Sci.*, series iv., vol. ii., pp. 91–92), the primitive mollusc is rather to be sought in the early larval stages, such as the Veliger form. Even now one is tempted to think that the "primitive" has been introduced by the translator, since the author in his previous work, to which reference has already been made, simply labels his figure "Schème d'un Mollusque," which is rather a different thing.

Dr. Pelseneer's explanation of the torsion of the gastropod body evidently now meets with Prof. Lankester's approval, for it is the only one advanced and is reinforced by an additional diagram.

A good deal more attention is paid, and rightly, to the shell than in the author's previous writings, and it is interesting to see Sharp's theory of the progressive disappearance of the anterior adductor muscle in certain successive forms of Lamellibranchs (which was first illustrated by specimens in the Index Hall of the Natural History Museum) made the subject of illustration, though in the text this disappearance is made the cause, instead of the consequence, of the alteration of the body-axis.

One or two other points need further attention. Allusion might advantageously have been made to the origination of the gill in Cyclas, Teredo, and Scioberetia by perforation of a continuous membrane: also to the discovery by Dall that Philobrya passes through a glochidium stage, which is therefore not confined to the Unionidæ.

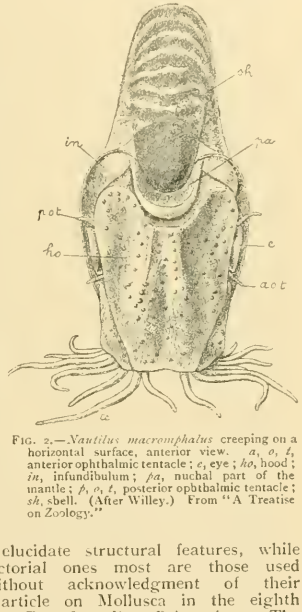


FIG. 2.—*Nautilus macromphalus* creeping on a horizontal surface, anterior view. *a, o, t*, anterior ophthalmic tentacle; *e*, eye; *ho*, hood; *in*, infundibulum; *pa*, nuchal part of the mantle; *p, o, t*, posterior ophthalmic tentacle; *sh*, shell. (After Willey.) From "A Treatise on Zoology."

The systematic portion is open to much criticism. It does not differ materially from that given in Dr. Pelseneer's previous works, though there is, so to speak, some shuffling of the cards. It is a great pity, however, that the nomenclature has not been brought up-to-date. This would have prevented such an error as recording *Zonites* as British.

The majority of the illustrations, which are all clear and well printed, are diagrammatic, or elucidate structural features, while of the few pictorial ones most are those used by Owen, without acknowledgment of their source, in his article on Mollusca in the eighth edition of the *Encyclopædia Britannica*. The greater number of these are now, very properly, attributed to their rightful authors, but of those still labelled "From Lankester after Owen" it has escaped observation that Nos. 71, 134, and 136 are after Adams, No. 158 after Philippi, and Nos. 66 and 135 are from S. P. Woodward's "Manual," while the well-known figure of *Sepia officinalis* (No. 299) is from Férussac and D'Orbigny's "Histoire."

The index would have been more useful had references to the genera cited elsewhere than in the systematic parts been included.

All these are, however, minor points, and the fact remains that malacologists now possess one of the best-written treatises yet produced in the English language on the morphology of the Mollusca.

(B V)².

[1] "A Treatise on Zoology." Edited by Dr. E. Ray Lankester, F.R.S. Part v., Mollusca, by Dr. Paul Pelseneer. Pp. 305; 301 text illustrations. (London: A. and C. Black, 1906.) Price 15*s*. net.

CYCLES IN CHRONOLOGY.[1]

THAT the 1260 years understood to be expressed by the "time, times, and a half" (taking "time" to indicate a prophetic year of 360 days each) of Dan. xii. 7, and repeated in Rev. xii. 6 and in Rev. xi. 2 and xiii. 5 under its equivalent term "forty and two months" (taking a month as thirty days), was in fact an astronomical cycle, was first suggested by Loys de Chéseaux in a work published at Paris in 1754, three years after the author's death. But it did not meet with much attention in England until a small work on the subject was published by Mr. W. Cuninghame in 1834, and it was subsequently more fully explained by Mr. H. Grattan Guinness in his "Approaching End of the Age," which appeared in 1878.

Dr. Bell Dawson however, in a pamphlet now before us, goes into the matter much more elaborately, using the most recent knowledge of the lengths of the solar and lunar years (by lunar year he means twelve lunar synodic months or lunations), and finds a remarkable correspondence between multiples of these which coincide with those of the number in Daniel. As seven is a perfect number in Scripture, and Daniel mentions three and a half prophetic years ("time, times, and a half"), he thinks that the 1260 must be doubled, which makes 2520 lunar years. Now a lunation contains, according to the most modern determinations, 29·530589 days; 504 of these are equal to 178,601 days and 2520 to 893,005 days within about four minutes. An eclipse-cycle is also pointed out, *i.e.*, that 649 solar years are almost exactly equal to 8028 (223×36) lunations (the former amounting to 237042·1853, and the latter to 237042·0355 days), which is much more accurate than the Metonic cycle.

Dr. Bell Dawson carefully notes the different values which have been found (observationally and theoretically) for the secular acceleration of the moon's mean motion; but he seems to have forgotten that though probably constant or nearly so in amount, its effect, when long periods of time are taken into account, varies like the accelerating force of gravity, as was pointed out by Halley, its discoverer, according to the square of the number of centuries. As Chéseaux had done before him, he shows the astronomical significance of the cycle 2300 years in Dan. viii. 14, as well as that of the 1260 years before spoken of; but he treats it somewhat differently. Chéseaux (whose scheme, we may mention, is explained in the second volume of Mr. Chambers's "Handbook of Astronomy") took the difference between 1260 and 2300 (*i.e.* 1040) years, and showed that 1040 solar years form a period almost exactly equal to 12,863 lunations, the former amounting to 379851·8839 and the latter to 379851·9624 days. But Dr. Bell Dawson takes them as lunar years (or periods of twelve lunations) and shows that 1780 (the mean between 2300 and 1260) lunar years is almost precisely equal to 1727 solar years, each exceeding 630773 days by only 0·27 and 0·37 respectively, and therefore differing from each other by only 0·10 of a day in that time or about 0·006 in a century. It does not appear that any reference is made to the 1290 and 1335 days of Dan. xii. 11 and 12. No attempt is made to discuss the *terminus à quo* (or therefore *ad quem*) of Daniel's periods, being beyond the scope of the paper before us, which treats only of the numbers themselves and their accordance with astronomical epochs.

Dr. Bell Dawson inserts a reflection on the inferior accuracy of the Roman calendar arrangements to those of the Chaldeans and other Oriental nations. It is probable, however, that when Julius Cæsar reformed the calendar he decreed that each fourth year should be an intercalary year, not because he was not aware that the actual length of the year was somewhat less than $365\frac{1}{4}$ days (a question which had been discussed by Sosigenes, who assisted him), but because he thought it would be a convenient rule and sufficient for all practical purposes. In this a distinguished astronomer of our own day (Prof. Newcomb) agrees with him; and indeed the chief object of the introduction of the Gregorian calendar was to bring back the date of the vernal equinox to that which it had at the epoch of the Council of Nicæa. W. T. L.

[1] "Solar and Lunar Cycles implied in the Prophetic Numbers in the Book of Daniel." By Dr. W. Bell Dawson. Pp. 20. (From the Transactions of the Royal Society of Canada, vol. xi., Section 3.)

PREVENTABLE DISEASE AND MILITARY STRENGTH.

IN a letter to the *Times* (June 6), Mr. St. John Brodrick directs attention to the serious diminution in the military strength of an army, not to say the terrible loss of life, which ensues in campaigns from diseases which are largely preventable. It is a truism, well recognised by medical men, that the soldier has much more to fear from the ravages of disease than from the bullets of the enemy. Mr. Brodrick points out that

"In South Africa the deaths per 1000 were 69 from disease and 42 from wounds, but the admissions to hospital were 746 per 1000 from disease and 34 from wounds. In other words, about 450,000 were passed through the hospitals for disease during the war, and 14,800 deaths occurred, while the admissions for injuries in action were only 22,000."

Dysentery and enteric fever are the great scourges of an army in the field, and, as was pointed out in an article in NATURE (lxxii., p. 431), are largely preventable. That this is the case is proved by the records of the Russo-Japanese War, in which the Japanese had a total of some 221,000 killed and wounded and 236,000 cases of sickness, a ratio very different from that which obtained in our own army in the Boer War. The Japanese have realised to the full the importance of hygienic measures in the field; sanitary corps went on ahead of the main army and chose the camping grounds, supervised the water supplies, and exercised a rigid sanitary control in all matters, with the above result.

Mr. Brodrick suggests one simple remedy:—

"Why should not the admirable body of Army Medical officers who have made sanitary conditions a study educate combatant officers in the elements of military hygiene? Every cadet at Sandhurst or Woolwich should be examined on passing out in a problem which he should grasp as easily as tactics or strategy, since upon it the fighting strength by which he is to win his battles depends. A captain before promotion to major might be encouraged to get a special certificate which would excuse him from all such training at the Staff College."

Sir Frederick Treves, in a letter to the *Times*, cordially supports this suggestion, and goes further, advocating that a like knowledge of a more elementary character should be possessed by the private soldier.

In addition it may be added that the formation of a sanitary corps seems desirable to aid the medical staff, to guard and control the water supplies, and the like. At present the Army Medical officer is powerless to enforce sanitary measures; although responsible, he can give no orders, and can only act through a commanding officer, often junior to himself, who has no technical knowledge. Moreover, through the Esher Committee, the Director-General, who formerly had direct access to the Secretary of State and had a seat on the Army Council, has been deprived of those privileges, the Adjutant-General at present being practically head of the Medical Department. Now that a former Secretary for War has directed public attention to the matter, it is to be hoped that those in authority will recognise that medical science is a vital part of military strength, a dictum which has for years been preached by the medical profession.

NOTES.

At the meeting of the council of the Royal Astronomical Society, held on Friday last, June 8, the following resolution was unanimously agreed to:—"That the council learn with deep concern of the danger threatened to the Royal Observatory, Greenwich, from the erection of a large electric generating station near the observatory; and desire to represent to the Admiralty at the earliest opportunity their conviction of the paramount importance of maintaining the integrity and efficiency of Greenwich Observatory, which has been adopted as the reference point for the whole world." It was further resolved that a copy of this resolution be forwarded to the First Lord of the Admiralty.

Mr. Haldane, M.P., Secretary of State for War, will open the electrical laboratory of the National Physical Laboratory on Monday, June 25, at 2.45 p.m.

At the twenty-fifth annual meeting of the Royal Society of Canada, recently held at Ottawa, Dr. William Saunders, the director of the Dominion Government's system of experimental farms, was elected president for the ensuing year, with Dr. S. E. Dawson vice-president.

Invitations have been issued by the Institution of Electrical Engineers for a conversazione at the Natural History Museum on Tuesday, June 26, to meet the visiting delegates from kindred institutions.

Prof. K. Birkeland, of Christiania, the inventor of the only successful commercial process for obtaining nitric acid by the direct oxidation of atmospheric nitrogen, will read a paper before the Faraday Society about June 26 entitled "Oxidation of Atmospheric Nitrogen by Means of the Electric Arc."

Much interest was aroused in India some time ago in the attempt to introduce the permanganate treatment of snake-bite. In the Central Provinces a large number of Sir Lauder Brunton's lancets were distributed last October for use by vaccinators and selected landholders. Several cases of successful treatment have been reported to Government, but unfortunately, says the *Pioneer Mail*, none of the reports gives sufficient detail to prove that the bites were really those of poisonous snakes, and it is therefore not possible to form any conclusions as to the value of the treatment.

A party of Birkbeck College zoological students spent Whitsuntide at West Mersea, near Colchester, collecting marine specimens. Owing to the low temperature of the surface waters the tow-netting expeditions were not very productive, but many and varied forms of life were brought up by the trawl and the dredge.

The annual conversazione of the Royal Geographical Society will be held at the Natural History Museum to-morrow evening, June 15.

A telegram from Reggio di Calabria states that fairly strong earthquake shocks were felt there on June 10 at 2.30 a.m. and 9.45 a.m. At Monteleone, Calabria, two strong shocks were felt at 2.45 a.m.

Prof. W. F. Kohlrausch, of Hanover, will be the president of the Verband deutscher Electrotechniker for 1906–8.

Dr. Bernhard Mohr, of London, recently presented to the museum of the German Chemical Society 100 letters written by the famous Liebig to Dr. Mohr's father, the late Prof. Friedrich Mohr, of Bonn, during the years 1834 to 1869.

Dr. Stutzer, assistant in the geological institute of the Freiburg (Saxony) Mining School, has been awarded a grant of 2000 marks by the committee of the Carnegie fund to enable him to continue his investigations on iron deposits in Lapland.

Prof. Ludwig Boltzmann, the well-known professor of theoretical physics in the University of Vienna, has been awarded the prize of the Peter Wilhelm Muller fund of Frankfurt a.M. The award consists of an appropriately worded gold medal and 9000 marks, and is made to the most brilliant workers in pure science.

At the seventy-eighth meeting of the Deutscher Naturforscher und Aerzte, which will be held this year on September 16–22 in Stuttgart, there will be an exhibition of scientific and medical appliances and subjects as in previous years. The König Karls Hall of the Königlicher Landesgewerbemuseum has been set apart for the purpose. All announcements and communications may be addressed to the president of the exhibition committee, Dr. Lampert, Archivstrasse 3, Stuttgart, from whom further particulars may be obtained.

Prof. Walter Nernst, professor of physical chemistry in Berlin, has declined the opportunity of proceeding to Leipzig as the successor of Prof. Ostwald, whose resignation will take place on September 30. Prof. Nernst was formerly a privatdocent at Leipzig from 1889 to 1891, when he accepted a professorship in Göttingen University. According to the *Physikalische Zeitschrift*, Prof. Ostwald's successor is to be Dr. K. Haussermann, professor of technological chemistry and director of the applied chemistry laboratory of the Technical High School, Stuttgart.

A special meeting was held in the Great Hall of the University of Athens on May 20 to celebrate the fortieth anniversary of Dr. A. C. Christomanos's appointment as professor of chemistry in the University. A large audience, including the Greek Minister of Education, the University professors and students, and many of the general public, was present. Dr. A. C. Dambergis, the professor of pharmaceutical chemistry, referring to the great work which Prof. Christomanos has done in the forty years, asserted that the greatest has been the pioneer work in the introduction of scientific chemistry into Greece with the provision for laboratory work in chemistry and the other sciences, and more particularly in organising so successfully the large chemical department of the University with its laboratory accommodation for 130 students. Prof. Christomanos was the recipient of numerous honours, including several from foreign countries.

Dr. Rudolf Knietsch, the director of the Badische Anilin- und Soda-Fabrik, died on May 28 at the early age of fifty-two. From the *éloge* dedicated to Dr. Knietsch's memory by the Badische Anilin- und Soda-Fabrik, we learn that Dr. Knietsch was born in 1854 in Oppeln, in Schlesien. From 1876–1880 he studied at the Technical High School in Berlin, and graduated in 1881 at Jena University. He was for a short time an assistant in Dr. Emil Jacobsen's private laboratory, and in 1882 entered the Farbenfabrik von Bindschedler und Busch in Basle, where he worked at the nitration of dichlorobenzaldehyde and the preparation of chloroindigo. In 1884 he joined the Anilin- und Soda-Fabrik. He founded in 1888 the industry of liquid chlorine, and devoted himself with zeal to the task of modifying the Winkler process of preparing sulphuric anhydride. Knietsch read an important communication on the results of this work before the German Chemical Society in 1901. For the solution of the problem of the commercial preparation of synthetic indigo Dr. Knietsch proved himself to be the right man in the right place. In company with a number of earnest colleagues he worked out and developed the present manufacturing processes for the preparation of the materials necessary for the synthesis of indigo and other dyes. Always broad-minded, he was ready at any time to replace existing plant and methods by improvements. In 1904 Knietsch was placed at the head of the firm. The Verein deutscher Chemiker, at the annual general meeting in Mannheim in 1904, awarded the Liebig gold medal to Dr. Knietsch, and at the opening of the new Technological Mechanical Institute of the Dresden Technical High School in 1905 the honorary degree of Dr. Ing. was conferred on him.

THE weekly weather report issued by the Meteorological Office for the period ending June 9 shows that the present month has opened with typical summer weather. The major portion of the United Kingdom was entirely rainless, the only rains reported occurring in parts of Scotland and Ireland, and amounting only to few hundredths of an inch. Bright sunshine was for the most part greatly in excess of the average, 80 per cent. of the possible duration occurring in the Channel Islands and 71 per cent. in the south of England. The temperature averages were generally rather low, and in the south of England the sheltered thermometer at night fell below the freezing point.

WE learn from the Journal of the Society of Arts that what can be done by sanitation to stamp out malaria is shown by Mr. Consul Morgan in his reference (No. 3565, Annual Series) to the work of the Italian Red Cross Society during late years to stamp out malaria in the Roman Campagna. The first attempt was made in 1900, when the returns showed that not less than 31 per cent. of the inhabitants of the "Agro Romano" had been fever-stricken. In 1901 the figure was returned at 26 per cent., 20 per cent. in 1902, 11 per cent. in 1903, 10 per cent. in 1904, and 5·1 per cent. during last year. These results were obtained by strict sanitary measures, use of wire nets so as to prevent access of mosquitoes to cottages, and free distribution of quinine among the peasantry.

THE annual dinner of the London section of the Society of Dyers and Colourists was held on May 23, when a representative company was presided over by Sir Thomas Wardle, president of the society. In proposing the toast of the London section of the society, the president expressed his astonishment at the beautiful work being done in the dyeing industry in Italy, and how much pure chemistry is being made use of in that work. London, he continued, is taking an interest in chemical development, and he suggested that the Dyers' Company might associate itself in some way with such a body as the Society of Dyers. Sir Thomas Wardle concluded his address by appealing to the younger men to take advantage of the splendid scientific training now available, and to induce others to do the same, for by such methods many of our lost industries would be won back. Responding to the toast of the "Allied Industries," Dr. J. C. Cain said no doubt to some extent our patent laws, the lack of cheap alcohol, and other causes have had a certain amount of influence in the downfall of the English aniline dye industry, but in his opinion the only real cause has been the lack of a man of commanding genius, like Perkin or Nicholson, who could discover a colour, make it, and sell it. Prof. R. Meldola, F.R.S., in proposing "The Visitors," remarked that we have lost tone in our supremacy in this branch of manufacture, but the blame is not on the shoulders of the dyers, who have always been on the *qui vive* to utilise new discoveries It was the English and Scotch dyers who first took up chemical dyes and encouraged the manufacturers to proceed. Mr. F. Robinson proposed "The Chairman," and directed attention to the fact that present-day results and modern methods could never have been attained but for the research chemists and their work. At one time dyeing was more an art than a science; now our chemists have made it practically a science. The old dyestuffs such as indigo and madder are gradually and surely disappearing, and are being supplanted by synthetic products. The English dyeing and colouring industry is moving with the times, and will eventually hold its own against all rivals.

WE have received a copy of No. 12 of the fifteenth volume of the *Zeitschrift für Oologie und Ornithologie*, said to be the only serial in the world specially devoted to the interest of the egg-collector. The present part contains notes on the eggs of two African birds previously unknown to collectors, general observations and suggestions on subjects intimately connected with oology, and descriptions of certain eggs from Turkestan.

IN the report for the year 1905, the committee of the Albany Museum, while referring with satisfaction to the general progress of that institution and the present state of the collections, directs attention to the congested state of the buildings, and the urgent need for more space and for additional funds, if the work is to be carried on in an effective manner. The appointments of Profs. Duerden and Schwarz to the zoological section are stated to have been followed by most satisfactory results.

IT has been stated by those who have investigated the subject in the selachian group that fishes lack lymphatic vessels other than those of the visceral system, the superficial and deep-seated vessels of the heart and trunk being regarded as veins, and their sinuses as venous sinuses. However this may be in the case of sharks, Mr. W. F. Allen, in a paper on the lymphatics of the loricate fish Scorpænichthys, published in the Proceedings of the Washington Academy (vol. viii., pp. 41–90), shows that it is not so in the case of the group to which the latter belongs. On the contrary, Scorpænichthys has as fully developed a lymphatic system as any vertebrate, so that it may be said that in general wherever connective tissue exists there lymphatics will be found.

THE February and March issues of the Proceedings of the Philadelphia Academy contain a paper by Mr. J. A. G. Rehn on tropical American grasshoppers of the group Acridinæ, with descriptions of several new forms, and likewise the commencement of one by Dr. R. Smith on the phylogeny of the races of a species of gastropod of the Eocene genus Volutilithes. In the case of the genus Fulgar, it has been supposed that certain Miocene forms represented the ancestral stock of the living American species. According to the author this is not so, the fossil forms being decadent senile offshoots from the original line, which appear, however, to be dominant. A very similar state of affairs is shown to exist in the case of Volutilithes, with the important exception that the main ancestral line is the one which is dominant.

The Ostracoda of the San Diego region (No. 1), the California shore-anemone, *Bunodactis xanthogramma*, and sexual dimorphism in the hydroid polyps of the genus Aglaophenia, form the subjects of articles nine, ten, and eleven of Contributions from the San Diego Marine Laboratory issued in vol. iii. of the Zoological Publications of the University of California. In the article on dimorphism (by Mr. H. B. Torrey and Miss Martin) it is shown that in the genus mentioned, not only are the gonophores dimorphic, but an analogous dissimilarity also obtains in the jointed plumose structures known as corbulæ, of which numerous examples are figured. The plate intended to illustrate Mr. Torrey's paper on the sea-anemone was destroyed in the San Francisco fire, but a new one will be supplied later.

The April issue of *Spolia Zeylanica* is of more than usual interest. It opens with a translation of an article by Dr. F. Doflein, of Munich, entitled "Termite Truffles," being the description of certain remarkably nodular masses of fungus cultivated in their nests by white ants in Ceylon. The hillocks of these termites were found by the author to contain a number of large chambers, each approximately the size of a cocoanut, and each containing one or more large friable masses, looking somewhat like small bath-sponges. These cakes were occupied by thousands of termites, ensconced in the cells and connecting passages. The framework of each was beset with numerous white nodules of the size of pins' heads, which proved to be fungus-growths. These nodules are eaten by the larvæ of the workers and soldiers and by the sexual forms at all ages, the adult soldiers and workers having, however, other food. That the funguses are introduced and cultivated by the termites seems undoubted. In the same publication Dr. A. Willey records a singular instance of symbiosis in a crab, originally described from Mauritius under the name of *Melia tessellata*. When first described its habit of holding sea-anemones in its two front claws was not noticed, but although this was observed later on in Mauritius, it has been generally overlooked. According to Dr. Willey's account and figure, the crab holds in each claw a small white anemone, which it presents, with the tentacles fully expanded, to every intruder, in "true boxing attitude." The ground-colour of the crab is whitish with a rosy flush on the front of the shell, which has also a pattern of black lines. "Probably both crab and actinians benefit by the association, the actinians enjoying increased mobility, and the crab sheltering and defending itself with the living gloves with which it is provided." In the author's opinion, the stinging threads of the anemone are the active means of defence and offence.

A leaflet, No. 16, published by the Department of Agriculture in British East Africa, contains the reports on various samples of cotton grown at Golbanti and Malindi. The cotton was produced from Egyptian Afifi seed, except for one sample of Sea Island and one of American upland. The soils on which the crops were grown were a heavy alluvium or a lighter red soil, the latter yielding much better results, owing probably to its requiring less cultivation. The values, except for the Sea Island, ranged between fivepence and sixpence per pound. There is a striking difference between the yield from Egyptian seed on the red soil and the other crops obtained.

The green colour of plants is such an ever-present reality that the explanation is apt to be overlooked. The absorption spectra of chlorophyll and the curves of absorption and assimilation do not directly furnish a solution, and it is only from the consideration of these, together with the effects produced by the absorption and dispersion of light rays in the atmosphere, that a satisfactory explanation is obtained. The subject is ably discussed by Prof. E. Stahl in *Naturwissenschaftliche Wochenschrift* for May 6, where he points out that the two pigments contained in chlorophyll are suited to the sun's rays as modified by reflection, the colours being complementary to those of the chlorophyll-absorbing rays that predominate in diffused light, and that certain rays, *e.g.* the ultra-red, are excluded wholly or in part owing to the danger of too great absorption in direct sunlight.

The fungus *Phycomyces nitens* is well adapted to physiological investigation owing to the rapidity of its growth and its sensibility to stimuli. Proceeding out of investigations by Elfving wherein curvature of the sporangiophores was attributed to physiological action through space, Prof. L. Errera was led to experiment on the curvatures caused by the presence of various substances such as rough and polished metals, porcelain, glass, deliquescent salts, marble, mica, &c. The results so obtained, and the notes relative to them, had been sufficiently fully drafted before Prof. Errera's death to allow of publication, and they appear in *Recueil de l'Institut botanique*, Brussels, vol. vi., 1905. It was found that Phycomyces curves towards bodies that absorb moisture and away from those that give off vapour. Thus the sporophores curve towards an unpolished rod of iron, but not towards a piece that is perfectly polished. A number of photographs accompany the paper, of which one of the most striking is reproduced. A dry, porous pot is suspended over the Phycomyces growing on bread in a moist atmosphere. The pot absorbs moisture, and the sporophores have curved right over the surface of the pot, some of them ultimately turning upwards owing to the stimulus of gravity.

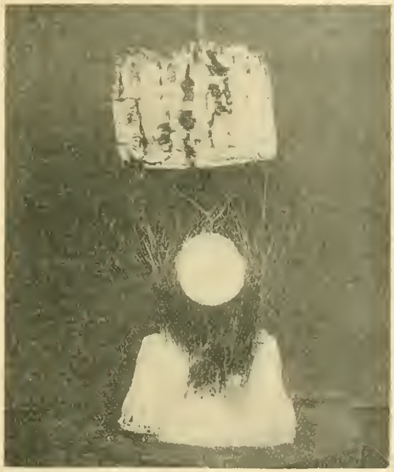


Fig. 1.—*Phycomyces nitens* stimulated to grow towards and over the surface of a porous pot.

THE report for 1905 of the Botanical Exchange Club of the British Isles, prepared by Mr. J. W. White, has been received. Besides being the official organ for the publication of notes by the collectors or special authorities on the correct determination of the plants, the report provides a record of new or rare species with the localities in which they have been found. The new records include *Caltha radicans* for Perthshire, *Ulex Gallii*, var. *humilis*, for Cornwall, the aliens *Hibiscus Trionum* and *Bromus unolioides* collected in Salop, *Lotus tenuis* from near Cardiff, and *Epipactis atrorubens* from Banff. The specific determination of the large-flowered Œnothera so plentiful on the Lancashire coast having been questioned, Mr. C. Bailey sent specimens to Dr. O. Focke, of Bremen, who considers that it is probably a form of the famous variable *Œnothera Lamarckiana.*

THE Home Office has issued for 1905 statistics of the persons employed, output, and accidents at mines and quarries in the United Kingdom, arranged according to the inspection districts. The total number of persons employed was 887,524, of whom 858,373 worked at the 3252 mines under the Coal Mines Act and 29,151 at the 688 mines under the Metalliferous Mines Act. At the quarries under the Quarries Act there were 94,819 persons employed. The death-rate from accidents was 1·49 per 1000 persons employed for coal miners and 2·49 per 1000 for metal miners.

WE have received the two latest additions to the valuable series of bulletins issued by the Peruvian Corps of Mining Engineers. In *Boletin* No. 30 Mr. Carlos E. Velarde gives a detailed account of the means adopted to obviate accidents in the mines of the Cerro de Pasco. *Boletin* No. 31 is a monograph on the mineral resources of the province of Cajamarca, by Mr. F. Malaga Santolalla. The work covers eighty-three pages, and is well illustrated and furnished with maps and sections. The coalfields of the province are of considerable importance, bituminous coal being worked at Yanacancha and anthracite at Punre. Descriptions are also given of mines of silver-lead ores, of copper, antimony, and sulphur. In fact, the province is one of exceptional mineral wealth.

MESSRS. SWAN SONNENSCHEIN AND CO., LTD., have published a second edition of Mr. C. H. Hinton's book on the fourth dimension. The first edition was reviewed in the issue of NATURE for July 21, 1904 (vol. lxx., p. 269), and it is only necessary to say that the new edition differs chiefly by the addition of a new chapter of twenty-three pages on a language of space. The new chapter is also published separately.

OUR ASTRONOMICAL COLUMN.

PHOTOGRAPHING THE CORONA WITHOUT A TOTAL ECLIPSE.—A communication from MM. Millochau and Stefanik referring to a recent note in these columns (May 31, p. 112) on their proposed method of photographing the corona without a total eclipse of the sun points out that the meaning of part of their note in the *Comptes rendus* was misinterpreted.

The successful experiments at Meudon dealt with the feasibility of photographing the line at λ 5303 with a *spectrograph*; and others, performed since their communication to the academy was published, have clearly affirmed the possibility of observing the green coronal line when the atmosphere is sufficiently pure and suitable screens are employed. It is this study of the *spectrum* of the corona that they hope to complete on the summit of Mont Blanc.

OBSERVATIONS OF NOVA GEMINORUM.—The results of some interesting observations of Nova Geminorum, which were made by Prof. Barnard between the date of the Nova's discovery (March, 1903) and February 27, 1906, appear in No. 6, vol. lxvi., of the Monthly Notices (R.A.S.).

At the time of discovery the magnitude of the Nova was 8·0, but it steadily decreased until at the present time the object is but very little brighter than the fifteenth-magnitude star which slightly precedes it.

The observations made in order to discover any possible difference of focus between the Nova and the surrounding stars indicated no such difference at first, but on September 21, 1903, it was found that the focus for the Nova was 0·29 inch further from the object-glass than that of a tenth-magnitude preceding white star. In connection with these observations a curious feature was noted on March 30, 1903. The Nova appeared to have two distinct foci, both of which gave sharp images. The one image was of about 8·5 magnitude, of reddish-yellow colour, and at the ordinary stellar focus, whilst the second was of the tenth magnitude, about 0·39 inch further out, and of a beautiful crimson colour. On April 6 the crimson image was still present, though not so strong or definite, and on April 27 it had entirely disappeared. This image was probably due to the strong Hα line in the spectrum of the Nova.

Measures of the distances between the Nova and the surrounding comparison stars, of which Prof. Barnard gives a chart, indicate a decrease of distance between one of the latter and the Nova. From this it would appear that the Nova is in motion, but that cannot be stated as a fact until further measures have been made. The measures of the position of the Nova gave no indication of a parallax.

PERSONAL EQUATION IN PHOTOMETRIC OBSERVATIONS.—In No. 4089 of the *Astronomische Nachrichten* Prof. Ceraski directs attention to the fact that in recording the results of observations made with the Zöllner photometer it very often happens that no mention is made of the relative positions of the real and the artificial stars during the observation, and asks that this should always be carefully recorded by the observer.

There is often an effective personal equation introduced into the results, depending upon whether the real star is to the right or to the left of the artificial star when the observation is made, and as this equation varies with the instrument employed and the magnitude of the variable star at the moment of observation, it becomes important that the conditions should be carefully recorded and the resulting corrections applied when the final values are computed.

COMET 1906*b* (KOPFF).—In No. 4087 of the *Astronomische Nachrichten* Herr M. Ebell publishes a newly derived set of elements and an ephemeris for comet 1906*b*. The following are the elements:—

$$T = 1905 \text{ Oct. } 18{\cdot}6620 \text{ (Berlin M.T.)}$$
$$\left.\begin{aligned} \omega &= 158^\circ\ 42'\ 11''{\cdot}4 \\ \Omega &= 342^\circ\ 13'\ 35''{\cdot}1 \\ i &= \ \ 4^\circ\ 14'\ 32''{\cdot}4 \end{aligned}\right\} 1906{\cdot}0$$
$$\log q = 0{\cdot}522130$$

The ephemeris shows that the comet has just passed from the constellation Leo, wherein it was discovered on March 13, into Virgo, and is situated about one-third of the distance between υ Leonis and β Virginis, reckoning from the former.

A note in the *Observatory* (No. 371) points out that the perihelion distance of this comet is greater than any previously recorded, with the exception of that of the comet of 1729. Prof. Wolf has found an image of the comet on a plate secured on January 14, 1905, more than a year before the discovery, an event which is unique in the history of cometary observations. At that time the magnitude of the object was about 0·4 that at the time of discovery, and approximately equal to the present magnitude.

OBSERVATIONS OF VARIABLE STARS.—Twenty-two newly discovered variable stars in Carina are announced in Circular No. 115 of the Harvard College Observatory. The variability of these stars was discovered by Miss Leavitt from the examination of six plates taken with the Bruce telescope, the total number of variables discovered from these plates being now thirty-nine. The star H 1232 is found to be an Algol variable, and a number of the observations made near minima, together with an ephemeris for May, June, and July, are given in the circular.

A plan proposed by Prof. Bailey for the construction of a variable star Durchmusterung, in which the cooperation of amateur and other astronomers is sought, is described in No. 116 of the same publications.

The results of a number of variable-star observations made by Mr. S. D. Townley at the Lick Observatory during the summer of 1902 are published in No. 95 of the Lick Observatory Bulletins. Most of the stars observed were taken from the "Catalogue of Stars recognised as Variable since the Appearance of Chandler's Third Catalogue," which appeared in the *Astronomical Journal* (vol. xxii.) in 1902.

VISIT OF REPRESENTATIVES OF FRENCH UNIVERSITY EDUCATION.

THE French visitors have come and gone. To describe in detail the events of a crowded programme would be impossible. We can here only give a brief sketch. From the first meeting on Whit Monday, at the informal dinner given at the Empress Rooms of the Royal Palace Hotel, it was obvious that the *entente* between the French savants and their English hosts was sincere and cordial, and that it was of much older standing than the political agreement. The Vice-Chancellor, Sir Edward Busk, speaking in French, struck the right note at the outset, and Sir Walter Palmer, the chairman of the reception committee, and Mr. P. J. Hartog, the academic registrar of the university (who acted with Mr. W. K. Hill as secretary), both former students of the Sorbonne, welcomed, in the French guests, old teachers and fellow-students.

To the toast of "Our Guests," proposed by Sir Walter Palmer, responses were made by M. Bayet (for the Ministry of Public Instruction), M. Boutroux (for the Faculty of Letters of Paris), M. Lippmann (for the Faculty of Sciences of Paris), M. Chavannes (for the Collège de France), M. Thamin and M. Angellier (for the French provincial universities), M. Morel (for the Société des Professeurs de Langues vivantes), and M. Gautier (for the Guilde Internationale), several of whom, including MM. Lippmann and Angellier, spoke in excellent English.

On the following morning the official proceedings began with a reception by Lord Fitzmaurice and Mr. Lough, Parliamentary Secretary of the Board of Education, in the large room of the Foreign Office, followed by luncheon for 300 guests in the East Gallery of the University.

The gallery, which is nearly 200 feet long, was decorated with French and English bunting, and with red, blue, and white flowers; and the French robes of crimson silk (science) and yellow silk (arts), with the ermine-barred *epitoga*, the scarlet gowns and many-coloured hoods of the Englishmen, and the light summer dresses of the ladies, formed a gorgeous display. It was a surprise to the Frenchmen, who had been somewhat loth to don academic costume, very rarely worn in France, and only on solemn official occasions, to discover its value in a pageant. One of the most distinguished of them prophesied that the English fashion would before long be followed in France.

Official distinction was given to the reception by the presence of M. Cambon, the French Ambassador, who responded to the toast of the President of the French Republic; and the connection of the University with London was emphasised by the toast "Welcome to London" proposed by Mr. Evan Spicer, chairman of the London County Council, and responded to by M. E. Hovelaque, the French Inspector-General, who has of late years transformed the teaching of English in French schools, and who spoke with an ease and distinction that Englishmen might well envy. After lunch came addresses in the Great Hall to an audience of about 1800 persons. The Vice-Chancellor gave a brief but interesting sketch of the relation between the University of Paris and the older English universities; M. Liard, the Vice-Rector of the University of Paris, gave an account of the great and fruitful reforms in French secondary and university education, on which, as Sir Edward Busk justly said, he has for many years exerted "a commanding and beneficent influence"; Sir Arthur Rücker, principal of the University, showed how the ideal of Adam Smith of free and competitive teaching, and the ideal of Dr. Johnson of an endowed and privileged university were united in the University of London with its external and internal sides, and he amused his audience greatly by pointing out that while the test of "residence" at the Inns of Court was eating, and at Oxford and Cambridge was sleeping, that test in London had been divorced *a mensâ et thoro*; Prof. Sadler, as past-president of the Modern Languages Association, a number of the French guests of which were entertained by the University, gave an interesting and suggestive sketch of French influences on English education. After the addresses tea was served in the new, and still unfinished, chemical and physical laboratories of the Royal College of Science, over which the visitors were conducted by Sir Arthur Rücker, Prof. Tilden, Prof. Callendar, and the staff of the college. In the evening the guests were invited to meet fellow-specialists informally at parties given by Sir Edward Busk (modern languages and literature), Prof. and Mrs. E. A. Gardner (classics, archæology, and philosophy), Sir William and Lady Ramsay (mathematics and physical sciences), Mr. Mackinder (history and geography), and Dr. Waller, Dr. Farmer, Dr. Halliburton, and Dr. Starling (biological sciences).

On Wednesday morning, June 6, and afternoon, the County Council took charge of the visitors; they were driven in thirty-five carriages, headed by two mounted policemen, from the Royal Palace Hotel to Westminster, where they inspected the Abbey and school, then to the excellent Camberwell School of Arts and Crafts and the Oliver Goldsmith School, and so to Belair, the beautiful park of Mr. Evan Spicer, where lunch was served in an open marquee. The guests returned *viâ* Dulwich College and Picture Gallery, and drove through the Dulwich Common Park, now maintained by the County Council, in which there is a magnificent show of rhododendrons and azaleas. In the evening private dinners were given by the Vice-Chancellor and Lady Busk, the Principal and Lady Rücker, Dr. and Mrs. Bradford, Sir William Collins, M.P., Dr. Headlam, principal of King's College, Mrs. J. R. Green, Sir Philip Magnus, M.P., and Lady Magnus, Dr. and Mrs. T. L. Mears, Sir Walter and Lady Palmer, Dr. and Mrs. Pye-Smith, and the principal, professors, and lecturers of University College.

The evening concluded with a brilliant and crowded reception at the French Embassy.

On Thursday morning, June 7, a series of eight addresses was given in the Great Hall of the University of a singularly varied and interesting character, in which it may fairly be said that the English speakers, Prof. Gardner, Dean of the Faculty of Arts, who spoke in Latin, Dr. Waller, Dean of the Faculty of Sciences, and Sir William Ramsay, who spoke in French, did not fall short of the high literary level characteristic of French eloquence. M. Croiset and M. Appell, the Deans of the Faculties of Arts and Sciences of Paris, M. Léger, professor at the Collège de France, M. Benoist, Rector of Montpellier, and M. Morel, vice-president of the Société des Professeurs de Langues vivantes, gave addresses on which it is impossible to comment adequately. It is understood that they will be published later, when we hope to have occasion to describe them.

On the afternoon of Thursday, June 7, the French guests journeyed by special train to Windsor, where they were introduced by Lord Rosebery, Chancellor of the University, and by the Vice-Chancellor, to the King and Queen, and were afterwards entertained at tea in the Castle; and in the evening the proceedings, so far as London was concerned, concluded with a brilliant conversazione at the University.

On June 8 half the guests of the University and of the Modern Language Association were entertained at Oxford and half at Cambridge. The majority left London on Saturday and Sunday, June 9 and 10.

In these festivities there has been much brilliancy, much pomp and circumstance. But behind the show there has been real and solid work accomplished or begun. Lessons are learnt better from men than from books, and the lessons to be derived from French education, to which (with the Army) France has devoted the best part of her energies since 1871, have been sadly neglected by England. We have still to learn that solid secondary education is a necessary preliminary to fruitful university education; that it is possible to combine literary and scientific training; that both in secondary and in higher teaching, if the teachers are to stimulate individuality in their pupils, they must be given time and opportunity to cultivate and develop their own; that examinations may be used to test the power of taking general views, as well as of remembering an infinity of details; and many other things, which France can teach us. But apart from intellectual profit, there is a moral profit in a meeting of this kind. Blessed are the peace-makers; and the discovery of unsuspected and deep human sympathies between workers in the same intellectual fields, between men and women whose business it is to train up the young minds of their own people, makes for the peace of Europe.

ECONOMIC ENTOMOLOGY.[1]

(1) SINCE 1867 the State entomologists of Illinois have constantly issued very able reports on noxious and beneficial insects. The first were by Walsh and Le Baron; the last twelve have been by Prof. Forbes, the writer of the present work. In 1894 he issued the first part of "A Monograph of Insect Injuries to Corn." This extended to some 170 pages, with fifteen plates, and dealt only with those insects that attack the planted seed and the roots of corn of various kinds. This dealt mainly with wire-worm, white-grubs or chafer larvæ, ants, aphis, their natural enemies and means of prevention. The second part that has just appeared is very much better than that issued nearly twelve years ago. It treats of the insect injuries to those parts of the corn plant above ground, including stalk, leaves, and ear.

A very excellent plan we do not remember having seen before is adopted in the text, namely, that of grouping the insects under the following three headings:—(1) the more important pests; (2) the less important pests; and (3) the unimportant species.

In dealing with the first it is pleasing to note that the insects are dealt with in a strictly practical manner. Such reports as these can well be made to serve a double purpose if properly drawn up as this one is, namely, as a reference book for practical men and also for those who are studying the subject from a student's point of view. The coloured plates, of which there are eight, include the army-worm, corn bill-bugs, the chinch bug, the corn-worm, white-grub, the seed-corn maggot, and other well-known corn pests. The plates are good, and show in some cases, not merely the perfect insect, but the whole life-history and the damage produced on the growing plant.

Among the more interesting sections we find a good account of the damage caused by the chinch bug (*Blissus leucopterus*, Say) and the means of preventing it, of the army-worm (*Leucania unipunctata*, Haw.), and of the corn-leaf louse (*Aphis maidis*, Fitch). In regard to the latter some interesting new observations are recorded, although nothing very definite has been arrived at in regard to the life-history of this corn pest. The author (p. 133) refers to "the failure of all attempts to find or produce a bisexual generation or an alternative food plant of *Aphis maidis* or to learn how and where it passes the winter."

Some interesting notes are given on several species of Crambus, called popularly in the States "sod web-worms" or "root web-worms" (Figs. 1 and 2). Although we have many species of Crambus in Europe, no very material damage has been recorded. In America we learn that "not infrequently these 'web-worms' become so abundant as to cause brown and deadened spots in a lawn or meadow, sometimes, indeed, deadening the turf as thoroughly as white-grubs or cut-worms can do." Corn seems to be very heavily injured and even completely destroyed over considerable areas in early spring. This is an attack we must be prepared for in many localities in this country when grass land is broken up, an unlikely proceeding, however, at the present day with the low price of corn. Probably a good deal of damage is done here now, but has been attributed to other causes. The figures given by Forbes are thus reproduced to give an idea of the larval stage, during which the damage is done.

FIG. 1.—The Sod Web-worm (Crambus) web (*a*) containing larva, at base of young corn plant; *b*, *c*, injuries to leaf and stem.

In this country, again, we have not observed any injurious Syrphidæ or hover flies, but we find recorded by Forbes (p. 162) that *Mesogramma politum*, Say, feed, not on Aphides, but on the pollen and juices of corn and cotton (Ashmead). The whole work is full of interesting and sound material alike to the practical man and student. One point we notice; the corn-worm or cotton-worm is still called *Heliothis armiger*, Hübner, instead of *Heliothis obsoleta*, Fabricius, which antedates it.

A key to the discussion of insect injuries to corn is given which will prove very useful to those studying the subject in America, and even elsewhere, for where species differ genera often agree in various parts of the world. A very complete bibliography and a copious index complete the work, which is useful to us in many regions other than America.

(2) This work contains a good deal of useful information and a lot of what appear scrappy notes, which will, however, serve a useful purpose later on. The great difficulty of working at such a subject as the one Mr. Stebbing is engaged upon can only be estimated by those who have attempted the like.

The economic entomologist is often too apt to jump at specific and even generic determinations, or is loth to publish his observations unless the scientific name can be given. Some groups of insects are almost impossible to name specifically, and many others should only be treated by specialists, who have not always time or inclination to deal with the material sent them.

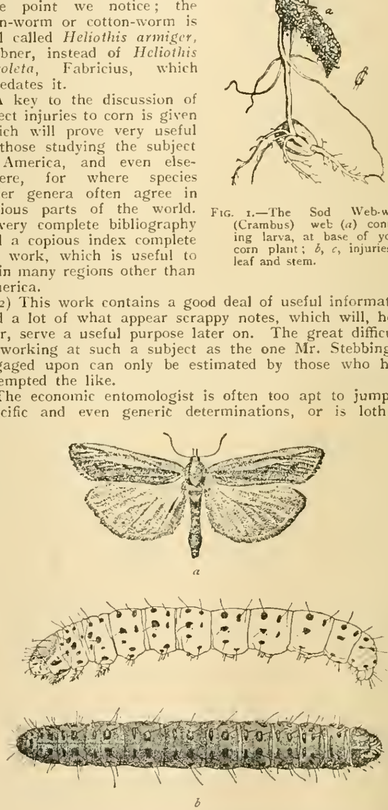


FIG. 2.—The Common Sod Web-worm (*Crambus trisectus*): *a*, adult slightly enlarged; *b*, back and side views of larva (much enlarged)

[1] (1) "A Monograph of the Insect Injuries to Indian Corn." Part i. By S. A. Forbes. Twenty-third Report of the State Entomologist on the Noxious and Beneficial Insects of the State of Illinois. Pp. 273+xxxiii; 238 Figures and 8 Coloured Plates. (Chicago, 1905.)

(2) "Departmental Notes on the Insects that affect Forestry." By E. P. Stebbing, F.L.S., F.Z.S., F.E.S. No. 3, with Preface and Index to vol. i. Pp. 335-469+8 plates. (Calcutta: Government Printing Office, 1906.) Price 2s.

Nevertheless, it is very necessary that we should record the bionomics of arthropods of economic importance, even though we have to leave to some future date the scientific nomenclature, which in many cases is quite as diverse as the sometimes derided popular one! It is thus pleasing to find in this work valuable information recorded without waiting for even the definite generic status of the pest in question.

From p. 379 to p. 385 is detailed in a most able manner the life-history and workings of a cerambycid beetle, probably a Stromatium, which attacks the sandal-wood tree.

This "borer" is well known to be one of the most assiduous pests in the sandal-wood area of North Coimbatore, and yet Mr. Stebbing tells us that he is as yet unable to obtain any beetles and that he is not even sure of its generic position. So much is recorded, however, that one has only to find and name the beetle and fill in a few details and the account is complete. The sandal-wood borer will remain the same to the Indian forester, who is indebted to Mr. Stebbing for that work of special value, its life-history, whatever technical name it appears under later on. Other forest enemies are recorded in similar manner; sometimes the genus is doubtful, sometimes the species.

The most interesting part of this work deals with the bamboo beetle or shot-borer (*Dinoderus minutus*, Fabricius). This and allied species are often very destructive to bamboos.

It is shown that this species is the chief pest to bamboos in Calcutta and in the hotter, damper parts of the country, apparently taking the place of the *pilifrons* in Upper India.

In the account of this pest we find recorded some real practical work with regard to protecting bamboos from the ravages of this insect. The conclusions arrived at show that soaking the rods for five days in water, then drying them and soaking them for forty-eight hours in common Rangoon oil, is the best method of treatment. Other interesting wood-borers are also dealt with, including a goat-moth (*Duomitus leuconotus*, Walker) found in Calcutta, Sikhim, and Ceylon, which attacks the Cassia trees just as our goat-moth attacks the ash and oak; and there is also a very full account of the Casuarina bark-eating caterpillar (*Arbela tetraonis*, Moore), a widespread pest in Casuarina plantations, where it often does much damage.

An unusual, yet useful, diversion we note in this report is that at the end of each subject are mentioned the "points in the life-history requiring further investigation."

The plates are for the most part rather crude, but serve their purpose. The photogravure of bamboos tunnelled into by the bamboo-borer is, however, an exception. A great foundation is being prepared in such a work as this; it is only a foundation, but, judging from what we have seen of this and others, it is one upon which we need not be afraid to continue building. FRED. V. THEOBALD.

THE SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES.

THE eleventh annual congress of the South-Eastern Union of Scientific Societies was held at Eastbourne on June 6–9 at the invitation of the local natural history society. On Wednesday evening, June 6, the retiring president, Prof. Flinders Petrie, opened the proceedings and gave up his chair to Dr. Francis Darwin, who delivered the presidential address. The title of the latter was "Periodicity," and in it Dr. Darwin pointed out that one of the most striking features of living things is their periodic or rhythmic character. Life itself may be described as a rhythm made up of alternate destruction and reconstruction. Protoplasm—"the physical basis of life"—is alternately falling to pieces by a degradation into simpler compounds and rebuilding itself from the food materials supplied.

In the address simpler instances were mentioned, such as are seen in the process of reproduction, for instance in the case of a plant, which produces a seed that gives rise to another plant, and so on. Again, allusion was made to the seasonal appearance and disappearance of the leaves of deciduous trees. Attention was turned to the time limits between the earliest and latest unfolding of the leaves in various trees and to the attempts which have been made by phænologists to explain these periodic phenomena as being strictly regulated by temperature.

In the end, however, Dr. Darwin was able to show that the plant is really master of the situation, and not the temperature, for among other things buds in ordinary circumstances will not develop at the end of summer, and at this time it is much milder than in the spring, when they begin to unfold and grow into shoots. The plant is, in fact, guided by internal rather than external conditions, for the bud has to go through certain invisible changes during its winter's rest before it is ready for its normal growth, and these invisible changes are part of the plant's automatic rhythmic capacity which enables it to be independent, to a large extent, of external changes. The same arguments were found to apply to the daily movements of plants. Increase of temperature may cause flowers to open in the morning, but it has no effect at night. Again, leaves that show sleep movements by falling at evening from a horizontal position to one which is, roughly speaking, vertical, will, even if kept in the dark, return to their original station in the morning. At nightfall the sleep movements again occur, though as the plant becomes more and more unhealthy owing to the absence of light they are gradually lessened. Dr. Darwin described a very interesting case of habit in a sleeping plant, namely, the scarlet runner, which he recently demonstrated. Like other plants, the one in question adapts itself to one-sided illumination by placing its leaves obliquely so that they are at right-angles to the line of illumination, and get the full advantage of the light. If a scarlet runner which has assumed this oblique position is allowed to go to sleep at night as usual, and is then placed in a dark cupboard, it will in the morning assume the diurnal position as already mentioned in the case of other sleeping plants. Most remarkably, however, it does not return to its normal day position, that is, with horizontal leaves, but takes up the oblique position already described. This looks like a reminiscence of its former position, and is interesting psychologically since it might almost be described as an instance of a plant taking advantage of its individual experience.

Another experiment showing how a periodic movement had been induced, and pointing to a kind of memory on the part of a plant, was described by Dr. Darwin, who finally touched upon circumnutation, which he looked upon as the raw material out of which movement in response to stimuli has been developed.

During the congress several papers were read which showed, not only that the neighbourhood of Eastbourne is very rich in plants, birds, and insects, but that there are many keen naturalists in the county of Sussex. For instance, Mr. J. H. A. Jenner dealt generally with nature near Eastbourne, a communication by the late Dr. Whitney and Miss Milner treated upon the flora of the Eastbourne district, while Mr. Ruskin Butterfield compared the birds of Sussex with the list for Great Britain, showing that from the county in question there is a greater number of birds recorded than from any other.

On Thursday evening, June 7, Dr. Jonathan Hutchinson gave a powerful discourse on the educational value of museums. He emphasised the need for large and inexpensive buildings, and showed the great importance of museums now that it has been recognised that things, and not words, must be studied if the memory is to be of any real use. He dwelt on a graphic method of teaching history adopted in Haslemere Educational Museum, which he founded, and also alluded at length to the moral effect of proper education.

Two papers dealt with geology, namely, that on sea erosion and coast defence, by Mr. E. A. Martin, and the geology of the Upper Ravensbourne Valley, with notes on the flora, by Mr. W. H. Griffin. The former contribution summed up the present situation, and was particularly suggestive, while the latter showed how much useful work a naturalist can do who devotes his time ungrudgingly to a particular district.

At the reception given by the Mayor of Eastbourne, Mr. Edward J. Bedford gave a most successful lecturette on bird architecture. The photographic lantern-slides which illustrated it were particularly good, which, seeing that Mr. Bedford began his work in this direction so long ago as 1890, is not, perhaps, to be wondered at.

The last lecture, on Saturday morning, June 9, to which the teachers of the district were invited, was given by Mr. Wilfred Mark Webb, on nature-study. As two years ago Mr. Webb presented a formal paper to the union, he contented himself, after a few brief remarks, with showing by means of lantern-slides what directions the pursuit in question has taken or might take.

A number of interesting specimens were brought together to form the usual congress museum under the direction of Mr. E. W. Swanton, and the photographic surveys of Surrey, Kent, and Sussex contributed a selection of photographs.

The business done included the election of Prof. Silvanus Thompson as president for 1907, and the acceptance of an invitation to visit Woolwich for the twelfth congress in that year. Dr. Abbott, the founder of the union, its first secretary and late treasurer, was added to the list of vice-presidents, of whom besides Dr. Hutchinson, Mr. F. Merrifield, Mr. F. W. Rudler, the Rev. T. R. R. Stebbing, Dr. Treutler, and Mr. W. Whitaker attended the congress.

The perfect weather made the four excursions to Mickleham Priory and elsewhere a complete success, and a pleasing feature of the meeting was the votes of thanks to local secretaries, Mr. J. J. Hollway and Mr. Sparks, and their coadjutors, as well as that to the general secretary, the Rev. R. Ashington Bullen, which was emphasised by the whole company rising in their seats.

THE SURFACE TRAJECTORIES OF MOVING AIR.[1]

THE Meteorological Office has just published the results of an investigation into the movements of the air during storms and periods of barometric depression affecting the North Atlantic and western Europe. The authors deal, not so much with the discussion of theories about cyclones as with the results of direct observations on the direction and force of the winds as recorded at as many stations and as often as possible. Apart from ships' logs, the records from about 200 stations have been utilised.

The attempt has been made to trace the path of any body of air from the point where it descended from the upper regions of the atmosphere along the surface of the earth to the place where it ascended again, and the method used is briefly as follows:—Using hourly observations whenever possible, arrows have been drawn on a map through the position of the recording station showing the direction of the wind, and the length of the arrow is equal to the distance which the recorded velocity suggests as being the journey of the air during the half-hour preceding and the half-hour following the time of observation. By this method the trajectories are made up step by step through station after station as the hourly maps are made up. Anemometer records are consulted to decide where the velocity of the wind has been sufficiently constant to carry the trajectory properly from one hour to the next.

In the discussion of certain circular storms and barometric depressions which have passed over the British Isles, and which have been selected as typical examples, 162 trajectories were examined, and also the changes in the meteorological conditions along them. Naturally many of these trajectories do not represent the full course of the particular current considered, only the beginning, the middle or the end coming within the region under observation.

These trajectories have been divided into five classes. Class i.—Final-stage trajectories terminating generally, but not always, near the centre or the trough of the depression. These are marked by diminishing pressure, increasing velocity, and falling temperature. These currents end under cloudy skies and with rainfall. In some cases the end is caused by the meeting with a cross-current. The conclusion is that this air has fed the ascending current, and that the rain has been caused by the expansion and consequent cooling. These trajectories are always from almost due south, and show very little curvature.

Class ii.—Initial-stage trajectories, commencing in regions of fairly still air which may be quite near to the centre of the depression. The meteorological conditions and changes which characterise this class are the reverse of those for class i., even to this extent, that they flow from low pressure to high. There are many cases of this class shown; too many to suggest a mistake.

Class iii.—Looped trajectories generally cross the track of the depression twice, once in front of the storm and once behind, and may be taken as a continuation of classes i. and ii.

Class iv.—Spiral trajectories generally represent cold currents blowing from the east or north round the west of the centre of the depression to replace the southerly currents of class i.

Class v. has three subsections:—(*a*) trajectories from a point in front of the trough; (*b*) from a point in the rear; and (*c*) in the line of the trough. The meteorological conditions accompanying (*a*) and (*b*) are similar to those for classes i. and ii. Trajectories in the line of the trough are remarkable for the strength of the wind and for the small and irregular changes of pressure. The accompanying weather is generally cloudy, but without rain.

The trajectories over the Atlantic are obtained from observations made between August, 1882, and September, 1883, and, as only daily records are used, the investigation is on a much coarser scale. Moreover, they are more open to criticism, for there may be many changes in the meteorological elements in twenty-four hours. Some of the trajectories traced are remarkable for their length; for example, between December 23 and 30, 1882, one is traced from West Africa to North Russia, and another from Florida to the British Isles, and between November 13 and 17 one is followed from Hudson's Bay to the Adriatic.

In seeking to locate the positions of ascending and descending currents and the connection between these and the distribution of rainfall, it has been taken as proved that an ascending current of air is necessary for the production of measurable rainfall, and we are reminded that it is not necessary or usual for these ascending or descending currents to be vertical. They are generally very oblique. The approximate positions of ascending currents are located by noting the convergence of air to such places, divergence denoting descension.

Convergence may be produced by the trajectories being directed towards one point, or by air overtaking air which is preceding it in the same direction, or by the wind blowing towards a persistent cross-current. These are obvious and typical cases.

If two sets of isochronous points or trajectories be joined by lines, then the ratios of the enclosed areas will indicate convergence or divergence according to whether the second area is smaller or larger than the first.

The greater convergence takes place almost always in front of the centre of the depression, and this agrees with the area of greatest rainfall. As, however, the rain is generally brought by southerly winds, the rainy district is somewhat to the north of the area of convergence, the current evidently having continued its onward course whilst rising.

Some of the general conclusions deduced during the investigation may be given:—

(1) In the front portion of travelling storms there is air moving from high pressure to low and to lower temperature and rainfall, while in the rear, even quite close to the centre, there is movement from low pressure to high and towards improving weather conditions.

(2) Fast-travelling storms receive air from the right hand (south) of the path in front of the storm, and lose an equivalent amount from the rear at the same side. Slow-travelling storms receive air from the south direct to

[1] "The Life-history of Surface Air-currents; a Study of the Surface Trajectories of Moving Air." By Dr. W. N. Shaw, F.R.S., and R. G. K. Lempfert. (London: Published by the Authority of the Meteorological Committee, Wyman and Sons, Ltd.) Price 7*s.* 6*d.*

the centre, whilst air from the north flows round the rear.

(3) Southerly winds are generally short-lived as surface currents. Other currents last longer. They may persist until they reach the trade winds, or they may turn and join the depression from the south, or may disappear in some depression over the Atlantic.

(4) The central areas of well-marked anticyclones have not shown themselves to be the usual birthplace of descending currents. These generally originate in the "col" or shoulder of an anticyclone, or the areas of comparatively low pressure between two anticyclonic or two cyclonic areas. Only very rarely has a trajectory been traced back to the centre of an anticyclone.

(5) Surface observations have not indicated the conditions which mark out the track of a barometric minimum.

The publication contains some twenty-six valuable plates of weather charts with the trajectories plotted, and accompanied by full notes and selected observations along the trajectories. The trajectories have also been drawn having regard to the centre of the storm as a fixed point. There are also some mathematical notes by Mr. G. T. Bennett with reference to looped trajectories and the calculation of dilatation of areas in travelling storms.

W. M.

NEW ARCTIC EXPEDITIONS.

THE present season promises to be one of unusual importance in the annals of Arctic exploration, both in the way of scientific investigation of specific problems such as those stated in the paper by Sir Clements Markham published in the January number of the *Geographical Journal*, and in what may be more correctly described as "attacks on the Pole."

According to a note in the current number of the *Geographical Journal*, Mr. A. H. Harrison's expedition reached Herschel Island, near the mouth of the Mackenzie, in February last, where Mr. Harrison found Lieut. Hansen and the members of the *Gjöa* expedition. Writing on March 1, Mr. Harrison expressed the intention of making his way during April to Bailie Island, and thence to Banks Land, where he proposes to spend next winter.

The general scheme of the expedition—now formally designated the "Anglo-American" Polar Expedition—undertaken by Mr. Einar Mikkelsen and Mr. Leffingwell, has already been outlined in these columns (January 25, vol. lxxiii., p. 302). Since his arrival in the United States the American Geographical Society has voted Mr. Mikkelsen a sum of 3000 dollars, the largest grant ever given to an explorer by the society, and the council of the Royal Geographical Society has made a second grant of 100*l.* Mr. Mikkelsen has purchased a schooner of 66 tons burden, which he has named the *Duchess of Bedford*, and has now been able to elaborate his plans in considerable detail on the lines already announced (see the *Times*, April 21, and the *Geographical Journal*, vol. xxvii., p. 507). The programme is an extensive and extremely hazardous one, but if even a part of it is successfully carried out scientific results of great value will certainly be obtained.

The Danish or "Danmark" expedition, for which funds amounting to about 250,000 kr. have been raised by means of a Government grant and private subscriptions, will leave Copenhagen on July 1 under the leadership of Mr. L. Mylius-Erichsen, and make its way so far north as possible along the east coast of Greenland. There a landing will be effected, and the party will proceed along the east coast, wintering *en route*, to the most northerly point of Greenland, which is, in the leader's opinion, the most favourable place from which to make an attempt to reach the Pole. A sledge expedition will set out for the Pole from here, and return in time to winter on the ship the second year. In March, 1908, Mylius-Erichsen, accompanied by one of his staff and two Greenlanders, hopes to set out on the second part of his journey, and realise the daring plan of traversing the inland ice of Greenland on the broadest portion of the continent. The crossing is to be effected partly by motor-car, partly by dog sledges, and partly on ski, and is expected to occupy about two months and a half.

Mr. Walter Wellman has formed a project for reaching the North Pole by means of an airship. The vessel is to start from a base in Spitsbergen, and it is estimated that the return voyage of 1200 miles may be accomplished in from five to fifteen days. This expedition is being financed by Mr. Victor Lawson, chief proprietor of the *Chicago-Record Herald*, and a very full description of the airship —which is of a quite novel type—is given by Mr. Wellman in the April number of the *National Geographic Magazine*. The contract for construction was given to M. Louis Godard, of St. Ouen. According to a Reuter correspondent in the *Times* of June 5, the ship will leave Paris for Spitsbergen in a few days.

A CATALOGUE OF FOSSIL INVERTEBRATES.[1]

THIS catalogue of fossil invertebrates, compiled by Mr. Charles Schuchert, assisted by Messrs. W. H. Dall, T. W. Stanton, and R. S. Bassler, is arranged alphabetically, and gives the catalogue number of the department registers, the name of the species as written in the work cited, the kind of type (for instance, holotype, cotype), the formation, locality, author, and place of publication, with remarks on the present name if different from the one cited, or a cross reference when the same species appears in the list under more than one name. Remarks, together with sources of such, are added in brackets where necessary.

The list itself is preceded by an admirably clear and carefully written introduction by Mr. C. Schuchert, dealing mainly with type terms. Use is made of the contributions of Schuchert, Buckman, Cossmann, Oldfield Thomas, Bather, and others to the discussion of the terminology of type specimens, thus furnishing a valuable and concise summary of definitions, the understanding of which is necessary for the proper appreciation of the catalogue. In addition to terms already in use are others which are introduced here for the first time, and consequently call for brief notice. Primary types or proterotypes are divided into holotypes, cotypes (or syntypes), paratypes, lectotypes, and chirotypes, the last two terms being new. The term "chirotype" is proposed for "the material upon which a published manuscript name is based." In cases "where the original diagnosis is without illustrations or is accompanied by figures based on two or more specimens, the first subsequent author is at liberty to select from these cotypes a type for the old species, adhering, as far as can be ascertained, to the intention of the original author." Such a type specimen is designated a "lectotype." Supplementary types are divided into plesiotypes, neotypes, and heautotypes. "Heautotype" is a new term proposed by Buckman for "a specimen figured by an author as an illustration of his own already founded species, such not being a proterotype." Typical specimens are divided into "topotypes," "metatypes," "homœotypes," and "ideotypes" (new). The term "ideotype" is used by Buckman for specimens which come from places other than the original locality, and named by an author of a species after publication. The term "protograph" (suggested by Buckman for the original figure or figures illustrating a holotype) and "synthetograph" (a drawing which is a composite figure based upon several specimens of the new species) are also introduced here for the first time. For any artificial specimen moulded directly from a primary type Schuchert proposes the term "plastotype." For types of genera or genotypes the word "geno" is prefixed to the primary type terms, thus giving the corresponding terms "genoholotype," "genosyntype," and "genolectotype."

We cannot but feel grateful to Mr. Schuchert for his clear correlation of type terms. Although distinctly opposed to a multiplicity of terms in itself, we feel certain that such as are introduced in this volume justify their usage in the interest of scientific method.

I. T.

[1] Smithsonian Institution: Bulletin of the United States National Museum; Catalogue of Fossils, Minerals, Rocks, &c.. Merrill. Part i., Fossil Invertebrates. Pp. 704.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Dr. William Somerville has been elected to the Sibthorpian professorship of rural economy.

The following have been nominated to examine in the final honour schools:—in physics, Mr. W. C. D. Whetham; in chemistry, Prof. Arthur Smithells; in physiology, Mr. W. M. Bayliss.

An examination for a geographical scholarship of the value of 60*l.* will be held on October 11. Candidates, who must have taken honours in one of the final schools of the University, should send in their names to the reader in Geography, Old Ashmolean Building, Oxford, by October 1.

An appointment to the Oxford biological scholarship at Naples will be made next Michaelmas term. Candidates should send their names to the professor of comparative anatomy, the professor of physiology, or the professor of botany, by October 15.

CAMBRIDGE.—Dr. Nuttall, F.R.S., has been appointed reader in hygiene; Dr. L. Humphry has been re-appointed university lecturer in medicine, and assessor to the regius professor of physic.

The degree of LL.D. *honoris causa* will, on June 16, be conferred on His Excellency Paul Cambon, G.C.V.O., the French Ambassador.

A prize of 50*l.* from the Gordon-Wigan fund will be awarded in next Easter term for a research in chemistry to be carried out in Cambridge by a member of the University under the standing of Master of Arts.

A course of lectures and demonstrations in crystallography will be given during the long vacation by Mr. Hutchinson, beginning on July 7.

In the Mathematical Tripos, part i., two candidates are bracketed as senior wranglers, namely, Mr. A. T. Rajan and Mr. C. J. T. Sewell, both of Trinity. There are thirty-three wranglers. In part ii. all seven candidates are placed in the first class.

The diploma in agriculture has been awarded to six candidates, who have passed both parts of the examination.

The certificate of research has been awarded to two advanced students, Mr. P. Phillips and Mr. E. F. Burton, both of Emmanuel College, for researches in experimental physics.

Prof. Sims Woodhead will represent the University at the dedication of the new buildings of the Harvard Medical School on September 25 and 26.

The inaugural address of the local lectures summer meeting will be given by the Hon. Whitelaw Reid, American Ambassador, on August 2.

MR. HALDANE, M.P., Secretary of State for War, has consented to distribute the prizes at the London Hospital Medical College on Friday, July 13.

PROF. LECOMTE has been appointed professor of the botany of the phanerogams in the Paris Museum of Natural History, and Dr. Trouessart professor of zoology.

HERR ADOLF HALLICHS, managing director of the Friedrich Wilhelms metallurgical works, Mülheim, has been appointed a professor of the Technical High School at Aachen.

DR. R. SCHENCK, privatdocent for chemistry in the chemical institute of Marburg University, has been chosen for the professorship of physical chemistry in the Technical High School in Aachen.

DR. FRANZ ARTHUR SCHULZE, privatdocent and senior assistant in the physics institute in Danzig, has been appointed professor of physics in the Technical High School as successor to Prof. Zenneck, now in Brunswick.

MR. J. D. DALY, of the Department of Agriculture and Technical Instruction, Ireland, has been appointed secretary of the Royal Commission upon Trinity College, Dublin, and the University of Dublin.

DR. OTTO DIELS, senior assistant in the chemical institute of the University of Berlin, whose brilliant discovery of carbon suboxide was only recently made known, has been granted the title of professor. Dr. Karl Neuberg, assistant in the pathological institute of the same University, has also received the same honour.

AT the meeting of the Glasgow University Court on June 7 a letter of resignation was received from Prof. McKendrick, the professor of physiology. Prof. McKendrick has held the chair of physiology for thirty years, and has decided to retire at this time in order that his successor may have a considerable share in the equipment, and an opportunity of arranging the details of apparatus, both for teaching and research, of the physiological laboratories, which have been designed according to specifications supplied by Prof. McKendrick, and are now approaching completion.

IT is announced in *Science* that Yale University has received an anonymous gift of 1000*l.* to the forestry school, the income of which is to be used for the publication of works on forestry by graduates and members of the faculty.

THE council of the University of Paris has definitely approved of the scheme for the extension of the University. This will include, according to the *Lancet*, the construction of an institute of chemistry covering an area of 9000 square metres. Here will be established the various departments of chemistry belonging to the faculty of science and the department of applied chemistry which, since its creation, have been provisionally installed in some sheds. The cost of this will be 3,000,000 francs, which will be divided between the City of Paris and the State. The extension scheme also includes the acquisition by the University, in view of future necessities, of a plot of land of 14,000 square metres. Towards the cost of this land the University will pay 1,900,000 francs and the city 700,000 francs, to which will be added the donation from the Prince of Monaco. On a portion of this area will be erected the Institute of Oceanography, founded by the Prince of Monaco.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 15.—"On the Specific Heat of, Heat Flow from, and other Phenomena of the Working Fluid in the Cylinder of the Internal Combustion Engine." By Dugald **Clerk**. Communicated by the Hon. C. A. Parsons, C.B., F.R.S.

This paper describes experiments made with a gas-engine of sixty brake horse-power, devised to obtain data necessary for a more complete theory of the internal combustion motor, and also to discriminate between the effects of continued combustion in a gaseous explosion, and specific heat change, at temperatures between 200° C. and 1500° C. The new method of experiment consists in alternately compressing and expanding the highly heated gases within the engine cylinder while cooling proceeds, and observing by the indicator the successive pressure falls and compression and expansion curves from revolution to revolution.

From some two hundred indicator cards taken under varying conditions have been calculated:—(1) a curve of apparent specific heat of the gaseous contents at constant volume between 200° C. and 1500° C.; (2) curves of heat loss to the enclosing walls; and (3) distribution of heat in the working cycle calculated from diagrams only. The apparent specific heat at constant volume is proved to increase from 22 foot-pounds per cubic foot at 200° C. to 27·4 foot-pounds at 1500° C., and an examination of expansion curves and specific heat determinations made at different engine speeds and jacket temperatures shows that combustion is proceeding, and accounts for a part of the apparent increase of specific heat. Tables I. and II. show the apparent instantaneous specific heats and the mean specific heats in foot-pounds per cubic foot of working fluid at 0° C. and 760 mm.

Table I.—*Table of Apparent Specific Heats (Instantaneous) in foot-pounds per cubic foot of Working Fluid at* 0° *C. and* 760 *mm.*

Temperature °C.	Specific heat at constant volume ft.-lbs.	Temperature °C.	Specific heat at constant volume ft.-lbs.
0	19·6	800	26·2
100	20·9	900	26·6
200	22·0	1000	26·8
300	23·0	1100	27·0
400	23·9	1200	27·2
500	24·8	1300	27·3
600	25·2	1400	27·35
700	25·7	1500	27·45

Table II.—*Table of Mean Apparent Specific Heats in foot-pounds per cubic foot of Working Fluid at* 0° *C. and* 760 mm.

Temperature C.	Specific heat at constant volume ft.-lbs.	Temperature °C.	Specific heat at constant volume ft.-lbs.
0—100	20·3	0—900	23·9
0—200	20·9	0—1000	24·1
0—300	21·4	0—1100	24·4
0—400	21·9	0—1200	24·6
0—500	22·4	0—1300	24·8
0—600	22·8	0—1400	25·0
0—700	23·2	0—1500	25·2
0—800	23·6		

The curves of heat loss show that for equal temperature differences heat loss per unit surface exposed increases with density, and values are given of the heat losses for various temperatures. From these curves mean temperatures of the cylinder walls have been calculated, and shown to vary at full load from 190° C. for the whole stroke to 400° C. for the three-tenths stroke.

Calculations are made of heat distribution in the working cycle of the fluid which show that the total heat present in the form of combustible gas can be accurately calculated from the indicator diagram alone, by means of the new data obtained in the investigation.

It is pointed out that with a sufficiently sensitive indicating instrument the rate of continued combustion can be determined, and the true change of specific heat obtained from experiments made by the new method. The determination of the specific heat of gases heated by high compressions, such as one and a half tons to the square inch, is suggested, to avoid the complications introduced by combustion. It is shown that in these experiments the rate of loss of a mass of flame at 1000° C. to the comparatively cold walls of the cylinder was less than the rate of addition of heat by work performed by the piston, so that the flame temperature in the first compression rose from 1000° C. to about 1300° C., that is, compression in 0·25 second enabled a mass of flame to be handled in such a manner as to obtain accurate results. In these experiments, with maximum pressures of four hundred pounds per square inch, nearly twenty-eight tons total pressure was applied from 120 to 160 times per minute.

Mallard and Le Chatelier's experiments are discussed, and it is shown that no curve of specific heat can be deduced from their observations. It is pointed out that the curve of apparent change of specific heat of certain gases from 0° C. to 1500° C. has been here determined experimentally for the first time. The gases forming the working fluid consist mainly of carbonic acid, steam, nitrogen, and oxygen. The composition and all other details are given in the paper.

Anthropological Institute, May 22.—Prof. W. Gowland, president, in the chair.—(1) A series of slides of stone monuments found in Assam; (2) a paper on the "genna" (tabu) among the tribes of Assam: T. C. **Hodson**. The tabus are of two kinds, general or communal, as contrasted with private or individual tabus. Communal tabus are observed by the whole village, which consists of several exogamous subdivisions, and are automatic, in the sense that they are of regular occurrence or necessarily follow the occurrence of some event. These regular tabus are mostly connected with the crops, and are frequently times of great license. The village is made genna before the crop is sown, at the harvest-home, and sometimes on the appearance of the first blade of the crop. When the village is genna everyone must stay in until the tabu is over, and it sometimes lasts as long as ten days, and no one who is outside is allowed to come in. The village is also genna when a rain-making ceremony is necessary, and, in fact, any magical ceremony for the good of the whole community is necessarily accompanied by a general genna. Gennas are also occasioned by natural phenomena, such as earthquakes, eclipses, &c., and when the annual ceremony of laying the ghosts of those who have died within the year is held. Individual gennas are necessary at all important events in life, such as childbirth or marriage, and are as inevitable as crop gennas. They are also extended to certain foods, especially in the case of the head man of the village, and are also necessary when any person wishes to erect a monolith, usually for self-glorification. Such an individual is genna from the moment he takes the first steps towards erecting a monolith until the stone is finally in position. Slides of these monuments were shown by Mr. Hodson earlier in the evening. Gennas are also occasioned by the birth or death of any animal within the house, and warriors before and after a raid are subject to them.

Geological Society, May 23.—Mr. R. S. Herries, vice-president, in the chair.—The importance of Halimeda as a reef-forming organism, with a description of the Halimeda-Limestones of the New Hebrides: F. **Chapman** and D. **Mawson**. Calcareous algæ, nullipores, Lithothamnion, &c., have been frequently referred to as forming important contributions to the rock of coral-reefs. The material obtained in the great boring, the lagoon borings, and lagoon dredging at Funafuti has yielded a considerable quantity of Halimeda, and Dr. Guppy has described a Halimeda-Limestone in the Solomon Islands. Evidence such as this shows that the important deposits of calcareous plant-remains forming at the present day can scarcely be paralleled by any deposit formed in past geological times except, possibly, the limestones of the Alpine Trias, which owe their origin to the thallophytes Diplopora and Gyroporella. Among other Halimeda-Limestones mentioned by the authors are those of Christmas Island, Fiji and Tonga, and the New Hebrides.—Notes on the genera Omospira, Lophospira, and Turritoma, with descriptions of new species: Miss Jane **Donald**. The new species described in the paper belong to three genera, characterised by the possession of a band on all the whorls formed by the gradual filling up during growth of a sinus, and not a slit, in the outer lip.—Lantern-slide views illustrating the late eruption of Vesuvius and its effects: Prof. H. J. **Johnston-Lavis**. Nearly all the photographs were taken by the exhibitor, who explained the different phenomena portrayed. He considered this eruption to resemble mostly that of 1822, although the present crater was larger, attaining 1500 feet both north-by-south and east-by-west; it was probably 500 feet to 600 feet deep at least. The remarkable character about this eruption was the large amount of fragmentary material ejected, especially in a north-easterly direction, crushing in the roofs of the buildings in the towns of Ottajano, San Giuseppe, and Terzigno. At the first-named locality the depth attained was nearly 0·75 metre, made up as follows:—0·04 m. grey dust, 0·49 m. reddish lapilli, chiefly "supplementary ejecta," 0·20 m. black vesicular scoria, chiefly the "essential ejecta." The material which fell at the observatory and Naples had much the same arrangement, but was, of course, less, and practically only sand and dust. Near the base of the cone the ejecta attain to blocks several tons in weight; and it may be estimated that, at the north-eastern toe of the great cone, in some places, the débris must be 60 feet thick. It is to be seen as much as 30 feet in thickness in the new ravines that have been formed. After careful study, Prof. Johnston-Lavis had come to the conclusion that the remarkably uniform and deep scoring of the cone by very regular "barrancos" was due to the sliding and avalanche-like effect of the rapidly accumulating fragmentary material on the steep slopes, and not due to water-action. The volcano seems to have opened at four, if not five, different places on the south-western, southern, and south-eastern sides, giving rise to at least three important streams of lava. Another rift, to the north-north-east of the cone, emitted lava that forms an apron on that side of the mountain, and must, of course, have been formed early in the eruption, that is, before April 7 to 8. The ejected blocks are chiefly old lavas and scoria, partly re-cooked and metamorphosed, with their cavities filled by tachylytic juice from the fluid magma of the neighbouring chimney. The cavities are also often lined by sublimations of augite, hornblende, leucite, microsommite, hæmatite, halite, and a well-crystallised, yellow, deliquescent mineral which proves to be a new chloride of manganese and potash for which a new mineral name is proposed. A few fragments of limestone, and the various mineral aggregates derived by metamorphism from it, are met with, but they are chiefly re-ejected old ejected blocks. A light green spongy tachylyte is also frequent. The "essential ejecta," either as scoria or lava, does not show any marked difference from the usual products of Vesuvius in such eruptions during the last three centuries. Although much damage has been done, great areas of rugged lava-surfaces that would have required centuries to render cultivable are now available for the growth of woods, vines, and herbaceous plants.

Physical Society, May 25.—Dr. C. Chree, F.R.S., vice-president, in the chair. Colour phenomena in photometry: J. S. **Dow.** The author has found that to compare lights of different colours is chiefly a matter of practice. The central portion of the retina is more sensitive to red, and less sensitive to green, than the surrounding portion. When an attempt to photometer lights of different colour is made, differences are found as the distance of the eye from the photometer-screen is altered, and different results are obtained with different photometers. Differences of 5 per cent. can easily be obtained. The Purkinje phenomenon, generally regarded as a cause of uncertainty in ordinary work, only becomes noticeable at small illuminations and with large fields of view. Experiments are described to show that flicker photometers seem to be affected by colour-phenomena, but to a smaller extent than ordinary ones. Whether flicker or an ordinary photometer is adopted, it is necessary to specify the size of the field, the distance of the eye, and the order of illumination used in order to get consistent results.—Automatic arc-lamp: H. **Tomlinson** and G. T. **Johnston.** A simple form of automatic arc-lamp. A vertical brass tube supported by a wooden framework carries the upper carbon, which can be raised or lowered by hand and clamped in any position in the tube. The lower carbon fits into a hollow brass tube, and into the lower part of the tube is fitted an iron plunger. The plunger is surrounded by a solenoid, consisting of a layer of No. 14 copper wire, the internal diameter of the solenoid being slightly greater than the diameter of the plunger. The plunger dips into a box of mercury, and is made to float upright by means of a brass collar and by the rounded ends of three nails forming an equilateral triangle. The current enters the upper carbon through the brass cylinder, passes through the lower carbon into the mercury, and then through the solenoid. To "strike the arc" the lower carbon is raised to touch the upper one, and the plunger is then permitted to sink into the mercury until the suction of the solenoid balances the buoyancy of the mercury.—The theory of moving coil and other kinds of ballistic galvanometers: Prof. H. A. **Wilson.** The exact formulæ giving the quantity of electricity passed through various types of ballistic galvanometers in common use are obtained. The various types require different formulæ, all of which reduce to the same formula when the angle of deflection is small. In the case of a moving-coil galvanometer with rectangular coil, iron core, and pole-pieces arranged so as to give a radial magnetic field, the formulæ take a simple form. Bifilar galvanometer free from zero creep: A. **Campbell.** For measuring direct currents and voltages of ordinary range moving-coil galvanometers are convenient. The usual instruments are affected by gradual displacement of zero when a deflection is maintained for some time. This difficulty is got over by replacing the torsional suspension by a bifilar system with two wires so far apart that the gravity control swamps that due to the torsion of the wires. The wires are more than 1 cm. apart, and the sensitivity with 40 ohms resistance is 400 mm. at 1 metre for 0·001 ampere. The full deflection may be maintained for hours without causing a zero creep of 1 part in 2000. To attain good damping a powerful magnet is used.

Zoological Society, May 29.—Mr. Frederick Gillett, vice-president, in the chair.—Mammals collected by Mr. C. H. B. Grant in the Zoutpansberg district of the Transvaal, and presented to the National Museum by Mr. C. D. Rudd: H. **Schwann** and O. **Thomas.** The collection was obtained at two localities—Klein Letaba at 1000′ altitude and Woodbush at 4500′—and so gave a good general idea of the fauna of the region. In all it consisted of about 250 specimens belonging to fifty-one species and subspecies, of which several were described as new. In addition, the old genus Macroscelides was broken up into three, the new name Elephantulus being given to the group of which *M. rupestris* was the type, and Nasilio to that typified by *M. brachyrhynchus.*—The vascular system of Heloderma, with notes on that of the monitors and crocodiles: F. E. **Beddard.**—The external characters of an unborn fœtus of a giraffe (*Giraffa camelopardalis antiquorum* ♂ × *G. c. wardi* ♀): F. E. **Beddard.**—The South African diaptosaurian reptile Howesia: Dr. R. **Broom.**

DUBLIN.

Royal Irish Academy, May 14.—Dr. F. A. Tarleton, president, in the chair.—Some applications of Bessel's functions to physics: Prof. F. **Purser.** In this paper the author applies (1) the Besselian forms $K_0(nr)$ sin, cos nz and $J_0(mr)$ (sin h, cos h mz), where $K_0(nr) = J_0(<nr)$, to the solution of problems of electric potential, viz. the finite Leyden jar and equal circular disks fronting one another at different potential, the theory of the condenser formed by a circular disk midway between two large circular plates, and of the guard-ring electrometer. (2) The same functions are applied to some problems in fluid motion. (3) Certain problems in the theory of the elastic equilibrium of a right circular cylinder are discussed by the use of the Besselian forms

$$J_1\left(mr\right)\left(\frac{x}{r},\frac{y}{r}\right)\left(\sin h,\ \cos h,\ mz\right),$$

$$K_1\left(nr\right)\left(\frac{x}{r},\frac{y}{r}\right)\left(\sin,\ \cos nr\right)$$

where

$$J_1(x) = -\frac{d}{dx}J_0(x),\ K_1(x) = \frac{d}{dx}(K_0(x$$

(4) Lastly, the functions $J_0(mr)$, $J_1(mr)$ are applied to some problems of vortical motion of fluids under the influence of viscosity.—A map showing the relative distribution of various types of rock on the sea-floor off the west of Ireland, based on materials dredged by the Fishery Survey of the Department of Agriculture for Ireland: Prof. **Cole.** It is proposed to publish further details in the report of that survey, but meanwhile it is believed that the stones show the actual local distribution of rocks on sunken land, and are not the result of casual drift. The Porcupine Bank undoubtedly consists of a mass of olivine-gabbro, while a Carboniferous area west of co. Galway indicates that Connemara may have risen as an island in the Carboniferous sea.

Royal Dublin Society, May 15.—Prof. J. A McClelland in the chair.—Injurious insects and other animals observed in Ireland during 1905: Prof. G. H. **Carpenter.** In addition to records of several well-known farm and orchard insects, the paper contains an account of the rare "cauliflower" disease of the strawberry, due to the small nematode worm *Aphelenchus fragariae*, J. R. Bos, observed in county Wicklow.—A possible connection between the recent disturbances at Vesuvius and San Francisco: Rev. H. V. **Gill.** This paper contained an account of some experiments with rotating bodies, and an application of the principles involved to certain seismic phenomena. A hollow tee-totum weighted at one point will not spin about its axis of symmetry, but if it contain matter capable of shifting its position, it will automatically tend to steady itself, owing to the symmetrical distribution of the movable matter round its circumference. For example, if three steel balls of equal size be dropped into a smooth, hollow tee-totum they will take up equidistant positions round the edge. These results suggest the possibility of seismic disturbances being related in some such way. The above principles were applied to the disturbances which characterised the month of April—Vesuvius, April 8; Formosa, April 14; San Francisco, April 18. The possibility of this explanation being correct is supported by observed facts in connection with displacement of the poles associated with great earthquakes, and also by the positions of the localities referred to.

PARIS.

Academy of Sciences, May 28.—M. H. Poincaré in the chair.—Remarks on work recently carried out at the Observatory of Besançon: M. **Lœwy**.—Centres of gravity of spiraloid systems: Baton **de la Goupillière**.—An expedition in an aërostat, projected for the exploration of the North Pole: J. **Janssen**. An account of an expedition projected by Mr. Walter Wellman, and supported by the Geographical Society of Washington.—Addition to the note on the use of low temperatures in chemical analyses: MM. **d'Arsonval** and **Bordas**. In the majority of cases the vacuum obtainable by an ordinary pump is sufficient. In certain cases, however, the authors have found it advantageous to use either a mercury pump, or charcoal and liquid air, according to Dewar's method.—Magnetic observations at Tananarivo: Ed. El. **Colin**. Three tables are given showing the results of the absolute measurements of the declination, inclination, and the horizontal component at the Observatory of Tananarivo, taken weekly from May, 1905, to April, 1906.—M. Charles Trépied was elected a correspondant in the section of astronomy in the place of M. Perrotin. The properties which correspond to monogeneity for functions of a hypercomplex variable: Léon **Autonne**.—A particular class of Θ-functions: Henry **Bourget**.—The resistance of electrolytes for high-frequency currents: André **Broca** and S. **Turchini**. The authors showed a year ago that the theory of Lord Kelvin relating to the resistance of cylindrical conductors for currents of high frequency leads, in the case of metals, to results presenting systematic differences from those obtained experimentally. In the experiments in the present paper the conductor is an electrolyte. The resistance was first measured for a low-frequency current (42), and this assumed to be the same as with a continuous current. The resistance of the same solution was then measured with high-frequency currents (190,000 to 3,000,000). For very dilute acid or sulphate of copper solution the ratio of the two resistances thus measured was unity, but for solutions of higher conductivity the heating is less with a high-frequency current than with a low-frequency current, contrary to the result predicted by theory.—X-ray tubes with an automatic regulator: G. **Berlemont**.—The variations in the state of amorphous carbon under the influence of temperature and under the action of oscillations of temperature: O. **Manville**. Amorphous carbon, heated in a current of oxygen, commences at a definite temperature to give carbon dioxide, and at another, higher, temperature, carbon monoxide. These temperatures are a function of the temperature to which the carbon has been previously heated.—The acid phosphites of primary cyclic amines: P. **Lemoult**. The acid phosphites of aniline, *o*-toluidine, and *m*-xylidine are described, together with an advantageous method for preparing them.—The absolute atomic weight of terbium: G. D. **Hinrichs**. If the atomic weights of oxygen, sulphur, and hydrogen used in the determination of the atomic weight of thorium from the analytical figures be taken as the round numbers 16, 32, 1, then the atomic weight of thorium becomes also the round number 159, instead of the 159·22 deduced by M. Urbain.—A contribution to the study of pure ferrotungstens: Em. **Vigouroux**. Using the aluminothermal method, tungsten steels can be obtained containing 46·25 per cent. of tungsten; these, when extracted with dilute hydrochloric acid, yield the whole of the free iron, leaving a substance containing 68·7 per cent. of tungsten, a figure corresponding to Fe_3W_2.—Combinations of mercuric iodide and free methylamine: Maurice **François**.—Some hydro-anthracene derivatives: Marcel **Godchot**. A description of the mode of preparation and properties of octahydro-anthranol and its phenylurethane, β-anthracene hexahydride, γ-anthracene tetrahydride and its dibromo-derivative.—The rapidity of absorption of odours by milk: F. **Bordas** and M. **Touplain**. In an atmosphere containing only 1/100,000 of formaldehyde a few minutes' exposure is sufficient for the milk to show clearly the reaction of the aldehyde. The fresher the milk the more rapidly the absorption appears to take place.—A qualitative reaction of phosphorus: M. **Mauricheau-Beaupré**. The reaction is based on the depolishing of glass by the action of a flame containing small amounts of phosphorous compounds.—A new method for the microscopical analysis of flour and the determination of rice starch in wheat flour: G. **Gastine**. The flour is treated with certain colouring materials in solution, the whole slowly dried on the slide, and mounted in Canada balsam. The differential staining of the hilum is the basis of the method.—Oxydising catalysers and the generalisation of flameless combustion: C. **Matignon** and R. **Trannoy**.—Autocatalysis and the decomposition of a photochemical system: Béla **Szilard**. Details are given of the action of light on a solution of triiodomethane in chloroform.—The study of heterogeneous equilibria under varying pressures: E. **Briner**. The increased pressures are obtained by the use of a cylinder of compressed carbon dioxide, whilst the constancy of temperature during the reaction is ensured by a vapour jacket. A diagram of the apparatus used is given.—The nearly total transformation of the dextrins arising from the saccharification of starch into maltose: A. **Fernbach** and J. **Wolff**. The rate of production of maltose from the dextrins is much slower than the conversion of the starch into the dextrins, so that it is incorrect to assume that the reaction is finished when the liquid no longer gives the iodide of starch reaction. It is proved experimentally that if there exists a dextrin not transformable into maltose, it can represent only a minute fraction of the original starch.—The principles of gutta-percha obtained from *Palaquium Treubi*: E. **Jungfleisch** and H. **Leroux**. From the crude gutta from the leaves of this plant a new substance has been isolated, to which the provisional name of paltreubin is given. It appears to be a mixture of two isomeric alcohols of the formula $C_{30}H_{49}.OH$, the acetates of which were prepared.—The spores of a Streptothrix: MM. **Brocq-Rousseu** and **Piettre**. Under certain conditions of cultivation the spores could be obtained in such abundance that they could be analysed. The analyses given are stated to be the first published on the spores of the lower fungi.—An invasion of algæ (*Colpomenia sinuosa*) on the oysters of the Vannes River: M. **Fabre-Domergue**.—The evolution of some crustacean gregarians: L. **Léger** and O. **Dubosq**.—Researches on the relations between emotional states and infection: M. **Vaschide**. It is known that the leucocytes play an important part in the pathological processes of infection, the state of infection being especially connected with an increase in the proportion of leucocytes with polymorphic nuclei. The author has found that certain profound emotions are followed by an increase in the polynuclear leucocytes. The author cites well-known facts in pathology in support of his results.—Experimental infection by *Trypanosoma brucei*. The destruction of the parasite in the spleen: A. **Rodet** and G. **Vallet**. Experiments on dogs and rats show that in infection by this trypanosome the spleen and the other lymphoid organs are foci for intense destruction of the parasites. The spleen is endowed with an energetic trypanolytic power, and this organ evidently plays an important part in the defence of the body against infection.—The pathogenic importance of bronchial adenopathy: Gabriel **Arthaud**.—The frequency and the probable etiological *rôle* of *Uncinaria americana* in beri-beri: F. **Noc**.—The contradiction of glacial erosion: Jean **Brunhes**.—The degree of mineralisation of subterranean waters: F. **Dienert**.

NEW SOUTH WALES.

Linnean Society, April 25.—Mr. C. Hedley in the chair.—The geology of the volcanic area of the East Moreton and Wide Bay districts, Queensland: H. I. **Jensen**. The district investigated lies between the Pacific Ocean and Moreton Bay on the east, and the beds of the Mary and Stanley Rivers on the west; and between Cooran on the north and North Pine on the south. It is important from a geological point of view on account of the variety of igneous rocks to be found within its borders. The author shows that the low-lying district east of the Blackall and D'Aguilar Ranges, which is composed essentially of Trias-Jura sandstones belonging to the Ipswich Coal-measures and Tertiary alluvials, has been subject to oscillatory movements of elevation and depression in late Tertiary times. At present elevation is going on, as evidenced by raised beaches at Point Arkwright and elsewhere along the coast. The D'Aguilar Range north of Woodford is made up of Trias-Jura sandstone, but to the south of this point it consists of highly interesting plutonic and metamorphic rocks belonging in part to the Gympie beds, in part to much older formations. The country to the west of the D'Aguilar Range forms a peneplain with an average elevation of 500 feet. The Blackall Range is shown to consist of basalt capping rhyolites and rhyolitic tuffs, and Trias-Jura sandstones. The Maroochy district was a centre of great volcanic activity, rhyolites, andesites, dacites and basalts, as well as extensive areas of tuff and breccia, being here found.—The botany of Howell (Bora Creek), N.S.W.: a tin-granite flora: J. H. **Maiden**. Howell is situated nineteen miles to the south-east of Inverell. The tin-granite area under consideration extends in a two- or three-mile radius from the township. It lies on the western New England slope, at an elevation of about 2500 feet, and is included in E.9, New England County, of the botanical map to be found in the society's Proceedings for 1901 (p. 766). A list of the plants found so far, about 150 species referable to forty-two natural orders, is given. The locality is especially rich in Acacias, *A. neriifolia* perhaps being most abundant.

DIARY OF SOCIETIES.

THURSDAY, JUNE 14.

ROYAL SOCIETY, at 4.30.—The Experimental Analysis of the Growth of Cancer: Dr. E. F. Bashford, J. A. Murray, and W. H. Bowen.—On the Electrical and Photographic Phenomena manifested by certain Substances that are commonly supposed to be Ætiologically Associated with Carcinoma: Dr. W. S. Lazarus-Barlow.—The Bone Marrow; a Cytological Study forming an Introduction to the Normal and Pathological Histology of the Tissue: Dr. W. E. Carnegie Dickson.—On the Relation of the Liver Cells to the Blood Vessels and Lymphatics: Dr. P. T Herring and Dr. S. Simpson.—Studies on Enzyme Action, Lipase, II.: Prof. H. E. Armstrong, F.R.S., and Dr. E. Ormerod.—Studies of the Processes operative in Solutions, I., The Sucroclastic Action of Acids as Influenced by Salts and Non-electrolytes: R. J. Caldwell.—The Origin of Osmotic Effects: Prof. H. E. Armstrong, F.R.S.

MATHEMATICAL SOCIETY, at 5.30.—Exhibition of Models of Space-filling Solids: W. Bailey.—The Algebra of Apolar Linear Complexes: Dr. H. F. Baker.—Supplementary Note on the Representation of Certain Asymptotic Series as Convergent Continued Fractions: Prof. L. J. Rogers.—On Certain Special Types of Convertible Matrices: J. Brill.

INSTITUTION OF MINING ENGINEERS, at 11 a.m.—Address by the President.—The Commercial Possibilities of Electric Winding for Main Shafts and Auxiliary Work: W. C. Mountain.—Electrically-driven Air-compressors, combined with the working of the Ingersoll-Sergeant Heading-machines, and the subsequent working of the Busty Seam: A. Thompson.—Practical Problems of Machine-mining: Sam Mavor.—The Strength of Brazed Joints in Steel Wires: Prof. Henry Louis.—Bye-product Coke and the Huessener Bye-product Coke Ovens: J. A. Roelofsen.—Considerations on Deep Mining: George Farmer.

SOCIETY OF PUBLIC ANALYSTS, at 8.—An Examination of the Method of Milk Analysis used at the Government Laboratory in connection with Samples referred under the Sale of Food and Drugs Acts: H. D. Richmond and E. H. Miller.—On the Examination of Linseed, Olive and other Oils: R. T. Thomson and H. Dunlop.—On the Composition and Valuation of Oils used for Gas-making Purposes: R. Ross and J. P. Leather.—Note on Fractional Distillation by Steam Vapour: H. Hardy and B. Richens.—A New Method for the Estimation of Tartaric Acid: A. C. Chapman and P. Whitteridge.

FRIDAY, JUNE 15.

INSTITUTION OF MINING ENGINEERS, at 10.30 a.m.—Rescue Apparatus and the Experience made therewith at the Courrières Collieries by the German Rescue Party: G. A. Meyer.—A New Apparatus for Rescue-work in Mines: W. E. Garforth.—A Rateau Exhaust-steam-driven Three-phase Haulage Plant: William Maurice.—Development of Placer Gold-mining in the Klondike District, Canada: J. B. Tyrrell.—Mining Education: Prof. J. W. Gregory.—The Capacity-current and its Effect on Leakage Indications on Three-phase Electrical Power-service: Sydney F. Walker.—Petroleum Occurrences in the Orange River Colony: A. R Sawyer.

NATIONAL ASSOCIATION FOR THE PROMOTION OF TECHNICAL AND SECONDARY EDUCATION, at 3.—Annual General Meeting.

MONDAY, JUNE 18.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—A Fifth Journey in Persia: Major P. Molesworth Sykes, C.M.G.

TUESDAY, JUNE 19.

ZOOLOGICAL SOCIETY, at 8.30.—The Nudibranchs of South India and Ceylon: Sir Charles Eliot, K.C.M.G.—Description of a New Species of Zebra: The Hon. Walter Rothschild.—On the Entomostracan Fauna of the New Zealand Lakes: Dr. G. Stewardson Brady, F.R.S.—Note on some Crustacea from the Freshwater Lakes of New Zealand: Dr. Charles Chilton.—A Classification of the Selachian Fishes: C. Tate Regan.

ROYAL STATISTICAL SOCIETY, at 5.—The Generalised Law of Error, or Law of Great Numbers: Prof. F. Y. Edgeworth.

WEDNESDAY, JUNE 20.

ROYAL MICROSCOPICAL SOCIETY, at 8.—On the Structure of some Carboniferous Ferns: Dr. D. H. Scott, F.R.S.

ROYAL METEOROLOGICAL SOCIETY, at 4.30.—The Development and Progress of the Thunder Squall of February 8, 1906: R. G. K. Lempfert.—The Mean Prevalence of Thunderstorms in Various Parts of the British Islands during twenty-five Years, 1881–1905: F. J. Brodie.—Note on a Typical Squall at Oxshott, May 25, 1906: W. H. Dines, F.R.S.

THURSDAY, JUNE 21.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: The Transition from the Liquid to the Solid State and the Foam-structure of Matter: Prof. G. Quincke, For.Mem.R.S.—Experimental Evidence of Ionic Migration in the Natural Diffusion of Acids and Salts. R. G. Durrant.—Ionic Velocities in Gases at Different Temperatures: P. Phillips.—The Action of Radium and Certain Other Salts on Gelatin: W. A. Douglas Rudge.—On the Electric Inductive Capacities of Dry Paper and of Solid Cellulose: A. Campbell.

CHEMICAL SOCIETY, at 8.30.—The Cleve Memorial Lecture: Prof. T. E. Thorpe.—The Constituents of the Essential Oil from the Fruit of *Pittosporum undulatum*: F. B. Power and F. Tutin.—Mobility of Substituents in Derivatives of β-Naphthol: J. T. Hewitt and H. V. Mitchell.

LINNEAN SOCIETY, at 8.—On the Botany of Southern Rhodesia: Miss L. S. Gibbs.—On the Authentic Portraits of Linnæus (lantern slides): W. Carruthers, F.R.S.—Plantæ novæ Daweanæ in Uganda lectæ: Dr. Otto Stapf.—On the Genitalia of Diptera: W. Wesché.

FRIDAY, JUNE 22.

PHYSICAL SOCIETY, at 5.—The Effect of Radium in Facilitating the Visible Electric Discharge *in vacuo*: A. A. Campbell Swinton.—A Comparison between the Peltier Effect and other Reversible Heat Effects: A. O. Allen.—The Effect of the Electric Spark on the Actinity of Metals: T. A. Vaughton.—Dielectric Strength of Thin Liquid Films: Dr. P. E. Shaw.—The Effect of Electrical Oscillations on Iron in a Magnetic Field: Dr. W. H. Eccles.

CONTENTS.

PAGE

THURSDAY, JUNE 21, 1906.

BRITISH INLAND NAVIGATION.

Our Waterways. A History of Inland Navigation considered as a Branch of Water Conservancy. By Urquhart A. Forbes and W. H. R. Ashford. Pp. xv+336. (London: John Murray, 1906.) Price 12s. net.

IT was originally intended to deal in this volume with the whole subject of water conservancy, which has been defined as "the scientific treatment and regulation of all the water received in these islands, from its first arrival in the form of dew or rain till its final disappearance in the ocean," tracing the evolution and subsequent history of the various branches of water conservancy, which, in addition to inland navigation, comprise fisheries, water-supply, the mitigation of floods, and the prevention of river pollution. Owing, however, to the greatly increased interest displayed in the improvement and utilisation of our inland waterways, this subject has been given precedence of the other branches, and forms the main purport of this book, though the other branches are occasionally referred to.

The appearance of the volume is in any case very opportune, for it has approximately coincided with the appointment of a Royal Commission to inquire into the condition of the inland waterways of the United Kingdom, and to investigate whether it might be possible to devise some scheme by which inland navigation in the British Isles, so long neglected, may be revived and improved, so as to serve profitably for the conveyance of bulky goods, and thereby reduce the cost of carriage, and thus place British manufacturers in a more favourable condition for competing with their foreign rivals, and especially with those for whom a paternal Government has provided the facilities of free and commodious inland waterways.

After a short introductory chapter on "The Objects of Water Conservancy," the rainfall, drainage areas, and principal rivers of the British Isles are referred to in a chapter on "The Water System of the United Kingdom," and certain important changes noted; whilst in the next chapter the legal aspects of water conservancy are dealt with. The authors trace three distinct periods in the history of the navigation of our waterways, namely, the first period, dating from early times up to near the close of the sixteenth century, when the rivers were used for navigation in their natural condition, as described in a chapter on the "Natural Waterways" of England; a second period, from the close of the sixteenth century to the commencement of the Bridgewater Canal in 1759, inaugurating the canal system in England, during which time inland navigation on the rivers was improved and extended by deepening their channels, of which some account is given in chapter v.; and, lastly, the canal era, dating from the construction of the Bridgewater Canal, which, after a chapter on ancient and early British canals, is dealt with in two chapters in regard to England and Wales. A chapter on "The Conservancy of Rivers in England and Wales since the Eighteenth Century" brings the history of English rivers down to the present time; whilst another chapter, on "Rivers and Canals in Ireland and Scotland," where the development of inland waterways was only commenced in the eighteenth century, completes the sketch of river and canal navigations in the United Kingdom. In chapter xi. the decline of inland navigation in the face of railway competition, and by the purchase of important links by the railway companies, is referred to, and statistics as to the total length of canals in the United Kingdom, their traffic and revenues are given; whilst the various causes which have contributed to the very depressed condition of the great majority of the canal companies are explained.

Though the book contains, as indicated by the preceding summary, a considerable amount of information as to the rise, progress, and present condition of the inland waterways of the United Kingdom, as well as the legislative enactments controlling them, which Mr. Forbes, as a barrister, is specially qualified to deal with, the most interesting subject at the present time is undoubtedly the one considered in the last chapter, namely, "The Resuscitation of Our Waterways," to which the previous portion of the book has gradually led up. In dealing, however, with this subject, it is important to draw a very definite distinction between the inland waterways with which the authors are concerned and the maritime waterways of the United Kingdom, such as the tidal estuaries and rivers and the Manchester Ship Canal, which, though referred to amongst inland waterways, are quite outside the scope of the book, and are in no need of resuscitation. The flourishing sea-going trade of Great Britain is, indeed, due to her maritime waterways, many of which have been greatly improved to keep pace with the growth of traffic and the increasing draught of large vessels; whilst the Manchester Ship Canal, though proceeding inland, and having unfavourably affected schemes for the development of inland waterways by its unsatisfactory financial results, is essentially a maritime waterway, and has proved of great value to the sea-going trade of the district by converting the inland city of Manchester into a seaport, independent of Liverpool and the railways.

Whereas, however, the United Kingdom, with its very extensive coast-line and numerous important tidal rivers, is exceptionally well fitted by nature for maritime trade, its restricted area and small river-basins, resulting in small rivers above their tidal limit, separated by high water-partings in proportion to the moderate distance between them requiring to be surmounted by a canal, place this country at a serious disadvantage in regard to inland navigation as compared with the continent of Europe, with its very extensive river-basins draining into large rivers flowing for long distances over comparatively level plains, and capable in some cases of being joined across their water-parting by a canal of requisite size, without having to rise to a considerable elevation, and at a reasonable cost. In spite, nevertheless, of these manifest disadvantages, there is no doubt that the inland waterways of England have been unduly allowed to fall into decay, owing to a surrender in several cases to the railways, the absence of concerted effort to procure uniformity of dimensions in through routes and to effect amalgamations, and the neglect of improvements. Those inland waterways which are under a single control, which possess the requisite traffic in bulky goods, and have been enlarged and improved to provide for the growth of traffic, such as the Aire and Calder Navigation with its coal trade, and the Weaver Navigation with its salt trade, have been able to maintain a very successful competition with the railways; and where waterways connect large centres of commerce and there is a large trade in bulky goods, the old, inadequate waterways have been able to retain a considerable traffic, as exemplified by the Leeds and Liverpool Canal, and the canals clustering round Birmingham and from the Potteries. A careful study of the statistics of Continental waterways proves that, notwithstanding the natural advantages they possess, and the uniformity in size and improvements which have been provided, only those waterways obtain a large traffic which deal with bulky goods and traverse long distances with merely moderate alterations in level.

The value of inland waterways in offering an alternative route to railways for bulky goods, and thus tending to reduce railway rates, as well as relieving railways from being overburdened by the least remunerative portion of their traffic, is obvious; but the points requiring solution are, from what source the funds can be provided for putting the principal waterways in a position to compete with the railways for the conveyance of bulky goods, and what waterways afford a good prospect of a reasonable return on the capital expended in their requisite improvement. The authors, in their final chapter on "The Resuscitation of Our Waterways," after directing attention to the interest aroused in recent years in inland navigation, the steps which have been taken for amalgamating some of the canal companies, the lesser cost of transport and maintenance in the case of canals than with railways, and the possibility of discharging goods at any places on the banks of a canal, indicate three methods by which the necessary improvements, unification of dimensions, amalgamation, and control of inland waterways, might be effected.

The first method is the conferring of additional powers on the Board of Trade to supervise the improvement and development of those waterways which have opportunities of trade in bulky goods, the necessary funds being lent them by Parliament or by local authorities. The second method is "the establishment of a canal trust to acquire, develop, extend, and administer, in the public interest, canals and navigations in England and Wales," which would be empowered to raise the requisite funds by the issue of guaranteed canal stock. The third method is "the nationalisation of waterways" by the purchase of the canals by the Government with funds raised by a loan with this object, which the authors consider is the best method, and one which would speedily repay the cost "by doubling our means of communication" and "by the immense incentive given to commercial enterprise." Unfortunately, this is a very optimistic view of the results of the purchase and improvement of our inland waterways by the Government, and not at all likely to be realised, for their total length in England and Wales is only about a fifth of the length of the railways; and only a few of these waterways could be improved with any prospect of a remunerative expenditure. Considering that many of the French canals have a traffic which could hardly pay the working expenses, as is the case with the Caledonian Canal, which belongs to the Government, it is evident that the purchase and improvement of the English canals as a whole would be a financial mistake; but the connection of Birmingham with a seaport by an adequate waterway, the improvement of some of the antiquated canals in its neighbourhood, and the development of some through routes might be effected with good prospects of satisfactory commercial and financial results.

RECENT BOTANICAL BOOKS.

(1) *Alien Flora of Britain.* By S. T. Dunn. Pp. xvi + 208. (London: West, Newman and Co., 1905.) Price 5*s.* net.

(2) *The Aconites of India.* Annals of the Royal Botanic Garden, Calcutta, vol. x., part ii. By Dr. Otto Stapf. Pp. ii + 115–197; with 25 plates. (Calcutta: Bengal Secretarial Press, 1905.) Price 1*l.* 1*s.*

(3) *An Enumeration of the Vascular Plants from Surinam.* By Dr. A. Pulle. Pp. 555. (Leyden: E. J. Brill, Ltd., 1906.) Price 15*s.*

(4) *Die europäischen Laubmoose.* By Georg Roth. Pp. xxviii + 1331. 2 vols. (Leipzig: W. Engelmann, 1903–1905.)

(1) IT has been pertinently remarked that the British cannot altogether escape the designation of aliens in view of the continual influx of foreigners, whether peacefully or formerly as invaders, but in such cases the descendants are eventually regarded as natives. Plants cannot, at any rate within historic times according to the author of this book, pass from the class of aliens to the class of natives. This is an exclusive view, but from a scientific aspect logical and correct. It is a difficult matter to establish a test for the validity of native species, especially in an insular country that has been extensively cultivated and the inhabitants of which have been the foremost voyagers in the world. The criteria adopted by the author depend mainly upon a consideration of the distribution of each species in Great Britain and adjacent countries. This applies especially to plants that are generally recorded as weeds from artificial habitats, but which may nevertheless be truly indigenous; the author distinguishes a considerable number of these that are readily noted, since their descriptions are placed within brackets. A

noticeable genus is Ribes, for which the author favours the inclusion amongst natives of the species *alpinum, grossularia, nigrum*, and *rubrum*. The compilation of this group has demanded much thought, and whether one agrees or disagrees with the discrimination, it is an extremely valuable expression of opinion, and affords the opportunity to those interested to place on record any apparently natural localities for these species. Less interesting, but forming an integral part of the subject, are the more obvious aliens, including introductions, casuals, and what may be termed drifts. The book fully bears out the expectations that were formed of its original and critical character, and to the author's wife due credit must be given for enabling the book to take shape when the pressure of official duties seemed likely to delay its publication.

(2) The early attempts to classify the Indian aconites were prompted by the desire to trace the source of the poisonous root known as Nepal aconite or Bikh. In 1802, when the East India Company decided to send a mission to Nepal, Dr. F. Hamilton was deputed to join the expedition in a scientific capacity, and he endeavoured without success to identify Bikh. After him Wallich took up the collection of Nepal aconites, but, unfortunately, his plants assigned to *Aconitum ferox* were not the source of Bikh, although such was assumed. The confusion so originated was increased when, later on, the same scientific name was applied to different plants from Kumaon and Garwhal, and these and other misnomers have continued to the present day. To Sir George Watt much credit is due for attempting to clear up the nomenclature. In touring through the localities mentioned he spared no pains to collect plants and to ascertain their vernacular names with any general information, and this has materially helped Dr. Stapf in preparing the present monograph. Most of the species fall into two sections—Lycoctonum, containing perennials, and Napellus, containing biennials. The latter is the important group including *Aconitum spicatum*, the true Bikh, and the allied Nepal species, *Aconitum laciniatum*, termed Bikhoma, also *Aconitum heterophyllum*, which contains a bitter but non-poisonous substance, *atisine*, and a similar species, *Aconitum palmatum*. Dr. Stapf decides against the occurrence of *Aconitum napellus* in India, the nearest congener being the poisonous species *Aconitum soongaricum*, of which the properties are unknown. In addition to the task of discriminating between the names ascribed to herbarium specimens and establishing the identity of vernacular designations, Dr. Stapf works out a classification based upon the anatomical structure of the roots. For the biennial species he distinguishes three types of root, the first, normal, showing one continuous ring of cambium; in the second the cambium is separated into several portions, and the bundles appear as star-shaped masses embedded in uniform tissue; the third is characterised by cambium bands having a circular or horseshoe-shaped cross-section.

(3) The colony of Surinam, or Dutch Guiana, has been visited by a large number of plant-collectors, of whom the most important, all about the middle of the last century, were Hostmann, Kappler, Focke, Splitberger, and Kegel, and quite recently Went and the author. A considerable number of the plants sent to Europe by the earlier collectors had been previously worked out, and a list of some fifty papers dealing with the classification of selected portions from different collections is given under the literature; but this is the first attempt to prepare a complete list of the vascular plants. The author has discovered twelve new species, including two in Podostemaceæ, two in Melastomaceæ, one in Loranthaceæ, and a Vanilla. Looking through the orders, the Leguminosæ are the most abundant, then the Orchidaceæ, Gramineæ, and Melastomaceæ in descending order. The Malpighiaceæ, Sapindaceæ, and Guttiferæ are proportionately well represented, and among the ferns Polypodiaceæ and Hymenophyllaceæ. Some of the more important genera are Miconia, Ipomœa, Piper, Peperomia, Inga, Schizæa, Vanilla, and the tropical American genus Dichæa. A tabulated comparison is made with the floras of British Guiana, French Guiana, and the Amazon district, showing that about 60 per cent. of the plants of Surinam occur in each of these regions, and that about 14 per cent. are endemic.

In the phytogeographical survey reference is made to a typical mangrove vegetation found in the river estuaries that gives place to a littoral alluvial belt. The vegetation of the river banks is extremely rich, mention being made of the araceous *Montrichardia arborescens, Pachira aquatica*, and *Cacoucia coccinea*. Further inland there are plains on higher ground called savannahs, but differing from the true savannahs or from the campos of Brazil, where sedges, grasses, species of Schizæa, Eriocaulaceæ, and Melastomaceæ are abundant. In the primitive forest Selaginellas and hymenophyllaceous ferns find a suitable habitat, while *Tecoma leucoxylon, Mimusops Balata, Eriodendron anfractuosum*, and certain Lecythidaceæ are amongst the important trees.

In addition, a list of vernacular names is given, and a few illustrations of typical plant formations that are excellent; also figures of the new species are provided and a map of the country. As Dr. Pulle has been at considerable pains to consult the principal collections in Holland and elsewhere, the enumeration is complete, and the volume forms a valuable contribution to the botany of tropical South America.

(4) To bryologists in this country Lindberg's system, in which the cleistocarpous mosses are incorporated with stegocarpous forms, is the most familiar, as Braithwaite and Dixon have both followed this arrangement. On the Continent, Brotherus has also adopted Lindberg's system in his classification of the mosses in the "Naturliche Pflanzenfamilien." Mr. Roth has preferred to conform more closely to Schimper's grouping, and in this respect and others his classification is very similar to that of Limpricht in "Rabenhorst's Kryptogamenflora." He retains a large number of independent genera

instead of uniting several as subgenera under one main genus, here again differing from English authorities. A good instance is afforded by a comparison of the species united under Weisia by Dixon with the same species that are referred by Roth to seven different genera; and two of these are quite separated from the others, as they fall under the Cleistocarpi. In his treatment of the Hypnaceæ, to which family one naturally turns, Roth also differs considerably from Schimper. Dixon collects ten of Schimper's genera under his genus Hypnum, but specifies five of them as subgenera. Roth has twelve equivalent genera, but again four genera are placed in a different family, and unnecessarily, although not without reason, the genus or subgenus Harpidium is changed to Drepanocladus. This is one of the names which, it is hoped, will be sustained when the nomenclature of the cryptogams is discussed at the next International Botanical Congress.

The points of difference between this work and Dixon and Braithwaite's books are so numerous that British moss-workers will refer to the "Europäischen Laubmoose" for contrast rather than for comparison. As a practical handbook for naming mosses the work deserves much commendation, and bears ample evidence that the writer has definite opinions to express. It is a great pity that analytical tables for distinguishing genera are not given, but the descriptions are good, and important characters are thrown into bolder type. References to the most recent discoveries of new localities and new varieties will be found. The illustrations are very numerous, but poor in execution.

PHOTOGRAPHY IN SURVEYING OPERATIONS.

An Elementary Treatise on Phototopographic Methods and Instruments. By J. A. Flemer. Pp. xix+438. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1906.) Price 21s. net.

THE assistance that photography can render in the laborious work connected with topographical surveys has been repeatedly insisted upon, and the recognition of the fact is being displayed in the construction of a class of instruments admirably adapted for use in the field. With the more convenient instruments that experience will suggest, and with the shortened methods that familiarity will supply, the employment of photography is likely to be still more general, though doubtless it will have to contend against a certain amount of prejudice in favour of older methods.

Mr. Flemer's book is intended to overcome these prejudices and to determine the exact field which the camera can usefully occupy in surveying operations. The method has its limitations. The accuracy of a map constructed from panoramic views must evidently depend upon the precision with which objects can be identified and measured on a photograph or its enlargement. The use of telephoto-lenses or long-focused cameras would increase the accuracy, but at the expense of convenience. More numerous photographs taken at shorter distances would also have the same effect, but then the labour of collecting and reducing the material would approach that due to the ordinary methods. It is the object of such a book as this to show that photography has distinct advantages peculiar to itself. But in many directions in which extreme accuracy is unnecessary, perspective views can be of essential service. A series of panoramic pictures showing the alteration in the face of the country due to volcanic eruptions, or the recurrent changes in sand dunes caused by winds blowing from certain directions at regular intervals, seem to be peculiarly suitable inquiries for photographic methods. Similarly, the changes in glacier formation and the determination of their motion, alterations in coast-line due to erosion, or the location of rocks and buoys would suggest other applications for the process. In wars and manœuvres, either with or without the use of balloons, the process has a large field of application.

Since the translation of a perspective view or combination of views into maps possessing considerable accuracy of detail is likely to concern many other professions than that of a surveyor, properly so called, it is most desirable to have a treatise in which is set out clearly the methods of construction and of the principles underlying the practice of the process. This want Mr. Flemer's book is intended to supply. That the author is competent to deal with the subject practically we entertain no doubt, but whether he has been successful in conveying his knowledge to others it is very difficult to judge. Surveying is technical work that can hardly be learnt without actual experiment in the field under the eye of a trained teacher. What amount of preliminary information is a pupil supposed to have before tackling the problems the author introduces? Certainly one ought to be accustomed to the use of the plane table and the time-honoured methods of procedure before addressing himself to the study of perspective views. The method should be regarded, not as a substitute, but as an addition, to the recognised processes.

Mr. Flemer's book consists practically of three parts. After a short preliminary historic review to show how the principles have been welcomed in various countries, the author discusses the phototopographic methods that various authorities have recommended. The fact that we have so many varieties of detail shows that the subject has not yet taken that mechanical, stereotyped form which it may be expected to assume when fully developed. The second part opens with a chapter on lenses, which seems hardly necessary to introduce the description of the many photogrammetric instruments now in use. This latter is a really valuable and excellent section. Finally, we have the details of the photographic operations, including the development of the plates and prints. There is not much that is new that can be said here, and the treatment of pinhole photography which is naturally connected with this subject is unfortunately discussed in another place. W. E. P.

CONVERSATIONS ON CHEMISTRY.

Conversations on Chemistry. First Steps in Chemistry. Part ii., Chemistry of the Most Important Elements and Compounds. By W. Ostwald. Authorised translation by Stuart K. Turnbull. Pp. viii+373. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1906.) Price 8s. 6d. net.

THE original German edition of this book has been already noticed in NATURE (March 9, 1905, vol. lxxi., p. 435). The translation into English will make it accessible to a wider range of teachers, and to them it is to be warmly commended. No one can fail to be interested in seeing how one of the most lucid of German expositors, and one of the most ardent of reformers, presents the material of ordinary inorganic chemistry to the elementary student, and there are probably few people engaged in the business of teaching chemistry who will not find Prof. Ostwald's book of chemical dialogue eminently interesting and suggestive.

A book by so trenchant a critic naturally invites a close scrutiny, and particular interest will be felt in the treatment of certain points of difficulty which in a peculiar way beset the teaching of elementary chemistry. We may cite, for example, the definition or characterisation of an acid. Prof. Ostwald meets the case in a very simple way. On p. 16 it is written, "Only those compounds are acids which give off hydrogen with magnesium," and this is re-affirmed as quite correct on p. 17. We appreciate the advantage of a touchstone, but it may fairly be asked if, in the first place, magnesium is such a touchstone, and, secondly, whether this is the right kind of basis for the characterisation of an acid. In regard to the first point we think there is doubt, for although it is explicitly stated that water gives off no hydrogen with magnesium, and is not an acid, it is admitted later on p. 247 that "the metal has only a very slight effect on water," and, of course, it might be urged that at higher temperatures magnesium will actually burn in steam and liberate hydrogen in torrents. We think that Prof. Ostwald's pupil, who in this book is invested with a degree of zeal and adroitness calculated to make other teachers envious, might have been allowed to persecute his master a little more on the subject, until he had elicited the confession that on this question of acids, as on so many others relating to chemistry, the relativity and transition of things altogether preclude absolute definitions.

It is, perhaps, almost captious to make these remarks, for the way in which the teacher is exhibited in this book as anxious to be questioned is truly admirable, and most points are worked out with great ingenuity and address to an entirely logical conclusion. The allusion to things and phenomena of real human interest and the suppression of pedantry are also to be warmly commended.

The actual work of translation has, on the whole, been well done. The nationality of the translator is betrayed by occasional troubles with shall and will, and there are some positive mistakes in sense. Thus, "*Leimwasser in Fäulnis übergegangen*" is rendered "lime-water which has become foul," and on p. 40 the first two lines contain a mistranslation which makes a serious error both in fact and theory.

In conclusion, we may perhaps be permitted to regret that so useful a book has not been issued at a price which would make its wide dissemination among teachers more certain. A. S.

NENCKI'S COLLECTED WORKS.

Marceli Nencki Omnia Opera. Gesammelte Arbeiten von Prof. M. Nencki. Two vols. Erster Band. Pp. xlii+840. Zweiter Band. Pp. xiii+893. (Brunswick: F. Vieweg and Son, 1905.) Price 45 marks.

THE death of Prof. M. Nencki at the comparatively early age of fifty-four was a great blow to science. He attained a world-wide reputation as an investigator of the first order, and his laboratory at St. Petersburg became a busy hive of earnest workers, all fired with the enthusiasm and thoroughness of their master. The most fitting monument for such a man is the collection of his works presented to us in the two volumes which form the subject of this review. The labour of love in preparing this book for the press has fallen upon two of his most attached colleagues, namely, Nadine Sieber and Prof. J. Zaleski, and they have chosen the German language as that in which to publish his collected memoirs. They have written an account of his life in the introductory pages, but have wisely chosen to make this brief; his work was his real life, and this is allowed to speak for itself.

Nencki's name is best known, perhaps, for his researches that deal with the decomposition products of albumin, with the history of urea and its precursors in the body, and with the chemistry of hæmoglobin and other pigments. Probably few had any idea how varied were the investigations he undertook in other branches of biological chemistry, and how enormous was the output from his laboratory. The total number of papers now published amounts to three hundred and forty-six. They were issued from the year 1869 onwards, and include not only those written by Nencki himself, or in conjunction with his colleagues, but also those published by the workers in his laboratory.

It is interesting to note how with the advance in knowledge the subjects treated vary with the march of the years. An organic chemist at heart, Nencki best loved a research in which he could apply his chemical learning to obtain exact results. But he never lost sight of the application of chemical knowledge to the problems of medicine, pathology, and pharmacology, even although in many cases the results lacked that certainty and neatness which form the chemist's aim. As bacteriology, the giant daughter of physiology, became a specialised branch of study, we see how the resources of his laboratory were given over to the elucidation of its chemical relationships; and in more recent years the new subject of immunity equally attracted the diligence of the pupils whose work Nencki controlled and directed.

To attempt even an enumeration, still less a review, of the papers contained within the book would be out of place in a brief appreciation of its value. One can only recommend those interested in such subjects as have been indicated to procure this treasure-house of information for themselves.

W. D. H.

OUR BOOK SHELF.

Essais des Matériaux. By H. Bouasse. Pp. 150. (Grenoble: Gratier and Rey; Paris: Gauthier-Villars, 1905.) Price 5 francs.

THE ordinary mathematical theory of elasticity consists mainly in the examination of the consequences of the general principle involved in the statement of Hooke's law, "ut tensio sic vis," or, in other words, the proportionality of stress to strain. In many cases, however, this assumption is far from being satisfied, and the state of strain in a body at any instant depends not only on the actual stresses, but on the changes which have previously occurred in that body.

Prof. Bouasse's treatise consists in large measure of a classification of the various properties arising from the study of strains and stresses, such as permanent deformations, perfectly elastic deformations, viscosity, hysteresis, reversible and irreversible deformations and limits of elasticity. As the author points out, many of the phenomena are of common occurrence, and he instances the displacement of the zero reading of the galvanometer as a simple example. The various effects are illustrated by curves showing the relations between strain and stress. The ordinary theory of elasticity is of course touched on.

The printing of the preface in italics does not favourably impress the English reader at the outset, but everyone must agree with the conclusions at the end, in which the author points out that the subject has not received the attention it deserves, and this at a time when rapid advances have been made in most branches of physics. There is abundant evidence that Prof. Bouasse has given much careful thought and study to the subjects of which he treats, and even if his book does no more than attract attention to a neglected branch of physics it will fill a useful purpose.

The Scientific Roll and Magazine of Systematised Notes. Conducted by Alexander Ramsay. Bacteria. Vol. i. Pp. 528. (Acton, London, W.: R. T. Sharland.) Price 16s.

IT is difficult to comprehend exactly what place this work is designed to occupy. The author must have expended an enormous amount of time and labour upon it, but we regret to say we cannot help feeling that much of his work is misapplied. For example, the 200 pages or thereabouts occupied by the tables of bacteria, arranged according to size, can be of little or no value, because the size of bacteria is extremely variable, and because the finer measurements must be very rough. Had this space been devoted to a summary of bacterial characters and reactions, abstracted from original papers, a great deal of scattered material would have been gathered together, and the result would have been most valuable. The bibliography in the earlier parts should be useful, but the summary of characters contained in the later ones is too brief and scrappy to be of much value.

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.]*

Another New Vesuvian Mineral.

IN NATURE of May 31 I gave a preliminary note on a new mineral species *chlormanganokalite*, in speaking of which I made reference to its association with fine crystals of halite that I suggested were likely to prove rich in potash. The latter crystals occur as beautiful cubes often more than a centimetre in diameter, and of a transparent to a milky, opaline tint. They afford on analysis the following results as to their composition:—

KCl ...	87·57		KCl	87·93
NaCl ...	12·02	equal to	NaCl	12·07
Moisture	0·412			—
	100·002			100·00

If we adopt the formula $(KCl)_6NaCl$, we should theoretically expect the following composition:—KCl 88·5, NaCl 11·5, which is sensibly the composition found by analysis as above, especially when we consider the errors inherent to the estimation of these substances.

I think, therefore, we are justified in considering this mineral as a definite double chloride, which I propose provisionally to call *chlornatrokalite*. It is my intention to submit to analysis a number of similar minerals that I have collected at Vesuvius during the last twenty-six years to see if we have to deal simply with mixtures or definite chemical compounds. Spectrum analysis failed to show even traces of calcium, cæsium, rubidium, or lithium.

The great amount of potassium compared to sodium is not astonishing when we consider that potash is the dominant alkali in the paste from which Vesuvian lava and its other products are derived.

June 13. H. J. JOHNSTON-LAVIS.

The Discovery of Logarithms.

IN the review of a book, "Letters from the Dead to the Dead," which appeared in your number of May 31, your reviewer says:—"As another example we may take the notes to Henry Briggs's letter, in particular the *supposed* proof (p. 75) that Napier's true base is the reciprocal of *e* and not *e* itself. As the difference depends entirely on whether log sin 45° has a plus or a minus sign attached to it, it is interesting to speculate on how many readers will be *deceived* by what is after all a somewhat clever *hoax*." (The italics in the above extract are mine.)

I take it by the use of the words *supposed*, *deceived*, and *hoax*, your reviewer intends to intimate that the formula on p. 75 of "Letters from the Dead to the Dead" is faked, or made by the author to suit his own purposes. Nothing could be further from the truth. I have had the curiosity to make the calculation *de novo*, and I venture to submit that no fair or genuine criticism can be passed upon it. The expression $\log 1/\sqrt{2}$ must have the minus sign. Indeed, I almost wonder whether your reviewer has read the book he is reviewing, because in that book the author quotes from Macdonald's translation of Napier's "Constructio" the statement that e^{-1} *is the base required by Napier's reasoning.*

I am not concerned whether the book in question is a hoax or not. For my part, I do not believe that it is. On the contrary, I believe it will prove to be one of the great books of history. It raises too many fascinating questions to be non-suited in your summary manner, and the reason why John Napier, knowing in 1614 that logarithms computed to base 10 must supersede all others, went on computing his to the surd 1/2·7182818283 as base, is an historical mystery that demands a solution. It is ridiculous to suppose—nay, it is impossible to suppose—that the inventor of logarithms did not know that they must have a base. CECIL SEYMOUR-BROWNE.

The note under criticism purports to be a "proof" that the base originally used by Napier was the reciprocal of e, and not e itself. In reality, it is nothing of the sort. The arithmetical details are both unnecessary and insufficient for the purpose, and their insertion is unfortunately calculated to deceive many readers by obscuring the real points at issue. The same "proof" might equally well be employed to show that the original base was e instead of its reciprocal, but that the minus sign had been omitted from the logarithms of sines. If your correspondent will read any treatise on the history of mathematics, he will see an account of the train of reasoning which led Napier to the discovery of logarithms before the existence of a base or the connection between logarithms and indices had been suspected. There are doubtless many historical points connected with the discovery of logarithms that deserve closer study than they commonly receive, but the publication of a book of this kind is not likely to advance our knowledge of them. If one could be certain that all readers would take the book for what it is worth, no harm would be done. But there are, unfortunately, many people who possess a "little knowledge" (which is, of course, a "dangerous thing") who will derive a large amount of misinformation from the interpretation they will place on the contents of the book, and this misinformation will be very difficult to eradicate.

The Reviewer.

Distribution of the Forms of Corvus cornix and C. corone.

I should esteem it a favour if the writer of the review of Ralfe's "Birds of the Isle of Man" (Nature, May 31, p. 195) would more clearly explain his reference to the dimorphic forms of *Corvus cornix* and *C. corone*, and the "border-line, *i.e.* along the line from the Firth of Clyde to the Adriatic, &c."

The Firth of Clyde is not the limit of the line where they are known to interbreed. They interbreed north of the Firth of Forth, and as far north as Moray at *least*.

And as regards the Adriatic, the forms are known to interbreed and produce every variation of crosses or diverse plumages in *Siberia*.

No doubt your reviewer will be able to explain his meaning, but, as at present expressed, it is somewhat difficult to understand (*v.* p. 105).

The "carrion crow" (*corone*) seems to me to be the more aggressive of the two, and is slowly but surely pushing north in Britain, as I think references to our series of Scottish faunas will show.

J. A. Harvie-Brown.

Dunipace, Larbert, Stirlingshire, N.B., June 2.

The precise line—if there be one—marking the distribution between the breeding areas of *Corvus cornix* and *C. corone* is of little importance to the "problem" suggested to the readers of Nature in the review mentioned. Its direction, however, was taken from Newton's trustworthy "Dictionary of Birds," p. 117, where it is stated to be "an irregular line drawn diagonally from about the Firth of Clyde to the head of the Adriatic." The reviewer cited that statement as authoritative, since he has had no opportunity of personal observation on the subject. It is further stated on the page last cited, "it has now been incontestably proved that along or near the boundary where these two birds march, they not infrequently interbreed, and it is believed that the hybrids which sometimes *wholly resemble*—italics by the reviewer—one or other of the parents . . . pair indiscriminately among themselves or with the pure stock." If these be established facts, then the hybrid wholly resembling the black variety must, *if it occur in any considerable numbers*, retire to breed "to the south-western part of this quarter of the globe," and the hybrid wholly resembling the "grey neck" "to the north-eastern portion." How has this discrimination been acquired? Two further questions may be asked: Can the wholly black and wholly grey hybrids be recognised after they have left the nest? Can the proportion of pure breeds to hybrids in the general crow-population be determined?

The facts given in Mr. Harvie-Brown's letter seem to indicate that the crows in their nursery arrangements behave less perplexingly than the reviewer had deduced from the statements he has quoted above. The black and the grey crows may really be, therefore, not dimorphic forms of one species, but two distinct species.

The Reviewer.

The Date of Easter.

In your issue of April 5 an empirical formula is given for determining the date on which Easter falls in any year from 1900 to 2100. Having tried the formula for certain years within the limits stated, I find that it fails in the case of 1954. For that year it gives April 25, whereas the correct date is April 18. Perhaps some of your correspondents may be able to explain the cause of the discrepancy.

Alexander D. Ross.

Glasgow, June 1.

Your correspondent is correct in saying that the empirical formula of Gauss for determining the date of Easter gives April 25 for the year 1954, and I must confess my inability to assign a reason for its failure in this particular instance.

Chas. Leigh.

The Victoria University of Manchester, June 12.

Geological Survey of Canada.

In the issue of Nature of April 26, under the heading of "Notes," is a paragraph concerning changes in the organisation of the Geological Survey of Canada. This paragraph is liable to be misleading, and I shall be greatly obliged if you will kindly state the facts as they are. On March 27 last Mr. A. P. Low was appointed deputy head and director of the Geological Survey Department, and, at the same time, Dr. R. Bell simply returned to his former position of assistant-director and chief geologist, to which he had been appointed in 1892.

A. P. Low (Deputy Head and Director).

Geological Survey of Canada, Ottawa, Ontario, May 29.

THE FOSSIL VERTEBRATES OF THE FAYUM.[1]

A few years ago it was the fashion among vertebrate palæontologists to say that, at least so far as the Tertiary period is concerned, the Old World was played out in the matter of their special science, and that the scene of advance was shifted to America, where alone important and epoch-making discoveries were to be expected. All this has been changed by the discovery of the wonderful Lower Tertiary vertebrate fauna—or, rather, series of faunas in the Fayum, or lake-province, of Egypt, which Dr. Andrews (who, we are glad to say, has now the privilege of adding the letters F.R.S. to his name) has so admirably and lucidly described in the handsome quarto volume before us. Indeed, it is not saying too much to assert that these discoveries have practically revolutionised our conceptions of the mutual relationships of several mammalian groups, and also our ideas on many points connected with the past distribution and migrations of the mammals of the Old World. Perhaps the most important problem which Dr. Andrews has succeeded in solving is the origin of the Proboscidea; and if this had been the only result of his labours he would have been well entitled to undying fame. As it is, this discovery is only one of several of the highest importance in regard to mammalian evolution we

[1] "A Descriptive Catalogue of the Tertiary Vertebrata of the Fayûm, Egypt; based on the Collection of the Egyptian Government in the Geological Museum, Cairo, and on the Collection in the British Museum (Natural History), London." By C. W. Andrews. Pp. xxxvii+324; pls. 26, and text-figures. (London: Printed by order of the Trustees of the British Museum, 1906). Price 35s.

owe to him, and in some degree to others who have been working on the extinct Egyptian faunas.

Before proceeding further we may take the opportunity of expressing, on behalf of all palæontologists, our appreciation of the generosity of the Egyptian Government in putting at the disposal of the trustees of the British Museum, for the purpose of this catalogue, the whole of the valuable collection of vertebrate remains from the Fayum preserved in the museum at Cairo. We may likewise respectfully tender to the trustees of the national collection our sense of the benefit they have conferred on science by sanctioning the publication of the work before us. Nor must we omit to mention the name of Mr. W. E. de Winton, who has generously defrayed the expenses connected with some of the visits of Dr. Andrews to Egypt to explore and collect the palæontological treasures of this wonderful district.

It will not be necessary on this occasion to refer in detail to the history of the discovery of fossil vertebrates in Egypt. Suffice it to say that the first discovery was not made by the author of the volume before us, although it appears that he was present when the remains of ancestral proboscideans and other primitive mammals were first brought to light.

With a few unimportant exceptions, the whole of the remains described in the volume were derived from strata of Middle and Upper Eocene age lying on the northern side of Lake Moeris. In the author's opinion it appears that the Fayum strata, as we advance from earlier to later times, were, speaking generally, deposited nearer and nearer to some land-mass.

"In the early Eocene the presence of thick marine beds far to the southward shows that the shores of the Ethiopian continent were still remote from the area now under discussion; and this state of things seems to have continued till the Middle Eocene, as shown by the thick nummulitic beds of the Wadi Rayan series, and the exclusively marine character of the fossils both of those beds, the Ravine beds, and the Birket-el-Qurun series above. In the Qasr-el-Sagha series, on the other hand, there is much evidence that the shore was not far off, the presence of thick beds of clay, often current-bedded and containing numerous impressions of leaves, as well as the occurrence of land-mammals, pointing to this conclusion. In fact, the deposits at this horizon may be regarded as partly marine and partly littoral, there having been many small oscillations of level. In the Fluvio-marine (Upper Eocene) beds above, the near presence of a large land-mass is still more obvious, these deposits being, in fact, almost entirely fluviatile, and probably representing the remains of the delta of a great river which, for various reasons, Mr. Beadnell considers flowed from the south-west. At or near the end of the Eocene period this state of things was interrupted by an outburst of volcanic activity, which gave rise to the interbedded basalt-sheets of the Jebel-el-Qatrani; but after this the fluviatile conditions were again resumed, and appear to have continued with some interruptions throughout the Oligocene, Miocene, and, in part at least, the Pliocene periods. Throughout this vast epoch there seems to have been a general tendency towards a gradual advance of the coast-line northwards, and such interruptions and oscillations as did occur are marked by the presence of interbedded marine, littoral, and perhaps, in a few cases, lacustrine deposits."

Obviously, such a state of things affords just the conditions necessary for the preservation of the remains of a series of faunas, and as a matter of fact such remains have been found in two horizons in addition to those forming the subject of the catalogue.

The mammals may be divided into three groups. First, terrestrial forms, such as ancestral proboscideans, hyracoids, and the remarkable Arsinoitherium which appear to have been endemic to the Ethiopian region, and occur in both the upper and lower beds, and are unknown elsewhere. Secondly, terrestrial types like Ancodon and Hyænodon, represented in other parts of the world, and found only in the upper beds. Thirdly, primitive genera of sirenians and cetaceans, confined to the lower beds, some of which are widely spread, while others are unknown elsewhere and may be endemic. All the genera in the first group are ungulates, and, with one exception, belong to that generalised assemblage frequently known as subungulates.

The most striking of all these wonderful ungulates is undoubtedly the huge and powerfully horned Arsinoitherium (Fig. 2); but interesting as is this creature morphologically it adds but little to our knowledge of mammalian evolution, although there is a possibility that it may prove to be an offshoot from the hyrax-stock. In any case the occurrence of this and several other specialised types at such an early stage is one of the most remarkable features of the Fayum fauna.

Although Arsinoitherium is certainly the most ex-

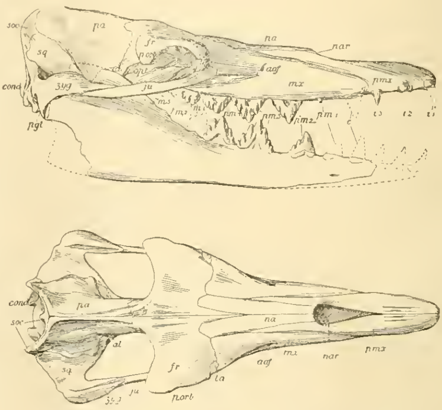


FIG. 1.—Lateral and superior views of the skull of *Prozeuglodon atrox*, a primitive Egyptian Cetacean. The letters refer to the names of the bones; ⅛ natural size. From "The Catalogue of Fayum Vertebrates."

traordinary of the Eocene Egyptian ungulates, it undoubtedly yields place in point of interest to the ancestral proboscideans. The probability that Africa would prove to be the original home of the Proboscidea was suggested, among others, by Prof. H. F. Osborn, who also conjectured that the hyraxes and certain other groups might likewise be of Ethiopian origin. In regard to the two groups mentioned, the truth of this bold prophecy has been fully demonstrated by the discoveries and investigations of Dr. Andrews. Since the evolutionary history of the Proboscidea, as revealed by these discoveries, has already been made familiar to the public in several journals—NATURE among the number—it will be unnecessary to go over the ground again, and it will suffice to mention that in Mœritherium, the earliest known representative of the group, we have an animal but little removed from the generalised common type of primitive ungulates. It may be added that while the Ethiopian origin of the Proboscidea has now been proved, it is nearly as certain that the passage from the mastodons to the elephants took place in south-eastern Asia, or in a lost land between the latter and Africa.

Next, perhaps, in point of interest is the discovery of comparatively giant forms nearly related to the modern hyraxes, which are now as isolated as the elephants. Unfortunately, these Eocene hyraxes—Saghatherium and Megalohyrax—throw little or no light on the ancestry of the group, although serving to show that it was certainly Ethiopian in origin. Whether certain Tertiary South American ungulates are related to the group is left by the author an open question.

Of not less importance are the discoveries and conclusions with regard to the origin and relationships of that isolated aquatic group of mammals now represented by the manatis and dugongs. On this point the author remarks that there seems to be much evidence in favour of the original view of de Blainville that the Sirenia are intimately related to the Proboscidea.

"In the first place, the occurrence of the most primitive Sirenians with which we are acquainted in the same region as the most generalised proboscidean Mœritherium is in favour of such a view, and this is further supported by the similarity of the brain-structure and, to some extent, of the pelvis in the earliest-known members of the two groups. Moreover, in the anatomy of the soft-parts of the recent forms there are a number of remarkable points of resemblance. Among these common characters may be noted the possession of: (1) pectoral mammæ; (2) abdominal testes; (3) a bifid apex of the heart; (4) bilophodont molars with a tendency to the formation of an additional lobe from the posterior part of the cingulum. The peculiar mode of displacement of the teeth from behind forwards in some members of both groups may perhaps indicate a relationship, although in the case of the Sirenia the replacement takes place by means of a succession of similar molars, while in the Proboscidea the molars remain the same numerically, but increase greatly in size and number of transverse ridges."

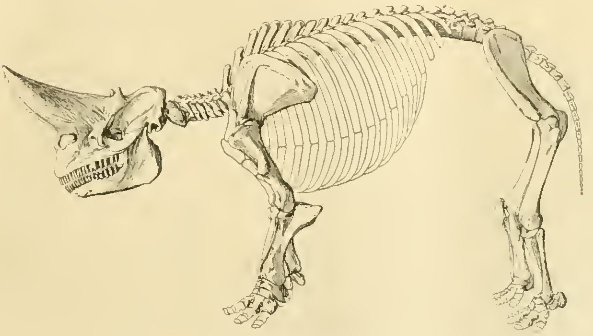


FIG. 2.—Skeleton of *Arsinoitherium zitteli*, $\frac{1}{32}$ nat. size. From "The Catalogue of Fayum Vertebrates"

These and certain other facts referred to by the author in a later paragraph point very strongly to the conclusion that not only are the Sirenia and the Proboscidea derived from a single ancestral stock, but that the Hyracoidea—and so Arsinoitherium—are also derivatives from the same stock, which must necessarily have been Ethiopian.

While thus definitely establishing the herbivorous ancestry of the Sirenia, Dr. Andrews appears to be equally convinced that the Cetacea (as, despite views to the contrary that have been expressed, we should naturally expect) are derivatives from a carnivorous ancestral type. On the evidence of specimens obtained from another part of Egypt, Dr. E. Fraas, of Stuttgart, has demonstrated the derivation of the whale-like Zeuglodon (Fig. 1) from that group of primitive carnivora known as creodonts. Dr. Andrews not only brings forward additional evidence in favour of this most remarkable line of descent, but he is confident—which Prof. Fraas was not—that Zeuglodon itself is an ancestral cetacean, and consequently that whales are the highly modified descendants of creodonts. It must be admitted, however, that the links between Zeuglodon and typical cetaceans are at present unknown; but it may be hoped that these will be eventually brought to light from the deposits of the Mokattam Range.

Of the other classes of vertebrates represented in the Fayum series we can say but little. Reference should, however, be made to the occurrence of a presumed ratite bird, which if rightly identified is the earliest known representative of the group, and suggests the Ethiopian origin of some members at least of the ostrich group in Africa. Such an ancestry, as the author remarks, would explain the resemblance existing between the true ostriches and the extinct Æpyornis of Madagascar, and might likewise serve to connect the former with the South American rheas.

Giant land tortoises are likewise proved by the Fayum discoveries to have occurred in this part of the world at a much earlier date, so far as is known, than elsewhere, and it is noteworthy that the extinct Egyptian species are near akin to the recent Mascarene and Malagasy forms. The association of tortoises belonging to the pleurodiran section, now confined to the southern hemisphere, is another fact of prime importance, as tending to throw light on the dispersal of that group and the former relations of the southern continents.

With regard to the latter point, Dr. Andrews comes to the conclusion that the new facts fully endorse the theory of a former land connection between Africa and South America. "Speaking generally, it appears that (1) probably in Jurassic times Africa and South America formed a continuous land-mass; (2) in the Cretaceous period the sea encroached southwards over this land, forming what is now the South Atlantic. How far this depression had advanced southwards at the end of the Secondary period is not clear, but it appears certain that the final separation of the two continents did not take place till Eocene times, and that there may have been a chain of islands between the northern part of Africa and Brazil which persisted even till the Miocene."

It will thus be apparent that from whatever point of view we regard the Eocene vertebrate fauna of the Fayum—whether from the morphological, the phylogenetic, or the distributional—it is practically impossible to overestimate its extreme importance. When we reflect that what has been discovered can only be the mere fringe of a most extensive Eocene and Upper Cretaceous Ethiopian fauna we shall be in a position to realise what a great part Africa has played in the past as a birthplace and centre of dispersal of mammalian groups, and how profoundly even the present discoveries have modified our conceptions of the past history of the mammalia and of the globe in general.

After a careful study of the volume before us, we have found no occasion for a single word of hostile criticism. The author knows his subject from every possible point of view in a most thorough manner, and has treated it in a thoroughly philosophic way from first to last, while the introduction is written in a style that will appeal to the general reader as well as to the specialist. It is, perhaps, not too much to say that it is the most important contribution to mammalian palæontology that has ever appeared within our own recollection on this side of the Atlantic, and if the twentieth century were to see no other work on mammals—either recent or fossil—it would still have a vast achievement to its credit. R. L.

THE CALIFORNIAN EARTHQUAKE OF APRIL 18.

THE accounts which are reaching this country enable us to form a better idea of the character of the Californian earthquake of April 18 last than could be done from the telegraphic reports of the daily papers, and one of the most striking facts which stand out is the wonderfully small amount of damage done in San Francisco by the earthquake proper. This does not seem to have exceeded the sixth or seventh degree of the Rossi-Forel scale, and the damage to buildings was practically confined to the overthrow of chimneys and of buildings which were either old and badly constructed, or of a design which rendered them especially liable to earthquake damage. The *Scientific American* of May 12 contains a view of the business part of the city, taken after the earthquake, but before the spread of the fire, in which the buildings show little signs of damage, beyond the overthrow of some of the chimney stacks. Where the city was built on made ground settlements and disturbances of ground level led to fractures of the water-mains, but it is not clear from the accounts which have reached us whether there was not also an interruption of the main conduit at some point between the city and the source of supply. Whatever the cause, the consequences of the failure of water were disastrous, and the fire, started by the earthquake, was able to spread unchecked.

FIG. 1.—The Burning of the Business District of San Francisco after the earthquake on April 18. From the *Scientific American*.

Apart from the loss of buildings and lives, San Francisco has lost its most important libraries and scientific collections; the Bancroft library of books and manuscripts relating to the history of the Pacific coast has been saved, as have most of the type-specimens of plants in the collection of the Academy of Sciences, but that is practically all. On the other hand, the Lick Observatory and the University of California have escaped damage, and the working part of the Leland-Stanford University has escaped the complete destruction which has been the fate of the memorial buildings of that institution.

The area over which the earthquake did serious damage was confined to a narrow strip of country extending from the town of Ukiah, on the Russian river, to the town of Salinas, near Monterey Bay. Beyond these limits the country is sparsely settled and may have been vigorously shaken without the fact being reported, but the limits indicated lie about 205 miles apart, or 125 miles north and 80 miles south of San Francisco; within this strip the damage was very capriciously distributed, and died out rapidly to the east and westwards; at Berkeley town many buildings were ruined, but the University of California escaped; San Jose was partly ruined, and most of the buildings of the Stanford University, at Palo Alta, were destroyed, but the Lick Observatory, about fifteen miles to the eastward, was uninjured, nor is any serious injury reported from the towns on the coast. These peculiarities in the distribution of the earthquake damage are explained in an article on the probable cause of the San Francisco earthquake by Mr. Frederick Leslie Ransome, published in the May number of the *National Geographic Magazine*. The article is illustrated by a very clear structural map of the San Francisco peninsula, and an equally clear description of the structural conditions of the region. Probably nowhere in the world have greater displacements taken place in geologically recent times than this district has witnessed; strata of Quaternary age have here been compressed, contorted, and lifted from 1500 to 2000 feet, and right through the peninsula run three nearly parallel faults, two of which, the Pilarcitos and San Andreas faults, are marked by lines of pools and lakes, proving the recent date of the disturbance to which they owe their origin. The third fault, known as the San Bruno fault, is the most important of the three; it has a throw of more than 7000 feet near San Francisco, and has been traced, with more or less certainty, from Point Arenas, 100 miles to the north-west, through Southern California, where it is known as the "earthquake crack," almost to the Gulf of California. A movement along this fault, and others parallel to it, appear to have been the cause of the earthquake, or at any rate of the curious localisation of damage noticed above. The San Bruno fault passes close to the Stanford University and to the city of San Jose, and crosses the main line of water-supply from the Crystal Springs reservoir to the city of San Francisco; it is, presumably, along this fault that the displacement reported in the newspapers took place. There are indications, too, of another fault running along the eastern margin of the bay through Santa Rosa and north-westwards along the valley of the Russian river past Ukiah, which may have been concerned in the violence of the earthquake at those places.

Two other articles in the same magazine deal with the times at which the disturbance was recorded by seismographs. From them we gather that the shock was recorded on a self-registering seismograph in the University of California at 5h. 12m. 38s. a.m. Pacific time, equivalent to 1h. 12m. 38s. p.m. Greenwich time. The seismograph of the United States Weather Bureau at Washington, 2435 miles distant from San Francisco, recorded the commencement at 8h. 19m. 20s. eastern time, corresponding to 1h. 19m. 20s. Greenwich time, and the seismographs of the United States Coast and Geodetic Survey at Sitka, Alaska, and Cheltenham, Maryland, also recorded the shock, commencing at 1h. 16m. 56s. and 1h. 19m. 24s. respectively, the distances from San Francisco being 1455 and 2450 miles. The magnetographs at these two places and at Baldwin, Kansas, were also affected by the passage of the earthquake waves, the times corresponding approximately with those of the arrival of the principal, or third, phase of the disturbance.

FIG. 2.—Map of the San Francisco Peninsula. From the model by Prof. A. C. Lawson. The principal faults are indicated by heavy black lines. From the *National Geographic Magazine*.

THE FORTHCOMING MEETING OF THE BRITISH ASSOCIATION AT YORK.

THE arrangements for this meeting, which will be held from August 1 to August 8, are very well in hand, being at least a month in advance of what they were twenty-five years ago, on the occasion of the jubilee meeting—one of the most successful ever held. The local fund now reaches more than 3000*l.*, and the greater part having been already paid up, the fund has been closed. The various committees are meeting regularly, secure good attendance, and the greatest interest and enthusiasm prevails. One of the local secretaries, Mr. Dale, having died, Mr. Henry Craven, who has succeeded him in the office of town clerk, has been appointed his successor.

The following is an epitome of the general attractions included in the programme:—

Wednesday, August 1.—The Lady Mayoress (Mrs. R. H. Vernon Wragge) will be "At Home" at the Mansion House from 3 p.m. to 6 p.m. to receive foreign visitors, members, associates, and lady ticket-holders. President's address in the exhibition buildings at 8.30 p.m.

Thursday, August 2.—The Sheriff of York and Mrs. Bentley will give a garden-party at their residence, Fulford Grange, to all ticket-holders, from 3 p.m. to 6 p.m. Conversazione in the exhibition buildings, by invitation of the executive committee, at 8 p.m. Music will be provided in the museum gardens, which communicate with the building and will be illuminated.

Friday, August 3.—Messrs. Rowntree and Co. will give a garden-party at their works, Haxby Road, to all ticket-holders, from 3 p.m. to 6 p.m. The works will also be open. Discourse on volcanoes, by Dr. Tempest Anderson, in the exhibition buildings at 8.30 p.m.

Saturday, August 4.—The Archbishop of York and Mrs. MacLagan will give a garden-party at the Palace, Bishopthorpe. Evening lecture to the operative classes by Prof. Silvanus Thompson, F.R.S., on the manufacture of light. The president, Prof. Ray Lankester, will take the chair.

Sunday, August 5.—Special service in the Minster.

Monday, August 6.—The council of the Yorkshire Philosophical Society will give a garden-party in the museum grounds, to all ticket-holders, from 3 p.m. to 6 p.m. They have also intimated that the museum and grounds will be open daily to all members and ticket-holders who wish for a quiet resting-place. The president of the society, Dr. Tempest Anderson, will entertain to tea those who attend each afternoon. Discourse on the electrical signs of life, and their abolition by chloroform, by Dr. A. D. Waller, F.R.S., in the exhibition buildings, at 8.30 p.m.

Tuesday, August 7.—The Dean of York and the Canon in Residence will give a garden-party, to all members and ticket-holders, in the Deanery and residentiary grounds, from 3 p.m. to 6 p.m. Conversazione in the exhibition buildings, by invitation of the executive committee, at 8 p.m. Music will be provided in the museum gardens, which will be illuminated.

Wednesday, August 8.—Meeting of general committee to receive the report of the committee of recommendations, 1 p.m. Concluding general meeting, in the Guildhall, at 2.30 p.m.

It is understood that a large number of important papers has been already promised, and it will be noticed that an unusually attractive series of garden-parties and receptions has been provided. In fact, the number offered has been so large that several very eligible offers of hospitality have had to be reluctantly declined. Practically all the principal residents in York and the neighbourhood have invited members of the association for the time of the meeting, besides a large number of private friends, who will swell the lists of members and associates attending.

The proposed excursion to Norway at the close of the meeting has fallen through, as little interest or support seemed forthcoming. The excursions will therefore be confined to Saturday, August 4, and the following have been definitely fixed:—

Scarborough and Whitby, stopping at Castle Howard.—The Mayor of Scarborough has intimated that he will be "At Home" to a limited number of those taking part in the excursion. Permission has been granted to view the Marine Drive, and the members and associates will be admitted to the Spa on the production of their tickets. It has also been arranged that the train shall stop at Castle Howard to enable any members to pay a visit, but it is understood that only a portion of the house and gardens will be available.

Harrogate, Brimham Rocks, and Pateley Bridge; conductor, Mr. W. Ingham.

Ripon, Studley Park, and Fountains Abbey.—The Marquess of Ripon has kindly promised to entertain a party of about 100 to luncheon, and the Mayor of Ripon will entertain the same party to tea.

Ilkley and Bolton Abbey.

Coxwold, Byland Abbey, Helmsley, Duncombe Park, and Rievaulx Abbey.—It is expected that the party will be entertained at Duncombe Park by the Earl of Feversham; conductor, the Rev. C. N. Gray.

Wensleydale; conductor, Mr. W. Horne.

Mount Grace, Guisborough, and Whorlton Castle.—Admiral Challoner has kindly invited the party to dinner, and it is expected that the Lord-Lieutenant of the North Riding will provide luncheon; conductor, Mr. F. J. Munby.

Driffield, Kirkburn, Wetwang, &c.; conductor, the Rev. E. Maule Cole.

Aldborough and Boroughbridge.—Three steam launches have been engaged to convey the party; conductor, Mr. A. S. Lawson, who will provide luncheon and tea.

A small guide-book will be prepared for each of the above excursions. It is understood that there will be also the usual semi-private excursions arranged in connection with several of the sections.

The exhibition of South African photographs taken by the members last year promises to be of much interest. There is ample accommodation for it at the reception room, and an active committee has the matter in hand.

KEW PUBLICATIONS.

THE "miscellaneous information" supplied from the Royal Gardens at Kew has ever been welcome to botanists and to those concerned in the utilisation of vegetable products. The earlier publications of Sir William Hooker and of his son and successor, Sir Joseph Hooker, are full of interesting matter with which the botanical and horticultural Press of the day was, owing to limitations of space, hardly able to cope.

Of late years such was the pressure of administrative duties that the publication of the Bulletin became very erratic. So much was this the case that we had almost given up the hope of seeing anything but "appendices" to volumes that seemed never destined to appear. In this we were mistaken. Within the last month or two we have received for notice the Kew Bulletin for the years 1900, 1901, 1902, 1903, 1904, and 1905.[1]

Some of these volumes are of exiguous proportions, but there they are, and the troubles of librarians and bibliographers are, in so far, set at rest. Much of the information is, of course, far from being up to date, and in some cases the gentlemen mentioned as having been appointed to fill certain positions have paid the debt of Nature before their nomination has thus been made public.

In spite of these circumstances we can but rejoice that the publication has been resumed, and that the sequence of the volumes is no longer interrupted. The contents are so "miscellaneous" that they do not lend themselves to anything like systematic review. We can only put the books on our reference shelves and welcome the fact, not only that the old gaps are, to some extent, filled up, but that there is now every prospect of the regular issue of that Bulletin to which we look for an official record of the manifold and most important work done at Kew.

A "Catalogue of Portraits of Botanists Exhibited in the Museums of the Royal Botanic Gardens, Kew," by Mr. James D. Milner, clerk and acting assistant-keeper and secretary to the National Portrait Gallery, has also just been published. The catalogue is introduced with a preface by the late director of the Royal Gardens. To botanists it forms a very interesting, but, we must add, a very incomplete list. Kew probably possesses a much larger number of portraits than are here mentioned, so that it is difficult to understand on what principle the selection has been made. The words "exhibited in the museums" do indeed imply that there are other portraits not thus displayed, but unless we are mistaken, or unless some re-arrangement has taken place recently, there are not a few hanging on the walls of the museums which are not included in the list. At any rate, we look in vain for any mention of the Balfours, father and son, of John Ball, of Broome, Babington, B. C. Clarke, Casimir de Candolle, W. T. Thiselton-Dyer, Eichler, Engler, A. Dickson, Farmer, Gardiner, Munro, Miers, Prain, Reichenbach, Seemann, Williamson, and many others whom it would be tedious to enumerate. No doubt many of these are "kept in portfolios," and can be inspected on application, but the absence in the catalogue before us of even the names of these more or less distinguished botanists gives an impression of serious incompleteness which is probably not justified by the facts. This is the more unfortunate as the collection is stated to be "probably unique." If so, the catalogue is very inadequate, as may be seen, not only by the few illustrations we have cited, but also by comparison with Dr. Wittrock's much fuller "Catalogus Stockholmiensis." The text, too, requires revision. In one place we are told of a bust wearing spectacles, and of another bust "in a ruff and fur-lined coat." On another page we are told of a botanist who graduated eighteen years before he was born!

There are other indications of imperfect proof-reading, to which we direct attention in the hope that the defects may be remedied in a subsequent edition. The catalogue, even in its present condition, is of such great interest that we cannot doubt that no long time will elapse before a second edition is called for, and one which can readily be made more representative of the progress of botany, especially in our own country.

[1] "Bulletin of Miscellaneous Information." Royal Botanic Gardens, Kew. (H.M. Stationery Office, 1900–05.)

BARON C. R. VON DER OSTEN SACKEN.

SYSTEMATIC entomology has sustained a great loss by the death of Baron Osten Sacken, as announced in NATURE of May 31.

Baron Osten Sacken was born at St. Petersburg on August 21, 1828, and at the age of eleven his interest in entomology was aroused by his meeting, at Baden-Baden, a young Russian entomologist, Mr. Shatiloff, who gave him his first instructions in collecting Coleoptera. Between 1849 and 1856 he held an appointment in the Imperial Foreign Office, and published papers on the re-classification of the Tipulidæ, as well as a list of the insects of the St. Petersburg district excluding Lepidoptera. His appointment, in 1856, as secretary of the Russian Legation at Washington opened up the second period of his entomological career in the United States. In 1862 he was appointed Russian Consul-General at New York, a post which he resigned in 1871, remaining, however, in America until 1877.

During this period of twenty-one years the main part of Baron Osten Sacken's entomological work consisted in working up the Diptera of North America, in close collaboration with Dr. H. Loew. This work had for its main object the compilation of a catalogue of North American Diptera of which a first edition was published as early as 1858 by the Smithsonian Institution. It was superseded by a far more complete second catalogue published twenty years later. A great deal of further time was taken up with the self-imposed and, at times, somewhat tedious task of editing and translating Loew's monographs, and, in addition, important papers were published on the Tipulidæ, Tabanidæ, Cecidomyidæ, and Cynipidæ. Between 1871 and 1873 some time was spent in Europe, and in 1876 an expedition was made to California the results of which were published under the title "Western Diptera" in the Bulletin of the U.S. Geological and Geographical Survey. Eleven new genera and 137 new species were described.

In 1877 Baron Osten Sacken came to Europe, and took up his abode at Heidelberg The present writer first met him there in the summer of 1877, and, being greatly interested in entomology as a hobby, a close friendship sprang up, which soon became a friendship for life. In the years which followed and which constituted the third period of his entomological career, Baron Osten Sacken published numerous critical papers on Diptera, and increased the number of his published writings from 53 to 179. In 1881 he published "An Essay on Comparative Chætotaxy," in which it was shown for the first time that the arrangement of the bristles on the bodies of Diptera afforded a valuable aid to their classification. In 1892 he published one of his most important papers, on the characteristics of the three divisions of Diptera, *Nemocera vera*, *Nemocera anomala*, and Eremochæta, in which two important innovations were introduced, one referring to the preservation of the distinction between the Brachycera and Nemocera, the other to the grouping of the families of Diptera into larger groups, for which he subsequently adopted Comstock's name of "Superfamilies."

The "Bugonia" superstition of the ancients regarding the production of bees from the carcases of dead animals found a ready explanation at Baron Osten Sacken's hands in the close resemblance to a bee of the common drone-fly, *Eristalis tenax*, the larvæ of which live in putrescent matter. In the paper, first published in commemoration of the twenty-fifth anniversary of the Italian Entomological Society in 1893, and afterwards amplified and printed at Heidelberg, Baron Osten Sacken traces in detail the history of the Bugonia in different ages and nations.

His last important task was to publish a "Record of My Life-work in Entomology," which he concluded in 1904, to quote his own words, "at the age of seventy-six, in good health, and with unimpaired eyesight."

Baron Osten Sacken took great delight in everything connected with mathematics, especially historical points, and the present writer has an early recollection of a question he proposed relating to the conchoid of Nicomedes. In his later years he made a collection of photographs of paintings of the great masters, and it gave him pleasure to arrange and classify them with the same systematic attention to minute detail that he had so successfully brought to bear on the classification of the Diptera. In his manner of living he was equally methodical, and this spirit is shown in the publication of his "Record." His interest in the work of others won for him many friends, who will greatly miss him. He has given us an excellent example of what can be done by a man who cultivates some branch of science for its own sake, and who is not debarred by pressure of professional duties from making the study his life-work. For such workers, biological rather than physical subjects in many cases offer the most promising field.

G. H. Bryan.

NOTES.

Prof. G. von Neumayer, who celebrates his eightieth birthday to-day, will receive the congratulations of many meteorologists and other scientific workers. Nearly a year ago the first part of a third revised edition of instructions and notes on scientific observations for travellers, edited by him under the title "Anleitung zu wissenschaftlichen Beobachtungen auf Reisen," was published, and the last part appeared very opportunely a few days ago. The work has been brought up to date, and is of such a comprehensive nature that justice cannot be done to it in a hurried notice, but we hope to deal with this important contribution to scientific literature in a future issue.

Mr. W. de Fonvielle informs us that Mr. W. Wellman and his balloon—the *United States*—have left Paris for Spitsbergen by way of Antwerp, where the balloon was shipped to Tromsö, and from there to Magdalena Bay, lat. 79° 40′ N. (Danes Island). The last part of the voyage will be executed on board the *Fritjof*, a steamer put at the disposal of the explorer by the American Government. Mr. Wellman hopes to be in Tromsö before June 25, and at Danes Island on July 1. There he will find everything ready for the inflation of his large balloon, measuring 6300 cubic metres, and having a gross lifting power of 7000 kilograms. The necessary preparation will be made by Major Hearsey, of the U.S. Weather Bureau, who left Paris a month ago in order to erect at Danes Island a shelter where the balloon may be housed during the preliminary experiments, which are expected to occupy the whole of July. It is only in August that the departure for the Pole is to take place, if the experiments have proved satisfactory and have been concluded. Mr. Wellman is travelling with Mr. Collardeau, a French chemist, and Mr. Hervieux, a French aëronaut, who is to be the pilot of the polar balloon. In addition to Mr. Wellman, the balloon will have on board Major Hearsey, Mr. Hervieux, and two Norwegian sailors who assisted him in his two previous explorations. A wireless telegraphy system will be established between the two stations of Tromsö and Danes Island. A meteorological station will also be established at the same places, supplied with a captive balloon for obtaining records of the temperature, humidity, direction and force of the wind in the free atmosphere. So for the first time since telegraphy (wire) was utilised in meteorology, American and European meteorologists will have at their disposal observations of the weather in the neighbourhood of the North Pole as well as from tropical stations.

The second of the two annual conversaziones of the Royal Society was held as we went to press last night.

Mr. W. R. Cooper has accepted the position of editor of the *Electrician* in succession to Mr. F. C. Raphael, who will retire on June 30.

It is stated by the *British Medical Journal* that the institute for the experimental investigation of cancer at Heidelberg is now complete. Prof. Czerny is the director; Dr. von Dungern has been appointed head of the scientific department, and Dr. von Wasielewski head of the department of parasitological research.

We learn from *Science* that Mr. George Eastman, of Rochester, N.Y., has subscribed 200*l.* annually for the next three years to enable the continuance of research work in photography at the Yerkes Observatory of the University of Chicago. The investigations will be carried on by Mr. R. James Wallace, photophysicist at the observatory.

The death is announced, in his eightieth year, of M. Edouard Piette, the distinguished archæologist. M. Piette was well known for his discoveries of prehistoric remains, among which may be mentioned those in the caverns of Mas d'Azil (Ariège) and of Brassempouy (Landes). Before his death M. Piette presented his invaluable collections to the Museum of Saint-Germain-en-Laye.

H.M. the Queen has extended her patronage to the "Country in Town" Exhibition which will be opened by H.R.H. Princess Christian in the Whitechapel Art Gallery on July 5. The exhibition will be open until July 19, and as admission will be free, contributions are invited towards the necessary expenses. All communications should be made to the honorary secretary, Mr. Wilfred Mark Webb, at Toynbee Hall, Whitechapel, E.

The *Times* correspondent reports that Dr. Calmette and M. Guérin, of the Pasteur Institute, Lille, have communicated to the Paris Academy of Sciences the results of experiments on protective inoculation against tuberculosis. Having found that dead tubercle bacilli are carried from the digestive tract to distant parts of the body, they made experiments in order to ascertain the immunising effect of dead tubercle bacilli administered in this manner. Young animals, heifers and kids were given by the mouth two doses, with a forty-five days' interval between, of 5 and 25 centigrams of dead tubercle bacilli (or even living bacilli of feeble virulence). A subsequent lethal dose of virulent tubercle bacilli proved innocuous to the animals treated in this way, showing that the dead bacilli had produced an immunity against the living virulent bacilli. Dr. Calmette and M. Guérin conclude that young cattle can be vaccinated by intestinal absorption of bacilli modified by heat, and that this method of vaccination is entirely without danger.

The council of the Society of Arts has awarded the society's silver medal to the following readers of papers during the session just completed:—Mr. W. F. Mitchell, The commerce and industries of Japan; Dr. William Arthur Aikin, Aspects of voice development; Mr. Leon Gaster, Progress in electric lighting; Mr. Walter Garstang, The fisheries of the North Sea; Captain G. S. C. Swinton, London traffic; Mr. Bernard B. Redwood, Motor boats; Mr. J. B. Millett, Submarine signalling; Prof. Thomas Oliver, Bridge building by means of caissons; Mr. Clayton Beadle, Watermarking; Sir James A. Bourdillon, K.C.S.I., The partition of Bengal; Dr. George A. Grierson, The languages of India; Colonel Sir Arthur Henry McMahon, K.C.I.E., Seistan; the Hon. Rodolphe Lemieux, K.C., French Canada; the Hon. J. G. Jenkins, Social conditions in Australia; Mr. Louis N. Parker, Historical pageants; Mr. H. Yates Thompson, Illuminated manuscripts; and Mr. Harry Powell, Cut glass.

The death of Herr Eduard von Hartmann is announced from Berlin. Born in 1842, he was intended for a military career, but retired from service in 1865 owing to a malady of the knee which made him a cripple for life. He received the degree of Doctor of Philosophy from Rostock University in 1867, and two years later published "The Philosophy of the Unconscious," the work on which his reputation chiefly rests. A very voluminous writer—his works contain upwards of 12,000 pages—he published, among other writings, "Phenomenology of Ethical Consciousness" in 1879, "The Religious Consciousness of Mankind in the Stages of its Development" in 1881, and "The Religion of the Spirit" in 1882. About three or four years ago there appeared "Die Weltanschuung der modernen Physik," one of the most important of his later works. His system was an amalgamation of Schopenhauer's doctrine of will with the metaphysic of Hegel, and the "Unconscious" which formed his first principle was but another name of the absolute of the German metaphysicians. "According to von Hartmann," writes one authority, "the Unconscious is the absolute principle active in all things, the force which is operative in the inorganic, organic and mental alike, yet not revealed in consciousness. It is the unity of unconscious presentation and will, of the logical (idea) and the alogical (will). The Unconscious exists independently of space, time and individual existence, timeless before the being of the world. For us it is unconscious, in itself it is super-conscious." The Schopenhauerian side of von Hartmann appealed to the prevailing pessimism of the time, but he himself was no pessimist; full of vigorous ethical feeling, and a strong opponent of the prophets of the *Weltschmerz*, he contributed not a little to the discussion of political and social subjects.

The Society of German Engineers, which with its 20,000 members is now the largest technical society in the world, celebrated on June 11–14 the completion of the fiftieth year of its existence. The opening ceremony was held in the Reichstag building in Berlin, under the presidency of Dr. A. Slaby. Congratulatory addresses were delivered by the Prussian Home Secretary, the Prussian Minister of Education, the Oberbürgermeister of Berlin, and the rector of the Berlin Technical School, as well as by numerous representatives of kindred societies in Germany and other countries, Mr. Bennett Brough (Iron and Steel Institute) speaking for the British societies and Prof. K. E. Hilgard (American Society of Civil Engineers) for the American. The proceedings terminated with a lecture by Dr. W. von Oechelhaeuser on technical work past and present, in which he compared the engineering works of the ancients with those of modern times, and endeavoured to forecast what the future of engineering would be. On June 12 a lecture was given by Dr. A. Riedler, on the development and present importance of the steam turbine; and on June 13 papers were read by Prof. Muthmann, on methods of dealing with atmospheric nitrogen; and by Dr. Hoffmann, on the utilisation of power in mines and metallurgical works. Throughout the week an elaborate programme of visits, excursions, and social functions was arranged for the 1231 members and 464 ladies who took part in the meeting. The German Emperor honoured the society by accepting the Grashof gold medal, and by conferring decorations on the president and other prominent members. An interesting history of the society is given in *Engineering* of June 8. The growth of the society has certainly been remarkable. It was founded in 1856 at Alexisbad, in the Hartz, by twenty-three young engineers. Friedrich Euler was elected the first president, and Franz Grashof the first secretary and editor, the work of the society being carried on in the secretary's private study. The society now has a stately house of its own and a staff of forty-seven officials. Its weekly journal last year cost 26,162*l.* for publishing and 6425*l.* for postage.

THE fourth part of vol. xxvi. of Notes from the Leyden Museum is devoted to invertebrates, more especially crustaceans and insects, Dr. van der Weele contributing three papers on Neuroptera, Mr. C. Ritzema one on a new Sumatran beetle, while Dr. de Man discusses and figures certain crustaceans of the genus Palæmon.

HUNTED for four months in the year over a great part of England, and almost everywhere shot and trapped on every possible occasion, the otter, observes Mr. J. C. Tregarthen in a delightful article in the June number of the *Monthly Review*, yet manages to survive in the British Isles in a manner and in numbers which are truly surprising. The fox, were he not rigorously protected, would disappear from the greater part of England in a very few years, and yet the otter, without the aid of any protection and despite unremitting persecution, continues to flourish in our midst, and this, too, in face of the fact that the female breeds only once a year, and then gives birth to but three or four cubs. The fact that he is here to-day and gone to-morrow—maybe a score of miles away—is, in the author's opinion, the reason of the otter's success in life. It will be news to many of our readers that there are no less than twenty packs of otter-hounds in England and Wales; and now that most of the "methods of barbarism" have been abolished, the author enters a vigorous protest against the attempts of "grandmotherly legislation" to abolish an ancient and exciting sport.

EXTRACTS from two letters written by Mr. T. R. Bell in 1903 and 1904 from India concerning certain butterflies in that country form the most generally interesting portion of the contents of the June number of the *Entomologist's Monthly Magazine*. Special stress is laid by the writer on dimorphism in these insects due to the time of year at which they were developed, the dry-season imagos, owing to what may be described as practical starvation, differing in many cases very markedly from the well-fed wet-season forms. On such differences several nominal species have been founded. Very noteworthy is the fact that in species of the same genus the differences between the dry and the wet forms frequently take quite different lines. "Ocellation" on the under-side of the wings appears, however, to be a distinct character of the wet forms. In breeding certain butterflies, such as some of the "blues," at Kanara it was noticed that males and females came out in equal numbers, whereas in a state of nature the latter are scarcely ever seen, or if observed are found in thick underwood, while the males bask in the open sunshine.

THE *Museums Journal* for May contains the report on the discussion following the papers on the relation of provincial museums to national institutions read at the Museums Association Conference at Worcester last year. The points for discussion ranged themselves under two main headings:—(1) that museums should be taken over by Government, and "run" practically without local assistance; and (2) that all important specimens should go to a national collection. The first proposition met with a direct traverse in one of the papers read, the author of which urged that museums get on much better in proportion as they are independent of Government aid. As regards the second point, which, in the case of zoological museums, related mainly to type-specimens, the question was raised as to the proper places of deposition for such specimens. Should, for example, Indian types go to Calcutta and American to New York, or, on the other hand, should types described in England be placed in the British Museum and those named in America be transferred to New York or Chicago, and so on? Incidentally, it was mentioned that if a national collection received such a valuable augmentation it ought to do something in return, and it was accordingly suggested that the British Museum should start a zoological loan collection. No definite motion was agreed to on any one of these points.

A NEW salamander from North Carolina, remarkable for its brick-red legs, which contrast with the leaden hue of the body, is described in No. 1457 of the Proceedings of the U.S. National Museum by Dr. Stejneger under the name of *Plethodon shermani*. New crickets and leaf-winged grasshoppers, or "katydids," from Costa Rica form the subject of No. 1459 of the same serial, the author being Mr. J. A. G. Rehn. A species of Mimetica has the

FIG. 1.—*Mimetica crenulata*, lateral view of type.

"tegmina," or front wings, of the usual dried-leaf type, and of a form which defies description, although well shown in the accompanying illustration. In part 1458 of the same serial Mr. C. D. Walcott resumes his account of the Cambrian faunas of China, basing his observations on new material. It is anticipated that a fully illustrated report on the subject will be published before the close of the present year.

THE June number of the *Popular Science Monthly* contains several articles of great interest to biologists and geologists. Dr. D. S. Jordan has some suggestive observations on variation in animals and plants. He points out, for instance, that in many cases adaptive characters are older than non-adaptive, as exemplified by the fact that flying-fish flew before the differentiation of the existing genera. Mutation—or saltation, as he prefers to call it—is regarded as only an extreme development of individual fluctuation, the author adding that "while saltation remains as one of the probable sources of specific difference, its actual relation to the process of species-forming in nature remains to be proved." Prof. Carl Eigenmann's article on the fresh-water fishes of South and Central ("Middle") America is worthy of the best attention of all interested in zoological distribution. The leading features brought to notice are:—(1) the variety of the fish-life in tropical South America; (2) the paucity of family-types contributing to this variety; (3) the poverty of the Central American fish-fauna and its essential South American character, except for (4) the isolation of the fauna of the Mexican plateau; (5) the poverty of the Pacific slope fish-fauna and its essentially Atlantic type; (6) the "marine" character of the fishes of Lake Titicaca; (7) the poverty of the Patagonian fauna and its essential distinctness from that of Brazil; and (8) the similarity between the fish-fauna of tropical America and that of tropical Africa. As regards the latter point, the author observes that "a land-connection, whether a land-bridge, intermediate continent, or land-wave, between the two continents is imperative. This land-connection must have existed before the origin of existing genera and before many of the existing families."

As a result of visiting several of the more important herbaria in Europe to study the genus Eupatorium and several allied genera, Mr. B. L. Robinson has published some notes on the Eupatorieæ in the Proceedings of the American Academy of Arts and Sciences, vol. xlii., No. 1. In addition to the diagnoses of new species of Eupatorium and other genera, the pamphlet contains revisions of the genera Piqueria and Ophryosporus, also a discussion of the genus Helogyne.

A SUGAR experiment station was instituted in Jamaica in April, 1904, under the direction of Mr. H. H. Cousins, for investigating problems in connection with the sugar and rum industries. The report for 1905 indicates what is being done in the matter of cultivation experiments to test different manures and varieties and to select new seedling canes. The advantage to be gained by taking new varieties into cultivation is well shown by the results obtained on the Albion Estate, where the Mt. Blanc variety generally grown produces less than any other variety tested, and furnishes less than half the saccharose yield per acre of the seedling B 379.

AN inquiry into the manufacture of Jamaica rums, by Mr. C. Allan, occurring in the above report, deals with fermentation changes, more especially those that give the quality to *flavoured* rums. It appears that the flavour is due mainly to the large amount and nature of the ethers formed. Premising that the characteristics of Jamaica rum are derived from saccharine liquors rich in albuminous matter fermented by yeasts and bacteria, in the case of the high-flavoured rums bacterial action is greatly increased and special bacteria are developed, producing acids that in combination with alcohol form aromatic ethers. It is suggested that higher alcohols, furfurol, and aldehydes may help to give *body* to the spirit.

IN a paper read before the National Academy of Sciences, U.S.A., on April 17, the distinguished seismologist Major C. E. Dutton discusses the possible relationhip between volcanic action and radio-activity. The theory brought forward is that, in limited tracts at depths of less than four miles, rocks are melted by heat due to radio-activity. As the melting proceeds, the water contained in the rocks becomes explosive and an eruption follows. When all the lava is exhausted the reservoir is closed. In due course more heat is generated, rocks are again melted, and a second eruption takes place. This explains, not only the repetitive character of eruptions, but the comparatively shallow depth at which they originate. The horizon of molten rock, if it is dependent on secular cooling of the world, would be at a depth of 30 miles or 40 miles, while if it is due to radio-activity it may possibly be found at a depth of three or four miles.

AN interesting supplement on modern air compressors, covering twenty pages with seventy-three illustrations, is published with the *Engineer* of June 15. It gives an excellent review of the great strides made during the last fifteen years in the use of compressed air. The development of the use of compressed air as a means for transmitting power appears the more remarkable when it is remembered that during the same period the use of electricity for that purpose has grown enormously.

THE Engineering Standards Committee has made arrangements with a firm at Bilston to manufacture commercial sets of standard pipe-flange templates in large quantities. The templates are made, with extreme accuracy, of thin steel plate painted over with aluminium paint, a small piece being cut out at the extremity of each centre line so as to enable the fitter to see that the centre line of the template coincides with the centre line of his flange. The existence of these templates should enable full advantage to be taken of the standardisation that the committee has sought to effect.

IN a note to the *Rendiconti della R. Accademia dei Lincei* (dated April 22 last) Dr. F. Eredia gives the monthly and yearly rainfall values obtained at the Collegio Romano for eighty-one years, 1825–1905. Observations were begun there in 1788, but their continuity and uniformity were not quite satisfactory prior to 1825. The annual mean for this long period is 31·8 inches. The wettest months are October to December; the maximum fall in any month was 14·7 inches, in November, 1878.

THE weather report issued by the Meteorological Office for the week ending Saturday, June 16, shows that the weather for the period was fine and dry generally. The sky was cloudy in the eastern and southern counties of England, and some rain fell in all districts. Thunderstorms occurred in various parts of England on June 12 and 16. Temperature was generally low for the time of year, and in the east of England the mean was 4° below the average. At Dumfries, in the west of Scotland, the thermometer rose to 83°, and in the east of Scotland and in the north-east of England it exceeded 80°. In the north of Scotland the range of temperature for the week amounted to 49°. The winds were mostly from between north and north-east.

AN illustrated price-list of echelon diffraction gratings, just issued by Messrs. Adam Hilger, 75*a* Camden Road, N.W., will be found to be of interest by all practical spectroscopists. The gratings contain from ten to forty plates, the corresponding prices, including suitable mounts, ranging from 13*l.* to 120*l.* The heights of the plates vary from 32 mm. to 40 mm., but can be made higher than this if desired. The standard width of each step is 1 mm., and the thickness of each plate about 10 mm., but this latter dimension may be increased, with a corresponding increase in price, if so desired. The list also contains illustrated descriptions of the more generally used arrangements of the echelon apparatus and of the auxiliary spectroscopes and various accessories employed. Messrs. Hilger make a speciality of the constant deviation spectroscope most usefully employed with echelon gratings, and have just made an important alteration in the adaptation of the telescope and collimator which will greatly increase their rigidity, though the price remains the same.

THE results of a study of the infra-red region of the spectrum, made by M. Milan Stefanik at the Meudon Observatory, appear in the *Comptes rendus* for April 30. While working with the solar eclipse expedition in Spain, M. Stefanik found that, by placing a dark red screen before the slit of his spectroscope, he was able to see to a considerable distance into the infra-red. This led him to continue a research on this matter on his return to Meudon, where he employed a spectroscope having two prisms, containing benzine and carbon bisulphide respectively, and used as the light source an image of the sun projected on to the slit by a lens, after reflection from a silvered plane surface. Screens of various coloured alcoholic solutions were employed, and the best results were obtained when the screen absorbed all the luminous radiations of the spectrum, allowing only the extreme red and infra-red to pass. M. Stefanik has arrived at the conclusion that if only a limited region of the spectrum be allowed to enter the spectroscope this region is seen much better than if the total light were employed, for, despite the large absorption by the numerous pieces of glass included in his apparatus, he was able to observe and to map easily the spectrum down to 1 μ. The group Z was always easily visible, also X, and the lines π, ζ, σ, and τ more rarely. It appears from the variations in the intensities of the lines that some of them are of telluric origin. According to the *Annuaire* of the Bureau des Longitudes the infra-red is visible to 0·795 μ, but by the employment of the screens M. Stefanik has extended the limit to at least 0·900 μ.

THE Oxford University Junior Scientific Club is to be congratulated on the May number of its Transactions. Prof. H. A. Miers gives an interesting account of his recent investigations, in collaboration with Miss Isaacs, of spontaneous crystallisation and the nature of supersaturated solutions, while a paper by Mr. M. H. Godby, on the place of natural science in education, is full of good things, and deserves notice of a larger public.

IN a note in the *Physikalische Zeitschrift* (No. 8, p. 257) Drs. Stefan Meyer and Egon von Schweidler point out that Madame Curie, in a criticism of their work, referred to in NATURE (vol. lxxiii., p. 549), misinterpreted the tenor of their original communication in assuming that they considered polonium to consist of a mixture of radium D, radium E, and radium F. The conclusion they actually formed (Proceedings of the Vienna Academy of Sciences, February 1) was in reality the same as that arrived at by Madame Curie, namely, that polonium is identical with radium F. In another paper (Vienna Academy of Sciences, *Anzeiger*, No. 12) Drs. Meyer and von Schweidler confirm, however, the view that radio-lead is a mixture of radium D, radium E, and radium F, and describe the separation of these substances by electrolysis. Several determinations of the constant of decay of radium E were made as a means of characterising this substance, and the nature of a new radio-active product from actinium is discussed.

THE transformation of oxygen into ozone at high temperatures is the subject of a paper by Messrs. Franz Fischer and Fritz Braehmer in the *Physikalische Zeitschrift* (No. 9). It is shown that when a platinum wire or a Nernst filament is rendered incandescent whilst surrounded by liquid oxygen, or when an arc lamp or hydrogen flame is played upon liquid oxygen, ozone is formed. When the action is prolonged the amount of ozone formed increases; in one experiment 1 per cent. by weight of the oxygen used underwent condensation. Experiments are adduced to prove that the formation of ozone in these cases is solely a thermal phenomenon, and is not to be referred to an ozonising ultra-violet radiation. When any of the methods of heating described are adopted in ordinary air, nitric oxide appears to be the sole product; in such a case the ozone is not cooled and removed from the sphere of action sufficiently quickly to prevent its decomposition. It is well known that when a hydrogen flame burning in oxygen is played upon water or ice hydrogen peroxide is formed in minute quantity; it is interesting to note that when hydrogen is burnt in liquid oxygen no hydrogen peroxide can be detected. In the former case water is oxidised to hydrogen peroxide, in the latter molecular oxygen is converted into ozone.

OUR ASTRONOMICAL COLUMN.

DISCUSSION OF FACULÆ OBSERVATIONS.—An interesting discussion of the observations of faculæ, in which Prof. Mascari compares the frequency and intensity of these phenomena with the solar activity as indicated by sun-spots and the variation of the total luminous radiation from the solar disc, appears in No. 5, vol. xxxv., of the *Memorie della Societa degli Spettroscopisti Italiani*.

Since 1894 the groups of faculæ on the solar disc have been observed, and their number and intensity recorded, on every day that the atmospheric conditions were favourable. The intensities were classified in five groups, viz. brightest (V.V.), bright (V.), ordinary, weak (*d.*), and weakest (*d.d.*).

Analysing the results thus obtained, Prof. Mascari finds that the third class (and possibly the second and third classes) decreased in frequency from that year of sun-spot maximum until 1901, sun-spot minimum, and then increased regularly up to the 1905 maximum. The (*d.*) and (*d.d.*) classes varied in the inverse sense.

Assigning numerical values to these classes, from 5 for the (V.V.) to 1 for the (*d.d.*), and taking the grouped mean for each year as the relative annual brightness of the faculæ, Prof. Mascari finds that this mean brightness also varies with the sun-spot activity, being 2·83 in 1894, 1·88 in 1901, and 2·97 in 1905. Combining, as a product, the mean frequency of the faculæ for each year with their relative mean brightness a similar result is obtained, the respective values being 29·80 in 1894, 4·62 in 1901, and 19·63 in 1905.

These results, combined with those obtained by himself in 1901 and Tacchini in 1878 showing that the chromospheric phenomena were less bright at sun-spot minima than at maxima, led Prof. Mascari to the conclusion that the luminous radiation of the sun is greater at the spot maxima than it is at the epochs of minima.

NEW METHOD FOR THE DISCOVERY OF ASTEROIDS.—In No. 4, vol. xxiii., of the *Astrophysical Journal*, Mr. J. H. Metcalf, of Taunton (Mass.), describes a method which he has employed successfully in the photographic discovery of asteroids.

This method is really an adaptation of that employed in the photography of comets, where the observer, instead of following the guiding star in the usual way, regularly moves the photographic plate during the exposure so that it follows the object which he hopes to photograph, and thus obtains a well-defined single image of that particular object, whilst the surrounding stars are represented on the plate by trails.

By moving his plate in a direction parallel to the ecliptic at a rate previously computed for an ideal asteroid, Mr. Metcalf has obtained some excellent, well-defined circular images of several known faint asteroids, and has also discovered some new ones. For example, one of the reproductions which accompany his paper shows a pair of images of an asteroid of the thirteenth magnitude which he discovered on March 22.

RADIAL VELOCITY OF α DRACONIS.—A brief note by Herr H. Ludendorff, published in No. 4088 of the *Astronomische Nachrichten*, confirms the variability of the radial velocity of α Draconis announced by the Lick observers. According to the latter, the radial velocity on June 16, 1902, was 0 km., and on May 4, 1903, and June 19, 1904, it was -42 km.; values of -43 km. and -40 km. were also obtained.

On two plates secured with the Potsdam spectrograph (iv.) on May 23 and 24, 1903, the displacement of the lines λ 4481 and $H\gamma$ gave the radial velocity of this star as -17 km. and -14 km. respectively.

USEFUL TABLES AND FORMULÆ FOR ASTRONOMICAL COMPUTATIONS.—No. 15 of the Publications of the Groningen Astronomical Laboratory contains a number of tables for photographic parallax-observations, prepared by Dr. W. de Sitter. Each table gives the parallax factors, for each hour of R.A., for every 10° of latitude, and also shows the limiting dates between which a star of the stated R.A. may be observed photographically.

No. 16 of the same publications is given in the same volume, and contains a number of trigonometrical formulæ and a table of goniometrical functions for the four quadrants, compiled by Profs. J. C. and W. Kapteyn; additional formulæ, both for plane and spherical triangles where certain elements are small, are also included.

THE LEEDS ASTRONOMICAL SOCIETY.—We have just received No. 13 of the Journal and Transactions of the Leeds Astronomical Society, which gives a brief *résumé* of the work accomplished by the members of the society during the year 1905.

Eight papers read before the society during the session, dealing with popular astronomical subjects, are reproduced in the journal, together with a number of notes contributed by members to various publications.

From remarks made in the report it appears that this society is greatly in need of increased support, financial and general.

METEOROLOGICAL OBSERVATIONS.

FROM the "Jahrbücher" of the Austrian Meteorological Office for 1904 it appears that changes have recently been made in the comprehensive operations of that important institution. A considerable addition to its labours has been incurred by the transfer to it of the observations of earthquake phenomena originated by the Vienna Academy of Sciences; this organisation embraces a large number of stations. Owing to this transfer the office has adopted the title of Central-Anstalt für Meteorologie und Geodynamik. A considerable increase has been made in the number of weather forecasts sent gratuitously to provincial post-offices; in these telegrams an attempt is made to forecast the weather for two days in advance. On the other hand, it has been found necessary greatly to restrict the amount of data published from stations of the second and third order; this materially lessens the bulk of the year-book. The investigation of the upper air by manned and unmanned balloons is actively continued, and the results are published in the Proceedings of the academy. A separate appendix contains a revision of the yearly means of barometric pressure at various stations since 1886, by Dr. Margueles, and a discussion of thunderstorms and hail, by M. Prohaska.

The results of meteorological and magnetical observations at Stonyhurst College for 1905 have just been issued. This useful observatory possesses photographic recording instruments both for meteorology and terrestrial magnetism, and was one of the seven principal stations included in the scheme of the Meteorological Committee in 1868 for the discussion of the meteorology of the British Isles; its observations extend over the long period of fifty-eight years. The most notable feature of the year appears to us to be the shortage of rainfall, amounting to just upon 8 inches. The total rainfall was 38·84 inches; the least fall in any year was 31·25 inches, in 1887. The prevailing wind was between south and west on 237 days. Drawings of solar spots and faculæ were made on 196 days, and the stellar spectrograph was employed on nearly every available night.

The fourteenth report of the Sonnblick Society for the year 1905 contains statistics of several prominent mountain meteorological stations, including an interesting account of the observatory at the summit of Monte Rosa, at an altitude of about 14,960 feet. The Sonnblick station (Salzburg) is about 10,190 feet above the sea-level, and is far from an agreeable residence for its enthusiastic observers. The mean temperature for the year 1905 was 19°·9 F.; the monthly mean was only above freezing point in July and August, the absolute maxima in those months being 56°·8 and 45°·7 respectively. Rain or snow fell on 230 days, amounting to 68·8 inches, and fog occurred on 274 days. On January 1 the thermometer fell to −35°·3, being the lowest observed since the establishment of the observatory, the next lowest reading being −30°·3, in March, 1890; the wind was north-easterly, with high barometric pressure (30·71 inches) over Scandinavia and low (29·53 inches) over Greece.

The twenty-eighth yearly report of the Deutsche Seewarte, for the year 1905, shows a considerable increase in the useful work of that institution; the number of sets of observations contained in ships' logs exceeded those of the previous year by more than 28,000. These observations are utilised in the publication of monthly charts for the North Atlantic, quarterly charts for the North Sea and Baltic, the preparation of valuable daily synoptic weather charts of the North Atlantic (in conjunction with the Danish Meteorological Institute), and various other investigations. Special mention may be made of the efficiency of the arrangements for the issue of weather forecasts and storm warnings, and of the careful discussion and publication of the observations made at distant stations, including Labrador, the South Seas, the Far East, and German East Africa. The exploration of the upper air by means of kites is actively carried on; 233 ascents were made during the year, the mean of the greatest altitudes being 3910 metres. It has been found necessary to limit the altitudes, except on the days of the international ascents, owing to the frequent loss of the kites; the principal kite (which carries the instruments) broke away on twenty-two occasions, three of which were due to lightning. Unmanned balloons also reached altitudes of 9 to 17 kilometres; the usual inversion of temperature generally occurred between 9 and 11 kilometres. A discussion of the results obtained will be published later on.

The annual summary of the India Weather Review for 1904, which completes the discussion of the meteorology of India for that year, was issued recently. This vast area is, as before, divided into eleven provinces and fifty-seven districts for the purpose of dealing with medical and agricultural statistics respectively. In addition to various tables giving the usual monthly and other values, each element is separately considered under seasons, including the hot, cold, and monsoon periods. We can here only briefly refer to some of the general annual results. The year was characterised by smaller departures from the normal temperature than is frequently the case; the mean of the maxima for the eleven meteorological provinces was 88°·0, of the minima 68°·7, and the mean daily range 19°·4. The Arabian Sea was singularly free from storms; only eleven occurred, and they were all comparatively feeble, and their tracks were less westerly than usual. The rainfall stations now number 2486; the mean amount of rainfall was 57·26 inches, about $1\frac{1}{2}$ inches below the normal. On the Burma coast the fall was 152·65 inches, and in the Indus valley only 7·26 inches. During the year there was a marked increase in the number of sun-spots; the surface of the sun was not free from them on any day. Magnetic disturbances were recorded at Colába on 205 days, but there were only three days on which they were classed as "great."

The report of the Government Observatory, Bombay, for the year 1905 also quotes a remarkable deficit in the rainfall, it being stated as 41·5 inches below the normal of twenty-four years, 1873–1896. The total fall for the year was 33·66 inches only, and the amount for the previous year was 33·42 inches, both of which are record minimum falls, not even excepting that for the famine year, 1899, when 35·9 inches were registered. Milne's seismograph recorded thirty-seven earthquakes during 1905; those on April 4 and 9 and July 23 were very great disturbances. Plague in a severe epidemic form broke out at Alibág, but no cases occurred in the immediate vicinity of the branch magnetic observatory at that place; one case occurred at Colába in the month of April, notwithstanding that all precautions were taken.

The annual report of the Meteorological Department of the Transvaal for the year ended June 30, 1905, was received a few days ago. The central observatory, near Johannesburg, was first occupied in May, 1904, and is situated on an abrupt ridge of hills, nearly 6000 feet above sea-level. The department has been very active in supplying verified instruments, and has already some 250 stations in different parts of the colony, the majority of which record rainfall only; the observers are mostly volunteers, and receive no remuneration. The report, however, contains complete meteorological observations, or monthly results, for a considerable number of places, and very useful maps exhibiting the climatological features of the year in various districts. The diurnal periodicity of rainfall, so far as given, shows that the greater part occurs between noon and midnight. Nearly every fall of rain is said to be accompanied with thunder and lightning; some of the storms are very heavy, and a lightning recorder has been erected at Johannesburg which gives a permanent record of their intensity and duration. On the High Veldt the mean temperature of the twelve months ranged from 57° at Volksrust to 65° in the Waterberg, the extreme maxima from 87° to 104°, and the extreme minima from 14° to 29°. Telegraphic messages are received and exchanged daily, and the Government has sanctioned the appointment of an assistant, to be trained in weather forecasting at the Meteorological Office in London.

THE THEORY OF FREQUENCY-DISTRIBUTIONS.[1]

THREE brief but important notes on the theory of the law of error were communicated to the Royal Academy of Sciences at Stockholm last year by Mr. Charlier, director of the astronomical observatory at Lund. The first of these ("Ueber das Fehlergesetz") is a discussion on the lines, generally, laid down by Laplace. An "error" is supposed to be given by the sum of a large number of elementary errors, each with its own law of frequency; these laws need not be the same, but are subject to the condition that the frequency should not fall off with great rapidity on either side of the mode. On this condition, the law reached is the known expansion in terms of the normal function and its differentials, recently discussed in detail by Prof. Edgeworth (Camb. Phil. Trans., vol. xx.). In his second note ("Die zweite Form des Fehlergesetzes") Mr. Charlier discusses the complementary case, in which the condition stated does not hold, supposing, for instance, that each elementary error can only take the value zero or a, and that the probability of a is very small. The normal function of the former series is now replaced by an auxiliary function of more complex form. These two laws are referred to as Type A and Type B. The third note ("Ueber die Darstellung willkürlicher Funktionen") bears on the general mathematical method employed.

The present memoir, which is written in English, is a sequel to these purely mathematical notes, discussing the practical work of fitting such curves to given statistics and so forth. The method of fitting used throughout is Prof. Pearson's "method of moments," which has proved so widely applicable. The illustrations are numerous; for Type A, frequencies of stigmatic rays in Papaver, Johannsen's distributions of weight in beans, cephalic indices of Swedish recruits, and deaths from typhoid fever in groups of three successive days during an epidemic at Lund; for Type B, De Vries's statistics of numbers of petals in Ranunculus, and Johannsen's figures for sterility in barley. Davenport and Bullard's data for the numbers of glands in the fore-legs of swine are discussed under both heads. These illustrations are followed by a short section on the dissection of a compound curve by Pearson's method (Phil. Trans., 1893). One or two possible cases of approximation are discussed, and an interesting suggestion made as to the employment of a graphic method to lighten the labour of solving the fundamental nonic. The text of the memoir is followed by some tables giving, *inter alia*, the third and fourth differentials of the normal function, and values of the auxiliary function for Type B.

There are several incidental points of interest; a proof of the empirically discovered rule that the difference between mean and median is one-third of the difference between mean and mode for Type A deserves mention, and a suggestion as to an arithmetical check in calculating moments is worth consideration from the practical standpoint. If one may judge from a diagram (Fig. 5), curves of Type A may be bi-modal. Is this so? The point does not appear to receive special attention in the text. The statement on p. 15 that "as a rule it may be advisable to take the class range smaller than the standard deviation" would seem to be rather incautious. Surely, as a rule, it should be not merely smaller, but a good deal smaller—say one-third of the standard deviation or less?

The memoir and its preceding notes must be commended to the attention of all who are interested in the theory of frequency distributions either from the mathematical or the statistical side.

G. U. Y.

[1] "Researches into the Theory of Probability." By C. V. L. Charlier. Pp. 51. (Meddelanden från Lunds Astronomiska Observatorium, Serie ii. Nr. 4. Kongl. Fysiografiska Sällskapets Handlingar. Bd. 16.) (Lund, 1906.)

A PLEA FOR AN EXPEDITION TO MELANESIA.

DR. A. C. HADDON, F.R.S., recently brought before the research department of the Royal Geographical Society a plea for the investigation of biological and anthropological distributions in Melanesia. The Melanesian islands constitute a fairly well-marked biological province. Many of the islands are of large size, and there is reason to believe that some of these are vestiges of an ancient land-mass that probably became submerged in the Mesozoic period. The islands of Melanesia have yet to be studied from a geomorphological point of view, and their geology is extremely little known. Botanists would welcome a more ample knowledge of the flora of the district as a whole and of particular portions of it, and many problems of plant structure, distribution, and œcology require detailed investigation on the spot. The same remarks apply to zoologists. Botanists and zoologists alike would welcome an opportunity for extensive or intensive study of the systematic distributional or biological problems of plants and animals in Melanesia.

There are also many anthropological problems in Melanesia that require investigation in the immediate future, since the dying out or modification of arts, crafts, customs, and beliefs that is now taking place, and the shifting and mixing of populations, will soon render their solution difficult and even impossible. On the other hand, there are many districts never yet visited by a white man, and many islands of which science has no knowledge.

There is a certain amount of variation in the physical character of the people of these archipelagoes that requires local study for its explanation. A good deal is known in a general way about the arts and crafts of the Melanesians, but an investigation of the kind proposed would verify existing data, add an immense number of trustworthy facts, and localities could be ascertained of unlocated specimens in our museums, and the uses of doubtful objects could in many cases be discovered. By a combination of these two lines of inquiry, the physical and the cultural, the nature, origin, and distribution of the races and peoples of the West Pacific could be elucidated. Melanesia is peculiarly suitable for studying the stages of the transition from mother-right to father-right, and it would be important to discover the causes that have led to this transformation, and the steps that mark its progress. With this is associated the evolution of the family and the distribution and inheritance of property. Melanesia is also a favourable area for tracing the emergence of government. What are required at the present day are intensive studies of restricted areas, since it is only by careful regional study that the real meaning of institutions and their metamorphoses can be understood. The same applies equally to all the manifold beliefs and usages that are grouped under the term religion. The psychology of backward peoples has been greatly neglected, and the opportunity of a well-equipped expedition would do much to encourage students to undertake this research.

It is superfluous to extend this plea, as all ethnologists will agree that this work requires to be done, and that without delay. The presence of Government officials, missionaries, traders, and of returned indentured labourers tends rapidly to modify or destroy the old customs. Much has already disappeared in many places; we are yet in time in many others if we do not delay.

Dr. Haddon is convinced that the best means of accomplishing the end in view is to organise a prolonged expedition to the Pacific with the absolute control of a comfortable and steady steamer. The permanent staff on board should consist at least of the director, doctor, photographer, two stenographers, who should also be typists, and, if possible, an artist. Accommodation should be provided for a number of investigators, but these would not necessarily form part of the permanent staff. They would be conveyed to the district which they were to study and be removed therefrom when it was time to leave. The director would arrange with each investigator when the vessel would return, and the investigator would be left with all the apparatus, food, and trade that he required.

The general routine should be as follows:—an anthropological investigator would be expected to work on the general lines laid down by the director. When the vessel returned, all those on board would be required to help the investigator according to their several abilities; the expedition photographer would be placed at his disposal, and dances and ceremonies would also be kinematographed. The investigator would orally amplify his rough notes and dictate them to the stenographers, and, so far as possible, all notes should be typed in duplicate before the departure of the investigator, and a revision made of them before finally leaving the spot.

The foregoing remarks apply to anthropological investigators, but suitable arrangements could be made for geological, geographical, botanical, or zoological investigators; equal facilities should be given to American and foreign students; investigators should be of either sex.

It is only by an expedition of this kind that the anthropology of Melanesia can be studied as a whole and in detail. It would be an expensive undertaking, but the results obtained would amply justify the expenditure of time, labour, and money, and the data so obtained would constitute a mine of information for the present and future generations of students of man.

In the discussion which followed, Sir George Goldie, the president of the society, Dr. Herbertson, Mr. Chisholm, Dr. Seligmann, Mr. J. L. Myres, Mr. S. H. Ray, Mr. N. W. Thomas, Captain Wilson Barker, Major Darwin, Colonel Church, and the chairman, Sir Thomas Holdich, gave their cordial support to the proposed scheme. Several practical difficulties were pointed out, but none of them was insuperable. Some useful suggestions were also made. More than one speaker recognised that an expedition of this kind would serve as a valuable opportunity for increasing geographical, oceanographical, and meteorological knowledge.

DESTRUCTION OF ANIMALS IN AUSTRALIA.

IN the course of his address to the annual meeting of the Linnean Society of New South Wales, held on March 28, Mr. T. Steel, the president, alluded to a proposed method of destroying rabbits by means of an infectious disease, the precise nature of which is not yet disclosed. The idea, it appears, originated in Paris, and since the necessary funds have been subscribed by stock-owners and agriculturists, it is proposed to commence the experiment on a small island selected for the purpose. After discussing the arguments for and against the proposal, the president considered it highly undesirable that any such disease should be wilfully communicated to any species of animal, by means of which it might be disseminated throughout the country. As to the extermination of the rabbit, that is considered an impossible contingency; but means ought, and can, be found to keep the species in check without recourse to infectious diseases, which may be a danger to the community.

In the course of the same address Mr. Steel alluded to the necessity of special efforts if the native Australian fauna and flora are to be saved from destruction. Poison spread for rabbits is responsible for the destruction of a large number of indigenous mammals and birds, while, sad to relate, there are Europeans who will deliberately shoot down such harmless and peaceful creatures as the koala, or native bear, for the sake of so-called sport. Shooting domesticated sheep, it is remarked, would be equally worthy of such sportsmen.

A very similar note of alarm is sounded in the April issue of the *Victorian Naturalist* in the course of an account of a recent excursion by the members of the Field Naturalists' Club to the reserve for wild animals at Wilson's Promontory. Here the chief destruction is caused by half-wild dogs, which are not true dingoes, but the produce of a cross between the latter and dogs escaped from the fishermen of the district. If these pests are not soon exterminated there will be little hope of preserving any indigenous terrestrial animals in the reserve. With regard to the reserve itself, it is mentioned as a subject for regret that the whole area is cut off from the sea by a narrow strip of land which ought certainly to be added to the protected zone. If this were done, and certain neighbouring sawmills abolished, the reserve would probably flourish, provided it were separated from the mainland by a dog-and-rabbit-proof fence, and certain indigenous animals turned in from the adjacent districts. We wish every success to the movement.

ABERDEEN UNIVERSITY QUATERCENTENARY CELEBRATIONS.

ACTIVE preparations are being made in connection with the quatercentenary celebrations of the University of Aberdeen, and the new buildings at Marischal College, which His Majesty the King is to open in the last week of September, are approaching completion. The handsome new block—"a dream in granite"—which completes the quadrangle includes new class-rooms and laboratories for physiology, geology, and agriculture; new rooms for education, medicine, modern languages, &c.; a new library for scientific literature, and new offices.

Among the distinguished guests who have accepted the University's invitation are:—Lord Avebury, Sir Robert Stawell Ball, Prof. A. H. Becquerel, Prof. Behring, Sir William Broadbent, Sir Jas. Crichton Browne, Mr. Thomas Bryant, Lord Balfour of Burleigh, Mr. W. S. Bruce, of the *Scotia*, Mr. James Bryce, M.P., Sir William Crookes, Dr. Casimir De Candolle, Prof. Watson Cheyne, Prof. Yves Delage, Dr. Anton Dohrn, Sir Michael Foster, Sir Joseph Fayrer, the Duke of Fife, Sir Edward Fry, Dr. R. T. Glazebrook, Prof. A. Giard, Mr. Jonathan Hutchinson, Prof. Stanley Hall, Prof. Harald Höffding, Mr. R. B. Haldane, M.P., Prof. F. Hueppe, Prof. Jensen, Prof. Joseph Larmor, Sir Norman Lockyer, Prof. Lombroso, Sir Alfred Lyall, Dr. Donald Macalister, Major P. A. MacMahon, Signor Marconi, Prof. Mendeléeff, Prof. Menschutkin, Prof. Alexander Macalister, Prof. A. B. Macallum, Sir Alexander C. Mackenzie, Prof. Hugo Münsterberg, Sir John MacFadyean, Prof. Middleton, Prof. Mahaffy, Sir John Murray, Prof. Wilhelm Ostwald, Sir William Ramsay, Sir Henry Roscoe, Major Ronald Ross, Field-Marshal Earl Roberts, Sir James A. Russell, Dr. D. H. Scott, Dr. J. Hutchison Stirling, Dr. William Somerville, Prof. W. R. Sorley, Prof. Stirling, Mr. Thomas Shaw, M.P., Lord Mount-Stephen, Prof. J. J. Thomson, Dr. Thomas E. Thorpe, Prof. W. A. Tilden, Prof. G. D. Thane, Prof. Henry Turner, Prof. Giuseppe Veronese, Dr. J. A. Voelcker, Prof. Paul Vinogradoff, Prof. J. W. Wijhe, Prof. Weichselbaum, and Sir John Williams.

The following among other universities, colleges, and learned societies are to be represented by delegates:—University College, Bristol, Principal C. Lloyd Morgan; University of Cambridge, Dr. Henry Jackson, Dr. James Adam, and Mr. W. L. Mollison; University College, Cardiff, Dr. E. H. Griffiths; Trinity College, Dublin, Dr. Anthony Traill; Royal Society of Edinburgh, Lord MacLaren; Universities of Edinburgh, Glasgow, and St. Andrews; University of Leeds, Dr. Bodington; Royal Society of London, Sir Archibald Geikie; British Academy, Dr. J. A. H. Murray; Royal College of Physicians, Sir R. D. Powell; Royal College of Surgeons, Mr. Edmund Owen; University of Manchester, Dr. A. Hopkinson; University of Oxford, Dr. W. M. Merry, Prof. Henry Goudy, and Prof. Arthur Thomson; University of Wales, Principal H. R. Reichel; R. Accademia dei Lincei, Rome, Prof. Lanciani.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Harkness scholarship in geology has been gained by B. Smith, of Sidney, and the Wiltshire prize in palæontology by W. A. R. Wilks, of Gonville and Caius.

The Cavendish professor announces a course of demonstrations in physics at the laboratory during the long vacation, beginning on July 4.

The Victoria medal of honour has been awarded by the Royal Horticultural Society to Mr. R. I. Lynch, curator of the Botanic Garden.

A thousand willow-cuttings have been supplied from the garden to the Midlands Re-afforesting Association for the planting of waste-heaps in the "Black Country."

In the Natural Sciences Tripos, part i., thirty-eight men and no women obtain a first class; in part ii., twelve men and three women are in the first class, six being distinguished in physics and four in physiology.

MR. H. O. WILLS, of Kelston Knoll, near Bristol, has promised a contribution of 10,000*l*. towards the foundation of a university at Bristol.

THE annual garden-party will be held at Guy's Hospital on Wednesday, July 4, when Sir W. Cameron Gull, Bart., will distribute the medals and prizes to the successful students.

A GEORGE COMBE lectureship in general and experimental psychology has been established in connection with the philosophical department of the University of Edinburgh. The funds for the lecturer's salary will be provided mainly by the Combe trustees, who have also contributed 300*l*. towards the equipment of a laboratory.

THE Senate of the University of Dublin has decided to confer, at the summer commencements on July 31, the honorary degree of Sc.D. on Colonel David Bruce, C.B.; Prof. J. H. Poincaré, professor of mathematics and astronomy at the Sorbonne; Mr. E. T. Whittaker, F.R.S., Fellow of Trinity College, Cambridge, Astronomer Royal of Ireland; and Dr. A. E. Wright, F.R.S.

THE *Daily Chronicle* (June 20) announces that Sir William Macdonald has presented an agricultural college and an endowment of two million dollars (400,000*l*.) to the McGill University, Montreal. Sir William founded this agricultural college some time ago, in order to provide the youth of Canada with facilities for a thorough scientific education in agriculture.

AT University College (University of London) on July 3 the dean of the faculty of arts will read a report on the work of the session; the result of the University, scholarship and class examinations will be announced, and prizes and medals will be distributed by Dr. G. Carey Foster, F.R.S. (emeritus professor of physics, and formerly principal of the college). Lord Reay, president of the college, who will preside, will receive for the college from Prof. F. T. Trouton, acting on behalf of the subscribers, the portrait of Dr. G. Carey Foster, painted by Mr. Augustus John, and will present a replica thereof to Mrs. Carey Foster.

A COURSE of demonstrations and practical work in field and laboratory, on the applications of science to rural life and outdoor industries, will be held at the South-Eastern Agricultural College, Wye, about the last week in July or the first week in August. The course will be designed to meet the needs of science masters in rural secondary schools who have to teach various branches of science to country children. The work will be mainly practical investigation into the bearing of science on outdoor life, and lectures will be given to indicate the lines on which science teaching in rural secondary schools could be developed usefully. The cost of the fortnight's course will be 5*l*., including board and residence in the college. Full particulars may be obtained from the principal, Mr. M. J. R. Dunstan, at the college.

FURTHER generous gifts to education by American men of wealth are announced by *Science*. Mr. David Rankin, of St. Louis, has decided to give 400,000*l*. to found an industrial and manual training school in St. Louis. Mr. Clarence H. Mackay and his mother have together given 10,000*l*. for the immediate erection of a building for the College of Mines in connection with the University of Nevada. This building is to house the department of mining and metallurgy and that of geology and mineralogy. A recent State appropriation for the metallurgical laboratory has provided the University with a new ore-treating equipment which will be suitable for installing in the new quarters. The building will also contain a geological museum. Furthermore, Mr. F. M. Smith has arranged to provide an income of 200*l*. a year to be used for the support and encouragement of students in the mining school. This will in general be divided into five annual scholarships of 40*l*. each to be known as the F. M. Smith scholarships open to deserving students irrespective of citizenship or residence.

IT is satisfactory to know that the attempt made at the meeting of the Liverpool City Council to reduce the grant of 10,000*l*. to the University of Liverpool met with scant support. The grant was renewed by an overwhelming majority. We should like to agree with Sir Charles Petrie, who said at the meeting he could not think the mover and seconder of the amendment were serious, but there is still in this country a widespread want of appreciation of the national value of university teaching and research, and no effort must be spared to bring home to local authorities the duty devolving upon them to assist every grade of education to the fullest extent possible. As Chancellor of the University of Liverpool, Lord Derby has formally accepted from Miss Isabella Gregson, formerly of Liverpool, the gift of the Gregson Memorial Institute and Museum. The gift is to be utilised for university extension purposes, and represents in money value, with an endowment of 5000*l*. added by the founder, about 300,000*l*. It was erected some years ago by Miss Gregson at her mother's request for purposes of scientific recreation in memory of her father, mother, brother, and sister.

IN the foundation oration in connection with the Union Society, delivered at University College, London, on June 13, Sir Arthur Rücker, F.R.S., took for his subject the forthcoming incorporation of the college in the University of London. He emphasised the fact that University College is undenominational, and is to be united to an undenominational university. University College was the first great step towards bringing university teaching into the centre of the great masses of population. It may be said that the University of Cambridge owes indirectly its great physiological school to the college, for it was one of its students who developed there the idea. The college with its large resources has offered itself to the new university, and has made possible an absolute fusion. A sum of about a quarter of a million has been raised with this object in view. It is an open secret, Sir Arthur Rücker continued, that the University is in full negotiation with King's College with the view of that also becoming a college of the University. The University does not intend to injure or destroy University College in any way whatever; the college has a name and a reputation with which none but a madman would attempt to interfere. If the principal educational institutions in London are drawn together, it is hoped that the University will obtain the recognition, appreciation, and loyalty which are required for success. In conclusion, the principal of London University expressed the hope that the members of University College will support all movements for drawing the students of the University more closely together. All wanted to create a great university, and this would be of the very greatest importance to the whole of London.

THE Duke of Devonshire, as president of the National Association for the Promotion of Technical and Secondary Education, took the chair at the annual meeting held on June 15. During his opening speech the president said, in consequence of the exertions of the association in past years the position of technical and secondary education has been completely changed, the Government and the local authorities having taken up the question. The work for which the association was established to carry on has been to a great extent accomplished. The association is now no longer necessary for stimulating interest in the question of technical education or for promoting legislation. But, in the course of its existence, the association has done more than this; it has become the centre to which local authorities engaged in the work have been accustomed to look for advice, for information, and, to a certain extent, for guidance. Much of the work of the association is capable of being performed by the Government department. But from some communications which he had with the Board of Education a year or two ago, the Duke of Devonshire found that the department did not consider itself then in a position to undertake the whole of what is done by the association. It is, perhaps, possible that the present Treasury may take a different view, and that the Board of Education may be permitted by the Treasury to undertake a part of the work which has hitherto been exclusively carried on by the association. He therefore suggested that during the next year, in which provision is made for the continuance of the efficient work of the association, the executive committee should ascertain, by communication with the Government, how far the Board of Education is in a position to take up any part of the functions which the association has hitherto assumed; and if it should be found that those functions can be more usefully discharged in the future by a private association than by a department of the Government, practical consideration must be given to the manner in which it may be possible to secure a larger amount of assistance from the public. Lord Avebury and Sir Henry Roscoe also addressed the meeting.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 3.—"The Action of Pituitary Extracts upon the Kidney." By Prof. E. A. **Schäfer**, F.R.S., and P. T. **Herring**.

Intravenous injections of saline extract of the infundibular part of the pituitary body produce dilatation of kidney vessels accompanied by increased flow of urine; *i.e.* the extract has a diuretic action.

With the first injection this result is accompanied by rise of blood-pressure and contraction of systemic arteries. With subsequent injections the diuresis is usually attended, not by a rise of blood-pressure, but by a fall. This furnishes evidence that the diuresis is independent of the effects upon blood-pressure, and leads one to suppose that it is produced by a special constituent of the extract.

This conjecture is confirmed by the result of treating the extract with certain reagents which tend to abolish the rise of blood-pressure which is produced by a first injection, but leave the diuretic effect of the extract unaltered.

The diuretic as well as the pressor and depressor constituents of the extract are not destroyed by boiling. They dialyse through parchment paper. They are insoluble in absolute alcohol and ether.

Intravenous injections of extracts from the anterior or epithelial lobe of the pituitary body do not produce diuresis; these extracts exhibit no physiological activity.

It is concluded that the infundibular part of the gland produces an internal secretion which passes into the blood, and which, both indirectly owing to its general action upon the vascular system and directly by its special action on the renal vessels and renal epithelium, assists in promoting and regulating the secretion of urine; in other words, the internal secretion of the gland is ancillary to the renal functions.

May 10.—"A Variety of Thorianite from Galle, Ceylon." By Wyndham R. **Dunstan**, F.R.S., and B. Mouat **Jones**.

Specimens of thorianite from the Galle district of Ceylon were found to contain from 58·84 per cent. to 63·36 per cent. of thoria associated with from 32·7 per cent. to 27·9 per cent. of oxide of uranium. Ordinary thorianite from the Balangoda district contains 78·98 per cent. of thoria and 13·40 per cent. of oxide of uranium. The authors direct attention to the inter-replacement of thorium and uranium in the mineral, and conclude that the oxides of the two elements are present in isomorphous mixture, and are not chemically combined.

Chemical Society, June 7.—Prof. R. Meldola, F.R.S., president, in the chair.—Ammonium selenate and the question of isodimorphism in the alkali series: A. E. H. **Tutton**. Normal ammonium selenate crystallises differently from the seven rhombic normal sulphates and selenates of the alkalis already investigated, namely, in monoclinic prisms or tables. Rhombic mixed crystals of ammonium selenate and sulphate have been obtained, and it is concluded that ammonium selenate is dimorphous, and that the whole series of sulphates and selenates is probably isodimorphous.—The vapour pressures of binary mixtures, part i., the possible types of vapour-pressure curves: A. **Marshall**. By differentiating the equation of Duhem and Margules, $x d \log p_1 + (1-x) d \log p_2 = 0$, it has been found possible to classify the total pressure curves into twelve types, all of which are known to occur. The vapour pressures of the following pairs of liquids have been investigated experimentally:—nitroglycerol and acetone, diethylamine and acetone, ethyl alcohol and methyl ethyl ketone, water and methyl ethyl ketone, water and methyl acetate, water and ether, water and amyl alcohol.—The behaviour of acetylene with electrical discharges of high frequency: H. **Jackson** and D. N. **Laurie**. A semi-solid brown substance is formed when acetylene is subjected to discharges from an ordinary high-frequency apparatus, which sets to a hard and very insoluble solid on exposure to air. It is apparently a polymeride of acetylene. It absorbs oxygen readily up to about 8 per cent.—The behaviour of the vapours of methyl alcohol and acetaldehyde with electrical discharges of high frequency: H. **Jackson** and D. N. **Laurie**. Working with discharges of very short duration, the first change in the vapour of methyl alcohol is the formation of carbon monoxide and hydrogen; in the case of acetaldehyde the greater part of the vapour breaks up into methane and carbon monoxide, but acetylene and water are also produced in smaller quantities.—Note on 4-bromo-2-nitro-1α-naphthylamine: R. **Meldola** and H. G. **Dale**.—Dinitroanisidines and their products of diazotisation (second communication): R. **Meldola** and F. G. C. **Stephens**.—The action of sulphur dioxide and aluminium chloride on aromatic compounds: S. **Smiles** and R. **Le Rossignol**. The authors have previously shown that thionyl chloride reacts with phenetole in the presence of aluminium chloride, giving rise successively to a sulphoxide and a sulphonium base; it has since been found that this reaction may be brought about by sulphur dioxide with the aid of the same condensing agent.—Action of sodium on αα-dichloropropylene: Miss I. **Smedley**.—Resolution of lactic acid by morphine: J. C. **Irvine**. Fermentation lactic acid may be readily resolved into its active components by the crystallisation of the morphine salts.—Brazilin and hæmatoxylin, part viii.: W. H. **Perkin**, jun., and R. **Robinson**.—A study of the reaction between hydrogen peroxide and potassium persulphate: J. A. N. **Friend**. It is shown that solutions of hydrogen peroxide and potassium persulphate interact according to the equation $H_2O_2 + K_2S_2O_8 = 2KHSO_4 + O_2$. The reaction, however, is monomolecular, due to the formation of an intermediate and highly unstable compound.—The action of magnesium methyl iodide on dextrolimonene nitrosochlorides: W. A. **Tilden** and F. G. **Shepheard**. The same compound is formed from the α- and β-nitrosochlorides. It is insoluble in aqueous alkalis and in acids, though easily soluble in the usual organic solvents, and has the formula $C_{20}H_{32}ON_2Cl_2$.—Electrolysis of potassium ethyl dipropyl malonate: D. C. **Crichton**. A concentrated aqueous solution of potassium ethyldipropylmalonate yields on electrolysis the ethyl esters of α-propyl-β-ethylacrylic acid, dipropylglycollic acid, tetrapropylsuccinic acid, and probably dipropylacetic acid.—A new method for the measurement of hydrolysis in aqueous solution based upon the consideration of the motion of ions: R. B. **Denison** and B. D. **Steele**.—The oxidation of hydrocarbons by ozone at low temperatures: J. **Drugman**. Ozone acts slowly on saturated hydrocarbons, and the process is one of gradual hydroxylation. The reaction with an unsaturated hydrocarbon, such as ethylene, is instantaneous, even at temperatures far below 0°, and a very explosive addition compound is first formed.—Reactions involving the addition of hydrogen cyanide to carbon compounds, part v., cyanodihydrocarvone: A. **Lapworth**.—

Thiocarbamide as a solvent for gold: J. **Moir.** Two new complex gold salts have been obtained by dissolving gold in an acid solution of thiocarbamide. Their formulæ are $C_6H_{20}N_{12}S_6Au_2(SO_4)$ and $C_8H_{26}N_{16}S_8Au_3Cl_3$ respectively.—An improved Beckmann apparatus for molecular weight determinations: J. McConnell **Sanders.**

Linnean Society, June 7.—Prof. W. A. Herdman F.R.S., president, in the chair.—*Exhibit.* Tubes showing stages in the metamorphosis of a young flat-fish (*Pleuronectes platessa*), the plaice, leading from the symmetrical larva to the asymmetrical young flat-fish: the **President.** These fish were hatched and reared in the Port Erin Biological Station. Reference was also made to the operations conducted this year in hatching and liberating some millions of young plaice.—Two new species of Populus from Darjeeling: H. H. **Haines.** *Populus ciliata*, Royle, was re-described, and the two new species characterised, namely, *P. Gamblei*, which may or may not be the species described by Dode from imperfect material, and *P. glauca*, Haines.—Two reports dealing with Biscayan plankton collected during a cruise of H.M.S. *Research* in 1900: Dr. G. H. **Fowler.** (1) The Cephalopoda: W. E. **Hoyle.** Among seventeen specimens, five genera and two species were recognised; all but one (750 fathoms to 500 fathoms) apparently belonged to the epiplankton; not a single specimen was captured at the actual surface. (2) The Medusæ: E. T. **Browne.** As the area investigated was oceanic, the neritic Anthomedusæ were represented by only three species; while the Trachomedusæ and Narcomedusæ, which are essentially oceanic, were represented by seven and three species respectively, three species of Trachomedusæ furnishing 85 per cent. of the total specimens captured. Four rarities were recorded; one Narcomedusan was apparently new to science, and of interest as showing medusa-buds (which were not parasitic) developing as outgrowths of the stomach pouches.—The Conifers of China: Dr. M. T. **Masters.** The paper described the whole coniferous flora now known, including the discoveries of Messrs. E. H. Wilson and B. Hayata; eight new species are fully set out, five of these being of the genus Picea.

Royal Astronomical Society, June 8.—Mr. W. H. Maw, president, in the chair.—The ancient eclipses of the sun: E. **Nevill.**—Mr. Cowell's discussion of ancient eclipses of the sun: S. **Newcomb.** The above papers were discussed by Mr. Cowell in reference to his corrections to the secular acceleration. He concluded that, with the exception of the eclipse of Archilochus, which Mr. Nevill had shown to be entirely uncertain, they agreed with the theory, which was also supported by the Chinese eclipses now brought forward by Mr. Nevill.—Errors in the tabular places of Jupiter from photographs taken with the astrographic refractor at the Royal Observatory: **Astronomer Royal.**—Notes on polarisation phenomena in the solar corona, 1905 August 30: H. F. **Newall.**—Photographs of the corona of 1905 August 30, taken at Sfax, Tunis: **Astronomer Royal.**—In an oral communication Prof. H. H. **Turner** brought forward some results of his polarisation observations during recent solar eclipses, considered in reference to the constitution of the corona. Father Cortie said that we should consider the effect of explosive outbursts on the solar surface, and not regard the coronal phenomena as due only to the pressure of light.—A spherical slide-rule, consisting of two superposed stereographic projections of the sphere, arranged for solving various problems in spherical trigonometry: W. B. **Blaikie.**

CAMBRIDGE.

Philosophical Society, May 14.—Dr. Fenton, vice-president, in the chair.—The influence of a very strong magnetic field on the spark spectra of palladium, rhodium, and ruthenium: J. E. **Purvis.** The strength of the field was 39·980 units, and the general results are:—(1) Most of the lines divide into triplets, and several become quadruplets. (2) The value of $d\lambda/\lambda^2$ was calculated from the measurements of the distances of the constituents, and in several quadruplets the value is the same; the general appearance in intensities and polarisation of the separate constituents is also very similar. This is well seen in the quadruplets from palladium 3400·4 and 3258·7 when compared with the quadruplets from rhodium 3502·7 and 3474·7. In the triplets there are also lines which may be classified in the same way. (3) The displacements of the constituents of some of the divided lines are simple multiples of one another.—Experiments on the band spectrum of nitrogen in a magnetic field of 41·000 units: J. E. **Purvis.** The bands in the red, orange, and yellow become very weak, whilst those in the green, blue, and violet are brighter and stronger. But there was no shift of the bands, nor did there appear to be any widening or division of the lines forming the bands.—The ionisation of gases exposed simultaneously to Röntgen rays and the radiation from radioactive substances: T. **Noda.**

EDINBURGH.

Royal Society, May 28.—Sir John Murray, K.C.B., vice-president, in the chair.—Life in reservoirs in relation to water supply in towns: James **Murray.** The paper was a detailed discussion of the types of life met with in reservoirs, the time needed for new reservoirs to become stocked with animal life, and the conditions under which such life might do harm to the water. Rise of temperature was always followed by a great increase in the number of animals in the water, but so long as the loch or reservoir was large there was little chance of any serious results. The conditions under which animal life might possibly get into the mains were also discussed, and it was pointed out that Nature herself supplied a preventive in the tendency of free-swimming animals to swim against the current.—The Rotifera of the Scottish lochs: James **Murray.** Of the 177 species which had been discriminated, five were new. Many new observations on the structure and habits of the various species were recorded.—The Tardigrada of the South Orkneys: James **Murray.** Fourteen forms, obtained from a single tuft of moss, were more or less fragmentary. Two had been known before, but only three could be described as new.—The temperature of fresh-water lochs of Scotland, with special reference to Loch Ness: E. M. **Wedderburn.** The paper discussed the temperature distribution in the loch at different times and in different months. In addition to the usual type of sounding thermometer, a platinum thermometer was used in conjunction with Callendar's self-recording apparatus. The record showed on certain occasions the very rapid change of temperature which may take place at depths of 150 feet or 200 feet. This was traced to the slight rise or fall of the layer of water in which the temperature is changing most rapidly with depth, the so-called "Sprungschicht." Clear evidence was also obtained of the temperature seiche, first noticed by Mr. Watson. The observed period was in fair agreement with that calculated from the theoretical formula. At a depth of 5 feet very rapid changes of temperature were sometimes observed during night time, due clearly to convection currents. A sunshine recorder could, when required, be connected with the self-recording apparatus instead of the thermometer. At a few feet depth the effect of the direct action of the sun was very small. At a depth of only 2 feet it was impossible to detect the passage of a cloud in front of the sun. An estimation of the amount of heat which entered the water of the loch during the day was made, and came out at about a sixth or seventh part of the whole amount of solar heat available, according to Knott's calculation.

PARIS.

Academy of Sciences, June 5.—M. A. Chauveau in the chair.—The utilisation of turf for the intensive production of nitrates: A. **Müntz** and E. **Lainé.** The authors, continuing their researches on the artificial production of nitrates, find that if the animal charcoal used in their former work is replaced by turf as the medium for the growth of the nitrifying bacteria the yield is multiplied eight times. Fresh salts of ammonia can be added to the weak nitrate solution resulting from the first nitrification, and this again passed through the turf bed, and this process can be repeated until the percentage of nitrate present in the liquor is sufficient for its economical extraction commercially. The possibility of the turf itself furnishing the necessary ammonia compounds is discussed, and a method of distillation of the turf in superheated steam has been worked out, by means of which the yield of ammonia is greatly increased.—The dry avalanches and mud torrents in the recent eruption of Vesuvius: A. **Lacroix.**—The occurrence of crystals of sylvite in blocks thrown out by the recent eruption of Vesuvius: A. **Lacroix.** The crystals of sylvite (potassium chloride) were remarkable for their size, forming cubical crystals of more than 2 cm. in the side. In several specimens the sylvite crystals were covered with large cubical crystals of halite (sodium chloride). A description is also given of a rare mineral consisting of a chloride of sodium, potassium, and manganese.—Researches of the hydroxides of rubidium, cæsium, and lithium; M. **de Forcrand.** The hydroxides of rubidium and cæsium obtainable commercially both contain one molecule of water of crystallisation; the anhydrous hydroxides can be prepared from the commercial products by heating in a silver crucible, an atmosphere of hydrogen being necessary in the case of the cæsium compound to prevent the formation of higher oxides of cæsium. Anhydrous lithium hydroxide is readily prepared from the hydrate. The heats of dissolution of the three hydroxides were measured.—A theorem on plane algebraic curves of order n: G. B. **Guccia.**—An azimuth circle with reading microscopes for technical survey work: Ch. **Lallemand.** The circles are divided into tenths of degrees, and are read by estimation by bent microscopes carrying a cross-wire. The arrangement has the advantage of rapidity and simplicity, and a comparison with the various types of instrument in common use showed that it is only surpassed in accuracy by instruments furnished with reading microscopes carrying a micrometer screw.—The electrical control of synchronised clocks: Jean **Mascart.** A discussion of the possible accidents to a synchronised clock system, and the various means that have been adopted to inform the public that the electrical control of one of the clocks on the system has failed.—An experiment due to Hittorf and the generality of Paschen's law: E. **Bouty.**—The properties of surfaces for which the apparent angle of contact of water is zero: H. **Ollivier.**—The action of silicon chloride on nickel: Em. **Vigouroux.** By the action of silicon tetrachloride upon heated nickel two substances have been isolated, $SiNi_4$ and $SiNi_2$. That the former silicide is homogeneous and free from metallic nickel is rendered probable by the fact that it is not magnetic.—The decomposition of copper sulphate by methyl alcohol: V. **Auger.** A basic copper sulphate is formed, the sulphuric acid removed probably forming methyl-sulphuric acid.—Dibromodimethyl- and dibromodiethyl-amidobenzoylbenzoic acids and their derivatives: E. **Séverin.**—The variations in the size of the particles in colloidal hydrochloric-ferric chloride solutions: G. **Malfitano.**—A new micro-organism producing acetone: L. **Bréaudat.** The chromogenic organism described was found in the drinking water of Saigon, Cochin-China, and is capable of producing acetone from proteid material. The name proposed for the new species is *Bacillus violarius acetonicus*.—Contribution to the study of the soluble albuminoid materials of milk: M. **Lindet** and L. **Ammann.** It is shown that the casein of milk is, in part, dissolved by the calcium phosphate present. Experiments are described throwing light upon the causes of clotting of milk.—Contribution to the cytological study of bacteria: S. **Guilliermond.** The author concludes from his observations that a true nucleus does not exist in bacteria, and considers that the nuclei described by various authors are due to misinterpretation of the facts observed.—A new parasitic copepod of *Amphiura squammata*: E. **Hérouard.**—A new type in the family of the Virgularidæ: Ch. **Gravier.**—The excretion of the endogenous purins and uric acid: Pierre **Fauvel.** The quantity of endogenous purins and uric acid is constant even for a subject whose diet is free from purins, and this is still the case whether a milk diet, strictly vegetarian diet, or mixed milk-vegetarian diet be followed. This quantity varies little with the individual, and averages 0·4 to 0·5 gram of purins and 0·28 to 0·35 uric acid in twenty-four hours.—The state of the adductor muscles during life in the acephalous molluscs: F. **Marceau.**—Pulmonary tuberculosis in the tiger: P. **Achalme.**—A new explanation of glacial erosion: Jean **Brunhes.**

DIARY OF SOCIETIES.

THURSDAY, JUNE 21.

ROYAL SOCIETY, at 4.30.—The Transition from the Liquid to the Solid State and the Foam-structure of Matter: Prof. G. Quincke, For. Mem. R.S.—Experimental Evidence of Ionic Migration in the Natural Diffusion of Acids and Salts: R. G. Durrant.—On the Behaviour of Certain Substances at their Critical Temperatures: Prof. M. W. Travers, F.R.S., and F. L. Usher.—Note on the Phenomenon of Opalescence at the Critical Temperature: Prof. S. Young, F.R.S.—Ionic Velocities in Gases at Different Temperatures: P. Phillips.—The Action of Radium and Certain Other Salts on Gelatin: W. A. Douglas Rudge.—Barometric Variations of Long Duration over Large Areas: Dr. W. J. S. Lockyer.—On the Electric Inductive Capacities of Dry Paper and of Solid Cellulose: A. Campbell.

CHEMICAL SOCIETY, at 8.30.—The Cleve Memorial Lecture: Prof. T. E. Thorpe.—The Constituents of the Essential Oil from the Fruit of *Pittosporum undulatum*: F. B. Power and F. Tutin.—Mobility of Substituents in Derivatives of β-Naphthol: J. T. Hewitt and H. V. Mitchell.

LINNEAN SOCIETY, at 8.—On the Botany of Southern Rhodesia: Miss L. S. Gibbs.—On the Authentic Portraits of Linnæus (lantern slides): W. Carruthers, F.R.S.—Plantæ novæ Daweanæ in Uganda lectæ: Dr. Otto Stapf.—On the Genitalia of Diptera: W. Wesché.

FRIDAY, JUNE 22.

PHYSICAL SOCIETY, at 5.—The Effect of Radium in Facilitating the Visible Electric Discharge *in vacuo*: A. A. Campbell Swinton.—A Comparison between the Peltier Effect and other Reversible Heat Effects: A. O. Allen.—The Effect of the Electric Spark on the Actinity of Metals: T. A. Vaughton.—Dielectric Strength of Thin Liquid Films: Dr. P. E. Shaw.—The Effect of Electrical Oscillations on Iron in a Magnetic Field: Dr. W. H. Eccles.

WEDNESDAY, JUNE 27.

GEOLOGICAL SOCIETY, at 8.—Interference-Phenomena in the Alps: Dr. Maria M. Ogilvie Gordon.—The Influence of Pressure and Porosity on the Motion of Sub-surface Water: W. R. Baldwin-Wiseman.

THURSDAY, JUNE 28.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Sex-determination in Hydatina, with some Remarks on Parthenogenesis: R. C. Punnett.—On the Julianiaceæ, a New Natural Order of Plants: W. Botting Hemsley, F.R.S.—On Regeneration of Nerves: Dr. F. W. Mott, F.R.S., Prof. W. D. Halliburton, F.R.S., and A. Edmunds.—The Pharmacology of Ethyl Chloride: Dr. E. H. Embley.—The Alcoholic Ferment of Yeast Juice, part ii., The Coferment of Yeast Juice: Dr. A. Harden and W. J. Young; and other papers.

CONTENTS.

THURSDAY, JUNE 28, 1906.

THE ORGANISATION OF AGRICULTURE.

(1) *The Transition in Agriculture.* By Edwin A. Pratt. Pp. x+354. (London: John Murray, 1906.) Price 5s.

(2) *An Introduction to the Study of Agricultural Economics.* By Henry C. Taylor. Pp. viii+327. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1905.) Price 5s.

(3) *The Development of Agriculture in Denmark.* By R. J. Thompson. A paper read before the Royal Statistical Society, May 15, 1906.

(1) THIS is the work of an author whose previous writings on subjects of agricultural economy have attracted considerable attention. The present volume has a three-fold purpose—to describe recent developments of subsidiary branches of agriculture, the progress of agricultural cooperation, and the principles on which small holdings may have the best chance of success.

Mr. Pratt states that "it is open to consideration whether the bitter cry of the distressed British agriculturist has not been persisted in with undue energy of late years." It is certain, however, that the last period of agricultural depression, which reached its culminating point about 1892, was terribly acute, and the subsequent recovery has been correspondingly slow. That there has been recovery few authorities will deny, and we believe that the general agricultural outlook is more hopeful than it has been for some time. This is certainly the impression we gain from a careful perusal of Mr. Pratt's book; yet at the same time the author scarcely touches upon the main features of British agriculture, and in this respect the title of the work is not altogether justified. Wheat-growing has declined, it is true, to a very marked extent, and a great deal of arable land has been converted into pasture during the last quarter of a century. On the other hand, the decline in the wheat acreage has been somewhat balanced by an increase in the acreage under oats. The increases in the areas of those subsidiary branches of agriculture, as Mr. Pratt calls them, with which his book mainly deals, are relatively unimportant.

The breeding of live-stock, and especially the home and export trade in pure-bred pedigree animals, the fattening of cattle, sheep and pigs, grazing and dairying, all involve operations upon such a large scale, and require individual skill of such a high order, that we cannot conceive of any "transition in agriculture" which would seriously interfere with the size of the holdings, the acreage of the crops, or the capital necessary to maintain them. But if we except agriculture on the large scale as it has been and in all probability will continue to be carried on, we admit that Mr. Pratt has done useful service in bringing under review those important developments of comparatively minor industries which are not only of benefit to agriculture, but are nationally advantageous by helping to create and maintain a sturdy, independent race of Englishmen.

An interesting account is given of the commercial aspects of milk selling. The facts related are not new, though it may well be that they have not attracted much attention outside the districts affected or on the part of persons not immediately concerned. Farmers in the dairying districts have found it pay much better to sell fresh milk than to turn it into butter and cheese. The sale of fresh milk and cream is, in fact, practically our only agricultural monopoly, and it is not likely that foreign competition will seriously threaten it. But whereas formerly the milk producer was an individual unit at the mercy of the urban wholesale dealer or middleman, judicious combination amongst dairy-farmers has enabled them to protect their interests, and especially to secure a uniform and equitable price for the milk produced. In Staffordshire, Derbyshire, Cheshire, Essex, and Somerset, associations have been formed with this object in view, and their success has been remarkable. In one case, Mr. Pratt states, the financial gain thus secured through combination amounts to from 30,000*l.* to 40,000*l.* annually, or an average annual gain per member of from 30*l.* to 40*l.*

The descriptions of fruit-farming and the production of flowers, bulbs, vegetables, poultry, and eggs will repay careful study, and they may well encourage the further extension of similar crops in districts suited to them upon the cooperative principles that have proved successful.

We come finally to the author's views on small holdings. This question is now under consideration by a Departmental Committee of the Board of Agriculture, and it is well known that the new President of the Board, Lord Carrington, is deeply interested in the subject, his own experiments in that direction in Lincolnshire and elsewhere having met with striking success. Mr. Pratt discusses the question as to whether ownership or tenancy is the more expedient form of tenure, and he pronounces unhesitatingly in favour of tenancy. We believe that his conclusions on this subject are sound, and that the example of countries where freehold occupancy has resulted in heavy mortgages with the payment of "rent" in its most odious form should be avoided.

(2) Dr. Henry C. Taylor, the author of the book on "Agricultural Economics," is assistant professor of political economy in the Wisconsin University, and an expert in the Office of Experiment Stations of the United States Department of Agriculture. His work forms part of the "Citizen's Library of Economics, Politics, and Sociology," and is in effect a studious effort to apply to practical agriculture the principles of political economy. As such it should prove useful to young agricultural students in connection with their ordinary course of "political arithmetic." Dr. Taylor himself states that one of the aims of his book is the setting forth of "fundamental economic principles, which, when carefully followed, lead the way to success in agricultural production."

In thirteen chapters the author deals with the factors of production, the organisation of the farm, the size of farms, the prices of agricultural products, the distribution of wealth, the value of land, the methods of its acquisition, and the relations between landlord and tenant. He uses the term "capital-goods" to represent the live-stock and implements essential to agricultural production, and the word "capital" to represent the money-value of capital-goods. Land, capital-goods, and labour being the three factors of agricultural production, he discusses the economic properties of each. In regard to labour, which includes the work of the farmer himself, he advances some interesting economic propositions, especially as to the "qualitative and quantitative efficiency of farmers"—qualitative efficiency relating to the return a man can obtain from a given piece of land with a given supply of capital-goods, and quantitative efficiency to the quantity of land and capital-goods which a man can operate. He shows that the farmer with the highest degree of qualitative efficiency can make not only more than a living upon land of any grade, but that he can make the largest net profit on the most productive land after outbidding all competitors for its use. Thus, "owing to the higher rents which the more efficient are willing to pay for the better grades of land, the farmer can secure the largest net profit by employing that grade of land which corresponds to his degree of qualitative efficiency."

In discussing the principles which determine different methods of farming, the author points out that whereas formerly agricultural conditions demanded that farms should produce all that was required by the cultivators, modern conditions of increased population and improved facilities of transport have given rise to what is described as commercial agriculture, the system under which agricultural produce is grown in bulk, and marketed in return for other commodities required but no longer produced by the seller.

In this country we pride ourselves upon the superior yield of our agricultural crops. This is, however, due to a system of intensive cultivation, and Dr. Taylor shows that the extensive system of cultivation as pursued in the United States is that which is at present best suited to the economic conditions of the country. Pressure of population in the older States of the American Union is already causing a more intensive cultivation than that previously followed. "In new countries," Dr. Taylor writes, "where land is relatively abundant, extensive culture is generally most profitable, and the average size of farms is usually greater than in older countries where land is scarce, land values very high, and intensive culture most profitable."

Incidentally, the book contains many statistical details relating to the United States that are not readily accessible to the general reader. For instance, the land area of the United States is given as 1,900,947,200 acres. The area of the United Kingdom is 77,671,319 acres. The percentage of improved land, or, as we describe it, "land under crops and grass," is in the United States about 22, in England about 76, and in Germany about 60. Again, with regard to the size of farms, in the United States the average is given as 146.6 acres. In England it is about 65 acres (or 85 acres if holdings above one acre and not above five acres be not included); in Germany it is 19.2 acres, and in France 21.4 acres. This variation in the average size of holdings is, of course, significant of the different systems of land tenure, tenant-farming prevailing in England and peasant-proprietorship in France and Germany. In the United States most of the land is either cultivated by its owners or on the sharing principle. According to the census of 1900, the different classes of farmers in the United States are represented in the following proportions:—

Owners	54·9	per cent.
Part Owners	7·9	,,
Owners and Tenants	0·9	,,
Managers	1·0	,,
Cash Tenants	13·1	,,
Share Tenants	22·2	,,
	100·0	

An interesting description is given of the American system of "share-tenancy," which is scarcely, if at all, practised in this country. The principle of it is something akin to *métayage*, as adopted in France, Italy, and Spain. A share-tenant in America pays for the use of the farm a proportion (such as one-third or one-half) of the crops cultivated. The share is delivered to the owner in kind. The owner participates in the management of the farm, and, in fact, directs all the more important operations. Under this system the landlords are usually the older and more experienced men, who own more land than they can well cultivate, whilst the tenants are younger men who prefer share tenancy to fixed rent, because their risk of loss is less.

(3) Denmark is a concrete example of the successful development of "commercial agriculture." Mr. Thompson has made an elaborate statistical study of the agricultural conditions prevailing in Denmark, and his facts and figures are well worthy of careful study on the part of economists. Most authorities agree that the prosperity of Denmark is attributable to three causes—the system of land tenure, education, and cooperation. Thrift, the art of wisely saving and wisely spending, is a national characteristic of the Danes, and this, combined with the admirable organisation of their export trade in dairy produce, has enabled them to attain to a greater relative degree of agricultural prosperity than perhaps any other country. Whilst there may be much to admire and copy in the methods of agricultural organisation pursued in Denmark, it should be remembered that this little country is almost entirely dependent upon its exports to the free and immense markets of Great Britain, and that its system of wholesale grading for despatch to one country could not be applied, without modifications, to Great Britain, which has little or no export trade in dairy produce, and whose local home markets are scattered and unlinked with any central administration.

E. H. G.

THE MANUFACTURE OF CYANIDES.

The Cyanide Industry Theoretically and Practically Considered. By R. Robine and M. Lenglen. Translated by J. Arthur Leclerc, Ph.D., with an appendix by C. E. Munroe, Ph.D. Pp. xi×408; illustrated. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1906.) Price 17s. net.

THE stimulating effect on industrial research caused by the prospect of immediate material gain is strikingly illustrated by the progress of the cyanide industry. Until cyanide of potassium was applied to the treatment of gold ores, comparatively little interest was taken in its manufacture. The consumption amounted to about fifty tons a year only, and the old expensive and wasteful methods of obtaining it from ferrocyanide which had been made by the use of nitrogenous organic substances were deemed sufficient for the purpose. When the demand was rapidly growing in the 'nineties there was a rush of investigators to discover new and cheaper methods of manufacture. A fair amount of success was attained, and some thousands of tons of cyanide are now produced annually in Great Britain and Germany and sold at one-third the former price. The older processes have been abandoned and new ones introduced, and, although some doubt still remains as to the future of the industry, the field for useful research has been narrowed, and once again offers little attraction to the chemical "pot-hunter." Comparatively little cyanide is produced in France, however, and apparently it was the apathy of their fellow-countrymen on the subject which induced MM. Robine and Lenglen to write the book which has just been translated.

The authors divide their book into four parts, of which part iii., on the methods of manufacturing cyanide compounds, is alone of any real importance.

Part i., occupying sixty-five pages, deals with the chemistry of cyanogen and its derivatives. It contains no correct statement that does not appear in ordinary text-books of chemistry, and is distinguished by an extraordinary number of misprints or misstatements, such as "cyanogen does not unite directly with hydrogen," "it [cyanogen] becomes a liquid at 20°.7 under ordinary pressure," and "If the cyanide contains chlorides, the method [of estimation of cyanide by means of silver nitrate] is not accurate." There are no references to the sources of information, and the whole section seems to have been drawn up in a perfunctory way.

Of even less value is part ii., which occupies twelve pages, and is on "The Present Condition of the Cyanide Industry." None of the information given in this part appears to be of later date than 1901, and some of the tables of figures end in 1896. The tables refer mainly to France, but there is a list of works producing cyanide compounds which applies to the whole world.

Part iii. occupies 213 pages, and gives a clear account of a very large number of methods of manufacture, most of which, as the authors are careful to point out, have never been successful on an industrial scale. All the chief cyanide compounds are dealt with, and separate chapters are devoted to the manufacture of cyanides, ferrocyanides, ferricyanides, and sulphocyanides. Sulphocyanides and, to a less extent, ferrocyanides owe their importance to their use in the preparation of cyanides, but the authors devote most attention to the interesting direct synthetic processes of making cyanides from carbon and nitrogen or ammonia.

The fixation of atmospheric nitrogen is a fascinating problem which is likely to continue to exercise the minds of chemists, and the translator, as an agricultural chemist, expresses the daring hope that the publication of this volume will result in the solution of the problem on an industrial scale. It is, of course, well known that cyanides are formed in blast furnaces, and many attempts have been made to apply this knowledge, beginning with Bunsen's special furnace, which was built in 1845. In most of the later processes, atmospheric nitrogen, freed from oxygen by passing it over heated metals or by distilling liquid air, has been passed over carbides of metals heated in electric or other furnaces, but although some progress has been made, the cyanide industry still continues to depend on more roundabout chemical actions. One of these is the synthesis of sulphocyanide by the action of ammonia on carbon bisulphide in the presence of a base such as lime, followed by the reduction of the sulphocyanide by means of carbon, metals, or hydrocarbons.

Illuminating gas and its residues constitute a source of cyanide which has not been fully exploited. The authors anticipate that in the future a large proportion of the required cyanides will be obtained from gas works, and estimate that in France alone 4,000,000 tons of coal used annually in the manufacture of illuminating gas could be made to yield cyanide compounds worth from eight to twelve million francs, all of which is now lost. In other countries, however, the matter has not been overlooked, and it is certain that the illuminating gas used in the world could be made to yield far more cyanide than could possibly be disposed of, unless new uses for cyanide should be discovered. The progress of the cyanide industry is checked rather by well-founded fears of overstocking the market than by the neglect by manufacturers of their opportunities or by the need of fresh sources of supply.

In part iv., which occupies twenty-seven pages, there is an adequate account of the use of cyanogen compounds, and this is followed by an appendix of seventy-one pages. Here a digest is given of the United States patents relating to cyanide processes for the recovery of the precious metals. No doubt the list is fairly complete, but it has nothing to do with the main subject of the book, and does not contain any reference to patents relating to the manufacture of cyanides. However, as it shows the activity of the consumers of cyanide, it may be taken as a tonic by disheartened manufacturers, who, after all, are probably more interested in markets than in chemical formulas.

T. K. Rose.

A YEAR ON THE "SIBOGA."

Ein Jahr an Bord I.M.S. Siboga. Von Frau A. Weber van Bosse. Beschriebung der Holländischen Tiefsee-Expedition im Niederländisch-Indischen Archipel 1899–1900. Nach der II Auflage aus dem Holländischen übertragen von Frau E. Ruge-Baenziger. Pp. xiii+370. (Leipzig: W. Engelmann, 1905.) Price 6s. net.

IN this book Mrs. Weber gives a popular account of the expedition the scientific results of which have been described in the "Siboga-Expeditie" edited by Dr. Max Weber.

The *Siboga*, a twin-screw vessel of the Royal Dutch Navy, built for the East Indian service, deprived of her armament, and specially fitted for her scientific voyage, left Surabaya, on the north coast of Java, on March 7, 1899, and returned thither on February 26, 1900, having spent the interval—practically a year—in exploring the marine, and especially the deep-water, fauna of the East Indies. The expedition consisted of Prof. Max Weber and Mrs. Weber, two scientific assistants, a doctor, and a draughtsman, and received from the naval staff of the vessel those ungrudging and invaluable services which the officers of our own Navy so invariably put at the disposal of the scientific members of an expedition. The investigation of the marine flora was in the hands of Mrs. Weber.

The course of the *Siboga* lay at first along the coasts of the Lesser Sunda group from Java to Timor, then across the Flores Sea to Saleyer Island, and to Macassar, in Celebes, where the expedition was landed for a time while the ship made a trip to Surabaya. On her return the voyage was continued through the Macassar Straits to the Sulu Islands, then southwards across the Celebes Sea to Kwandang, in Celebes, northwards again to the Sangir and Talaur groups, southwards through the Molucca Straits to Obi, and eastwards across the Halmahera Sea to the coast of New Guinea. From Atjatuning, in New Guinea, the ship sailed by Ceram, Amboyna, Buru, and Buton to Saleyer again. Here the expedition was left during a second trip of the *Siboga* to Surabaya. When a fresh start was made the course lay eastward across the Banda Sea by Amboyna to Aru and back to Amboyna. From this place the *Siboga* returned to Surabaya along the Sunda Islands by a different route from that which she had taken at starting.

The story of this voyage is pleasantly told by Mrs. Weber. Scattered through her account of the everyday life of the ship and the happenings at various stopping-places and dredging-grounds are allusions to the scientific discoveries of the expedition. Some of the soundings are particularly interesting. It appears that the Lombok Straits, instead of being a deep cleft between Bali and Lombok, are in reality quite shallow (170 fathoms). Since Weber has already shown that the fauna of the East Indies changes only gradually from an Asiatic to an Australian character in an easterly direction, we have now probably heard the last of that old friend of our student days, "Wallace's Line"—a picturesque and fruitful hypothesis, for all the contempt with which it is apt to be treated nowadays. On the other hand, interesting soundings of considerable depth were obtained among the islands—some 2700 fathoms in the Banda Sea and in the Celebes Sea, 2200 fathoms in the Ceram Sea, 1500 fathoms between the Banda Sea and the Flores Sea, and 2000 fathoms close to land off Saleyer. Near the latter island great banks of calcareous algæ were found, which recalls Stanley Gardiner's observations on the importance of these organisms in Funafuti and elsewhere. The plankton also seems to have been unusually rich and plentiful. The sea bottom is in many places rough, entirely unlike the oozy bed of the great oceans, and was the cause of much loss and damage to gear.

The book is well got up and illustrated by some good photographs, and should prove interesting to the large class of readers who are attracted by books of travel.

YORKSHIRE FUNGI.

The Fungus Flora of Yorkshire. By G. Massee and C. Crossland. Yorkshire Naturalists' Union Botanical Transactions, vol. iv. Pp. 396. (London: A. Brown and Sons, Ltd., 1905.)

THE Yorkshire Naturalists' Union has held and maintained a high place in the history of British cryptogams, and its published Transactions abound in records of fungi in which the county seems to be peculiarly rich. It is hardly surprising, therefore, that a scientific society of such well-proved eminence should every now and then issue the results of its labours, originally published in its serial journal, in the form of a separate book.

To do this in the case of the fungi required more initiative and enterprise than with most other cryptogams, and the committee is to be congratulated, not only on having carried the work through, since 1902, but on having done it so thoroughly and efficiently.

When we extend our congratulations also to the two authors responsible for the work, we may take the opportunity of pointing out that while one is an amateur field naturalist of that peculiarly enthusiastic and accurate type for which Yorkshire has long been famous, the other is a professional mycologist of high reputation; and the combined labours of the two give us all the advantages of the accurate and industrious notes of a collector who knows his county thoroughly, together with the critical supervision of one who knows his herbarium equally well, and who has had shed on to his shoulders the cloak of Berkeley, and has been a fellow-worker with Cooke.

The book consists of 365 pages with appendices and an index, a too meagre bibliography, and more than 2600 entries. There is a short introduction and classification, with notes on the distribution within the county. The work is by no means a mere catalogue, though in many cases little more than the record of the name is given, together with the localities in which the fungus has been found growing. Interesting notes as to the habit of the fungus abound, and while it is, of course, impossible in such a work to define species or even genera, there are excellent explanatory notes here and there for the use of the critical systematist.

The volume, which is neatly printed, is, in spite of rather too many misprints, indispensable to every professional mycologist, and will, of course, be the basis for all other fungus floras of Yorkshire and other counties.

The work affords a very good example of the excellent services to science which may be contributed by the collaboration of individual workers who are experts in different departments and will join their forces loyally for the benefit of the rest.

Of course, it is not claimed that all the fungi of the large area covered are recorded, and much remains for other workers, especially in the domain of the smaller and lower fungi; but, as has already been pointed out, we have a firm basis for the benefit of further workers, and shall hope to see the records gradually rendered more and more complete.

OUR BOOK SHELF.

The Principles and Practice of Iron and Steel Manufacture. By Walter Macfarlane. Pp. xi+266; 96 figures. (London: Longmans, Green and Co.) Price 3s. 6d. net.

THIS is a difficult book to review so as adequately to represent the nature of its contents to the "technical students, metallurgists, engineers," and others for whom it is intended. The somewhat florid style of the introduction, "Machinery ponderous and powerful or nimbly delicate and deft . . ." would lead one to expect a kind of poetic phantasy woven to give joy to the general reader, and the expectation is supported by the last sentence, about iron being the Master Metal because it has so many good qualities in well-balanced proportion. Really it is quite human, however, in that it has many wicked ways also, well known to the aforesaid engineers.

Later in the work there is a compound of the general and the technical, as is evidenced by the type of illustrations, numbering about a hundred, of which a considerable proportion are reproductions from photographs; thus, "Fig. 6, Charging a puddling furnace"; "Fig. 44, Siemens casting pit with ladle in the distance," evidently taken with a short-focus lens, for the ladle seems about half a mile away; "Fig. 54, Shovelling lime into a steel melting furnace"; while "Fig. 52, Empty steel ladle," may be introduced to finish with a little humorous touch. Taking at random the working of an acid open-hearth charge, the author says that after melting (p. 117) "Oxidation steadily proceeds. In the first two stages the oxidation is effected by the excess air which enters the furnace along with the producer gas. The oxidised products SiO_2, MnO, and some FeO and Fe_2O_3 go into the slag. In the third stage oxidation is largely due to the oxygen in the ore which is fed in." On p. 122 the author distinctly says, "During the third or boiling stage . . . when this stage is reached ore is cautiously fed into the furnace. . . ." How long it would take an ordinary charge to come on the boil without ore one could hardly guess, but to bring it on in a reasonable time requires very considerable additions of ore to get the slag into proper condition. This is a grave error for an author who has been fourteen years in iron and steel works, and is also very misleading to a student of the subject. The matter has been dealt with in recent and ancient literature.

To sum up, the work may be of considerable interest to the general reader, but can hardly be recommended as a guide to the technical man engaged in such work as the manufacture of steel.

On Models of Cubic Surfaces. By W. H. Blythe. Pp. xii+106. (Cambridge: University Press, 1905.) Price 4s. net.

MR. BLYTHE has attempted a difficult task, to give an account of methods of constructing models of a cubic surface without either assuming all the theory of the surface as known or recapitulating it; the result, so far as the introductory portions of the book are concerned, is an unsatisfying mixture of rudiments and quotations and references to difficult theorems. As regards the latter portion Mr. Blythe may best speak for himself. "About ten years ago my attention was drawn to arranging the twenty-seven straight lines. . . . After constructing several models, I did not continue the series, for I subsequently found that a complete set had been made in Germany. . . . Copies of these models can be purchased. Still the models described in this book are sufficient to give an idea of the shape of a cubic surface."

We think Mr. Blythe is too modest, and that this little book of a hundred pages will be of interest to those who are studying the surface and desire actually to make models; but it must be confessed that in our opinion the writer would have been better advised either to make the theoretical portions more systematic or to have omitted them, and given a fuller account of the models with many more figures. Perhaps it is fair to say that Mr. Blythe's book is a good example of what may in cases be the bad effects of a too rigid and uniform examination system; it happens that cubic surfaces are outside what is regarded as the normal course of geometry for a student for the mathematical tripos; under a free and stimulating system, when Mr. Blythe first began to take an interest in models of cubic surfaces he would have been encouraged by his environment to go on and make a complete set, and other students would have helped him, and there would have been formed a fresh rootlet for the mathematical school to grow from; as it is, the environment requires either that he should invent a completely novel theory of the surfaces or models, or pay the penalty of being regarded as off the track, except by those few who value mathematics as they find it interests them.

A Synonymic Catalogue of Homoptera. Part i. Cicadidæ. By W. L. Distant. Pp. 207. (London: Printed by Order of the Trustees of the British Museum, 1906.)

MR. W. L. DISTANT has for many years made a study of the Rhynchota, and has paid particular attention to the Cicadidæ. The catalogue of this family, together with a synopsis of the subfamilies and genera now published, was, we learn from Prof. E. Ray Lankester's preface, generously placed at the disposal of the Trustees of the British Museum by Mr. Distant. This work should be of great assistance to students of this group of insects.

Iona. By Elizabeth A. McHardy (Mrs. Raymond Smith). Pp. 48. (Glasgow: R. Gibson and Sons, Ltd., n.d.) Price 1s. net.

THIS attractive booklet provides brightly written and well illustrated accounts of Iona—"the Blessed Isle"—and of Staffa with its wonderful Fingal's Cave, together with an appreciation of St. Columba. It should not be long before the little publication secures a wide popularity among visitors to the west of Scotland.

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.*]

Kew Publications.

As I was responsible before I left Kew for the publications noticed in NATURE of June 21 (p. 180), perhaps I may be permitted a few words of explanation.

The Kew Bulletin was not intended at the outset to rank with scientific journals. It was started at the desire of Parliament for the purpose of issuing, for public use, information for which there happened to be a demand, and of a commercial, or at any rate economic, kind. It was subsequently decided by the Government that it should be the vehicle for other matter, scientific or otherwise, for which prompt publication seemed desirable.

It is sent out to all the botanic and agricultural departments in correspondence with Kew in India and the colonies, and much of its contents is usually reprinted in the local journals.

It also serves the purpose of expeditiously answering inquiries at home. A stock of the numbers is kept at Kew for communication to correspondents. So useful has it proved in this way that it has been necessary to reprint more than once a large number of the articles. The output in any one year may have been exiguous; but if there was no urgent demand for information on some new subjects, there was usually more pressing work on hand than the mere manufacture of padding. As, however, the Bulletin is filed in many libraries, I was glad to have the leisure to put the successive annual volumes into a shipshape form. When the next general index is issued the whole series of volumes will form a sort of rough, though necessarily incomplete, encyclopædia of practical information on Indian and colonial agriculture and products.

The announcement of appointments may have been belated, but that again is of little consequence, as they are only intended to be items in a continuous record.

The catalogue of portraits was not supposed to be exhaustive, and does not compare, therefore, with the "Catalogus Stockholmiensis." It is simply a hand-list for the use of visitors of the portraits exhibited in Museum No. 1. The Kew collection has always been popular, and, as I know of no other, *is* "probably unique," but it has latterly grown out of all bounds. As the available space was restricted, I made a selection, and, so far as prints were concerned, had them uniformly framed. I was guided by considerations which I have stated in the preface, and I confess I was largely influenced for the purpose of public exhibition by artistic merit. Mere trivial photographs and cuttings from illustrated papers, though valuable so far as they go, seem to me most conveniently preserved in portfolios.

The personality of those who have made a mark in scientific history has, I think, a peculiar, because intimate, interest. The world is certainly the poorer for having no portrait of Gilbert White. Only recently I have seen the posthumous portraits of two distinguished men of whom no memorial now remains which bears the impress of vitality.

In the seventeenth and eighteenth centuries few men of any note disdained to transmit their portraiture to posterity by the aid of the engraver. It was not, indeed, until the middle of the last century that the practice expired in the more feeble art of the lithographer. Some examples of its decadence I felt obliged to withdraw as painful caricatures. Nowadays, modesty or indifference seems to leave neglected all but the most eminent. I am not without hopes that more space may be found at Kew for portraits. I hope the collection may continue, as in the past, to be the recipient of gifts from private liberality, and that in this way many obvious gaps may be filled up.

W. T. THISELTON-DYER.

Witcombe, Gloucester, June 25.

A Remarkable Lightning Discharge.

THE afternoon of Saturday last, June 23, was sultry, and it was therefore without surprise that about 8.30 p.m. we observed the reflection in the clouds of lightning to the west and south-west, and heard from time to time the low sounds of distant thunder; there was no indication of the storm coming near to us until 9.30 p.m., when we were startled by a tremendous explosion and a brilliant flash of light, which, according to some observers, was continued after the explosion took place. This explosion was, I think, the loudest that I ever heard, and the impression on all of us was that it was quite close, and I am told that it was heard nearly two miles off as if it was close at hand. The thunderstorm continued for some hours after this explosion, but never came near to us.

It was not until the next morning that we discovered the scene of the explosion of the fire-ball, if such was the nature of the agent.

In one part of the garden here there is a mound—the remains of an old greenhouse—of irregular form and height—on the northern side grown over with ferns, ivy, and weeds, from which, towards its western end, grows an ash tree of moderate size, which gives out its first branches between 16 feet and 17 feet from the ground. The leaves of the tree seem intact, but the ivy of the trunk, from immediately below the branches down to the mound, has been more or less stripped of its leaves; a space half round the tree has been disturbed, and the weeds and plants thrown down, very much as if they had been trampled down by human feet; and this disturbance is continued in a line down the mound on the northern side, the plants being depressed from above downwards, and the gravel path at the foot of the mound broken up more than halfway across. Many of the leaves of the ivy have been scattered about, and many of the leaves lying on the mound have been torn to pieces. Several pieces of dead wood on the mound have been broken asunder. A branch of ivy close to the root of the ash tree has been stripped of its bark; an old brick lying on the mound under the vegetation was broken into four pieces, two small pieces and two large of nearly equal size; one of these larger pieces was found on the mound, one was found about 7 feet 6 inches from the point at the foot of the mound where the disturbance was seen, one smaller piece was about 7 feet beyond this, and another yet 2 feet further beyond the last. A piece of highly-crystallised Old Red Sandstone lying on the mound was found with a new and unweathered exposure several inches in length, and fragments of the same stone with new faces were lying near.

The conclusion from these facts seems to me to be that the electric agent, whether a fire-ball or not, must have approached the ash tree in a nearly horizontal line and struck it just below the lowest branches, have passed down the tree to the mound, have disturbed the vegetation to the south of the trunk of the tree, have passed then towards the north down the mound, and then to have nearly crossed the garden path, when it disappeared. When exactly the explosion took place I feel at a loss to ascertain, but perhaps some of your readers may be able to assist in determining this point.

EDW. FRY.

Failand, near Bristol, June 25.

The Magnetic Inertia of a Charged Sphere in a Field of Electric Force.

DR. O. HEAVISIDE has investigated (NATURE, April 19) the slow motion of a charged conducting sphere through a uniform electric field, in a direction *parallel* to the electric force of the field, and has calculated the increase in the magnetic energy and inertia of the sphere resulting from the re-distribution of the charge under the influence of the field. His paper has suggested the following investigation, in which the slow motion of the sphere is *at right angles to* the direction of the electric field. But, as Dr. Heaviside has pointed out to me, this problem has no single definite solution. For, if the sphere, initially at rest in the field, be set in motion, the motion of the unequally distributed charges on the surface of the sphere will tend to give rise to magnetic force in the interior; but the magnetic force will only gradually penetrate into the interior, and electric curents circulating in the sphere in parallel planes will cause a magnetic force opposed to that due to the moving charges. If the conductivity be perfect, these currents will persist, and the interior of the sphere will be permanently free from either electric or magnetic force; but, with finite conductivity, the currents will die away, and the magnetic force will finally attain a definite value inside the sphere, although the electric force vanishes. In each of these cases a solution is easily found; but while the currents are dying away the magnetic energy gradually changes, and the calculation of the energy at any given time might be difficult. I therefore confine myself to the two limiting cases. The case of the final stage when there is finite cunductivity I had solved when Dr. Heaviside suggested to me that I should include the case of infinite conductivity in my investigation. The present communication is the outcome of that suggestion.

The sphere is of radius a, and carries a charge Q at a speed u, which is very small compared with v, the velocity of light; the strength of the field is F, and the specific inductive capacity is c. I employ Dr. Heaviside's units in order that my results may be comparable with his. The origin is at the centre of the sphere, and the axes of x and y are respectively parallel to the direction of motion and to the direction of the uniform electric field.

When u/v is very small, the electric force E, *due to the moving sphere*, is the same as if the sphere were at rest, and is therefore derivable from a potential function. Since there is no electric force inside the sphere, the induced distribution on the sphere produces the potential Fy at internal points, and hence produces the potential Fa^3y/r^3 at external points. Thus at internal points the components of E are

$$E_1=0, \quad E_2=-F, \quad E_3=0,$$

while at external points they are

$$E_1=\frac{Qx}{4\pi cr^3},$$

$$E_2=\frac{Qy}{4\pi cr^3}+Fa^3\left(\frac{3y^2}{r^5}-\frac{1}{r^3}\right),$$

$$E_3=\frac{Qz}{4\pi cr^3}+Fa^3.\frac{3yz}{r^5}.$$

Finite Conductivity, Final Stage.—In this case the magnetic force is entirely due to the motion of the charge on the sphere, and we have

$$H_1=0, \quad H_2=-ucE_3, \quad H_3=ucE_2,$$

and thus $H^2=u^2c^2(E_2^2+E_3^2)$.

If, now, we write

$$x=r\cos\theta, \quad y=r\cos\phi\sin\theta, \quad z=r\sin\phi\sin\theta,$$

we find that for internal points $H^2=u^2c^2F^2$, and that for external points

$$H^2=u^2c^2\left[\frac{Q^2\sin^2\theta}{16\pi^2c^2r^4}+\frac{QFa^3}{2\pi cr^5}\cos\phi\sin\theta(3\sin^2\theta-1)\right.$$
$$\left.+\frac{F^2a^6}{r^6}\left(1-6\cos^2\phi\sin^2\theta+9\cos^2\phi\sin^4\theta\right)\right]$$

The magnetic energy is $\frac{1}{2}\mu H^2$ per unit volume, and thus the total magnetic energy is

$$T=\tfrac{1}{2}\mu u^2c^2F^2.\tfrac{4}{3}\pi a^3+\tfrac{1}{2}\mu\int\int\int H^2r^2\sin\theta\,dr\,d\theta\,d\phi,$$

where r ranges from a to infinity, ϕ from 0 to 2π, and θ from 0 to π. On effecting the integration, we find

$$T=\tfrac{1}{2}u^2[\mu Q^2/6\pi a+16\pi\mu c^2F^2a^3/5]=\tfrac{1}{2}mu^2,$$

where m is the magnetic inertia.

For motion parallel to F instead of right angles to it, Dr. Heaviside finds (Nature, April 19)

$$T=\tfrac{1}{2}u^2[\mu Q^2/6\pi a+8\pi\mu c^2F^2a^3/5].$$

When the quantities are measured in ordinary units the results become

$$T=\tfrac{1}{2}u^2[2\mu Q^2/3a+4\mu c^2F^2a^3/5] \qquad \text{(Searle)}$$

and

$$T=\tfrac{1}{2}u^2[2\mu Q^2/3a+2\mu c^2F^2a^3/5], \qquad \text{(Heaviside)}$$

where, if we use C.G.S. electromagnetic units, we have $\mu=1$ and $c=(3\times10^{10})^{-2}$.

Infinite Conductivity.—In this case a system of currents flows round the sphere, on its surface, in planes normal to the axis of z, the distribution being such as to give rise to a magnetic potential $-ucFz$ at internal points. The magnetic force due to these conduction currents then neutralises, at internal points, the magnetic force ucF due to the moving charges. The external magnetic force *due to the conduction currents* will satisfy Laplace's equation for very slow speeds, and must, therefore, be expressible in zonal harmonics, while, for all speeds, the magnetic force normal to the sphere must be continuous. If $z/r=\cos\psi$, the normal force at points just inside the sphere is $ucF\cos\psi$. The conditions are satisfied by the external potential

$$\Omega=ucFa^3\cos\psi/2r^2=ucFa^3z/2r^3,$$

for this is a zonal harmonic, and gives rise to the normal force $ucF\cos\psi$ at the surface.

Thus, at external points,

$$H_1=-d\Omega/dx, \quad H_2=-d\Omega/dy-ucE_3, \quad H_3=-d\Omega/dz+ucE_2,$$

where E_1, E_2, E_3 have the values already given. We thus find

$$H_1=\frac{3ucFa^3xz}{2r^5},$$

$$H_2=-\frac{ucQz}{4\pi cr^3}-\frac{3ucFa^3yz}{2r^5},$$

$$H_3=\frac{ucQy}{4\pi cr^3}+ucFa^3\left[\frac{6y^2+3z^2}{2r^5}-\frac{3}{2r^3}\right].$$

It will be found that $xH_1+yH_2+zH_3=0$ for all values of r, and thus the magnetic force is tangential to the sphere, a condition pointed out to me by Dr. Heaviside.

Hence we find

$$H^2=u^2c^2\left[\frac{Q^2\sin^2\theta}{16\pi^2c^2r^4}+\frac{3QFa^3}{4\pi cr^5}\cos\phi\sin\theta(2\sin^2\theta-1)\right.$$
$$\left.+\frac{F^2a^6}{4r^6}\left\{36\sin^4\theta\cos^2\phi-9\sin^2\theta(4\cos^2\phi+\sin^2\phi)+9\right\}\right].$$

Remembering that $H=0$ at points inside the sphere, we find, on integration through the external space, that the magnetic energy is

$$T=\tfrac{1}{2}u^2[\mu Q^2/6\pi a+6\pi\mu c^2F^2a^3/5].$$

When the quantities are expressed in ordinary units the result becomes

$$T=\tfrac{1}{2}u^2[2\mu Q^2/3a+3\mu c^2F^2a^3/10].$$

If an electron be a conducting sphere of radius 10^{-13} cm. with a charge of 10^{-20} electromagnetic units, an electric force of a billion volts, or 10^{20} C.G.S. units, per centimetre, would not change its magnetic inertia by so much as one part in ten billions, and the results are of no consequence in experiments on the electrostatic deflection of kathode rays; but it is possible that there are other cases where it would be necessary to take the change of magnetic inertia into account.

When u becomes comparable with v, the analysis becomes more complicated, but does not present any difficulty, at least in the final stage, with finite conductivity, provided a Heaviside ellipsoid be substituted for a sphere.

In conclusion, I desire to acknowledge the help I have received from Dr. Heaviside's suggestions, and to thank Mr. Norman R. Campbell for verifying the formulæ.

G. F. C. Searle.

The Date of Easter.

That the formula of Gauss for finding the date of Easter fails in certain cases, of which the year 1954 is one, was pointed out by Gauss in his original paper in the *Monatliche Correspondenz* (vol. ii., p. 129), where he shows that there are the following two exceptions to the formula in the Gregorian calendar:—

(1) When the formula gives April 26, Easter falls on April 19.

(2) When the formula gives $d=28$, $e=6$, while $11M+11$ divided by 30 gives a remainder smaller than 19, then

Easter does not fall on April 25, as given by the formula, but on April 18.

These exceptions are caused by an inconsistency in the Gregorian rule, caused by the adherence to the old custom, that Easter should never fall later than April 25.

Armagh Observatory, June 22. J. L. E. DREYER.

THE discrepancy between the date of Easter, 1954, April 18 as given by the tables in the Book of Common Prayer, and April 25 as given by the formula of Gauss, arises from a purely artificial contrivance of Clavius, who arranged the reformed calendar, which is thus described on p. 55 of "The Prayer Book Interleaved," 1873, in an account of the calendar founded on a paper by Prof. De Morgan:—"It will never happen as to mean lunations, and rarely as to real ones, that in the same cycle there should be the lunation of a given month beginning on the same day in two different years of the cycle; and such a thing never happened in the unreformed Calendar. Clavius thought it desirable to imitate this in the new Calendar; and he observed that by taking the preceding day whenever the Epact was xxv., and the year of the cycle after the 11th, he could avoid the reiteration, and thus make the desired resemblance." "Whenever the Epact should be xxv., the year of the cycle being upwards of 11, say that the Epact is 26. This is not an astronomical correction, but a mere conventional mode of reconciling the choice which Clavius made of the mode of writing the Epacts with an essential peculiarity of the old cycle of 19 years which that mode of writing would have otherwise destroyed." "In 1954 the Golden Number is 17, the Sunday letter C, and the Epact according to the ordinary rule, xxv. *Call it therefore* xxvi. Thence April 17 will be the 14th day of the Paschal Moon, April 18, Easter Day. If the Epact xxv. were used April 25 would be Easter Day." The paper by Prof. De Morgan will be found in the "Companion to the British Almanac" for 1845.

My copy of NATURE for April 5 has long since gone to Bolivia, but probably your correspondents will find that Gauss did not take into account this artifice of Clavius. If in this century golden number 6 and Sunday letter C had coincided, Easter would have been set on April 25, because 6 comes in the cycle before 11 instead of after it as 17 does. An inspection of Table III. for finding Easter will show in the two half-lines for April 17 and 18 the arrangement made by Clavius. C. S. TAYLOR.

Banwell Vicarage, June 22.

Musical Thunder.

EARLY this morning a storm broke in this neighbourhood accompanied by heavy thunder. During the storm I noticed that two of the peals began with a musical note of distinct and definite pitch. The "musical" portion of the peal lasted for about two seconds in each case, and the frequency of the note was both times about 400 per second.

This sound closely resembled a foot-fall in a narrow alley between high walls, and was only heard in two consecutive peals, separated by an interval of about a minute, the first being much more definitely musical than the second. In each case the interval between the flash and the first sound of thunder was about five seconds.

As is well known, a peal of thunder from lightning near at hand frequently sounds like a quick succession of raps or a volley of guns. Can the successive raps have followed one another so rapidly in this case that they combined to form a note?

If so, and if this note was due to a special configuration of reflecting surfaces in the clouds, possibly to others in slightly different positions, considerably different frequencies may have been observed.

The fact that two peals only sounded in this manner separated by the short interval of about one minute, and that the second was not so decidedly musical as the first, seems to indicate that they were due to some rapidly changing source such as one might expect the reflecting surfaces of a cloud to be. I listened carefully to determine that the note had its origin outside and was not due to resonance within the room, and in the second peal it was certainly outside, and probably had the first had its origin within the room I should have observed it.

I should be very glad to hear if anyone has observed a similar phenomenon. G. H. MARTYN.

1 Marden Road, S. Tottenham, N., June 24.

How do Inquiline Bees find the Nest of their Host?

THE following observation may serve to throw light on the above question, which has doubtless occurred to many entomologists. Yesterday I saw a specimen of the inquiline *Coelioxys quadridentata* enter the burrow of a leaf-cutter bee, *Megachile circumcincta.* I dug the nest out of the burrow, and in so doing scattered the sand over an area of several square inches, completely destroying all appearance of a burrow. I sat down to await the return of the Megachile, in order to identify the species, and was much astonished to see (and capture) in the course of the next ten minutes two more specimens of Cœlioxys, which came hovering over the spot and alighted on the disturbed soil. I can think of no other explanation than that these "cuckoos" were attracted to the spot by the scent of the excavated nest. I may add that during several hours spent on the heath where this occurred I saw no other specimens of Cœlioxys, and, further, that there was a fresh south-east breeze blowing at the time, and that the bees came up against the wind.

OSWALD H. LATTER.

Charterhouse, Godalming, June 24.

THE DISTURBANCE OF GREENWICH OBSERVATIONS.

IN the House of Lords on Thursday last, June 21, attention was directed to the threatened danger to the continued efficiency of the Royal Observatory, Greenwich, caused by the great electrical generating station erected by the London County Council about half a mile due north of the observatory. The danger was referred to by the Astronomer Royal in his report to the Board of Visitors on May 30, a summary of which appeared in NATURE of June 7 (p. 135). The generating station is situated exactly in the Greenwich meridian, as will be seen from the accompanying photograph of a view looking north over the top of the transit room; and the tall chimneys shown in the picture, as well as the heated air from them, will obviously interfere with some observations of northern stars, which are essential for latitude and refraction. Moreover, from tests already made it appears that the powerful engines which are being installed at the generating station will cause vibrations that will seriously affect the value of observations by reflection from a mercury horizon, required for the fundamental work of the observatory.

This is not the first time that the effects of generating stations and electric tramway systems in the neighbourhood of the observatory have been pointed out. About six years ago the question of the possible effect of disturbances from electric railways on the magnetic work carried on at the observatory was given careful consideration; and the hope was then expressed that in the event of future electric tramways regulations would be laid down by the Board of Trade to secure adequate protection for the magnetic work. The records in this department of the observatory have been obtained continuously on a general system for sixty-five years, but the astronomical work extends over more than two centuries and a quarter, and it would be unfortunate if circumstances should arise to break this chain of continuity.

The generating station established at Deptford—nearly a mile from the observatory—to supply the London County Council Tramways with electric power, has not caused such serious tremors as are produced by the small portion of the engineering plant now available for work at the new station, which is much nearer and larger. It appears, therefore, that if the new station is completed and equipped to supply electric power over London, though it was authorised only for the requirements of tramways, the work of the observatory will be impaired to no slight extent. When the scheme was first put forward, it was not supposed that the works or the engines would assume the gigantic and overpowering proportions now contemplated, and the Astronomer Royal, in referring to this point in his report, remarks :—

The question arises why the immediate neighbourhood of the observatory should be selected for the planting of generating stations on an unprecedented scale to supply electric power to distant districts. The very powerful engines required for such a large output are liable to cause

FIG. 1.—View of chimneys of the electrical works of the London County Council, looking north over the transit room of the Royal Observatory, Greenwich. The roof of the transit room is shown at the bottom of the picture.

vibrations the extent of which could hardly be anticipated from previous experience of ordinary engineering plant or of railway trains, which have hitherto not affected the work of the observatory.

The question as to the action the Government proposes to take to prevent the Royal Observatory from being injuriously affected by electric stations or other works, either at present or in the future, was asked in the House of Lords by Lord Ellenborough, who remarked that the difficulty which has arisen might have been obviated to some extent by the installation of turbines or triple-expansion horizontal engines instead of vertical engines. The Earl of Crawford pointed out that the interference with observations would arise from the heated air of the chimneys and the tremors due to machinery in motion. He said in the course of his remarks :—

The essentials for observation of an astronomical kind are stability and quietude. Nothing is so dangerous in astronomical observation as the unknown errors which have to be guarded against at the present time. If an error is known no great harm is done. In connection with the meridian, careful observations of the moon require to be made. For very many years the moon has been given over by the scientific world to Greenwich Observatory. The Royal Observatory has specialised on the moon mainly owing to the grand labours of Sir George Airy, the late Astronomer Royal, so that the position of the moon at a given time hence may be fairly accurately predicted. The observations at Greenwich, and the manner in which they have been carried out by the late Astronomer Royal, have led the whole scientific world to say, "Gentlemen, you know your moon so well, pray continue to be responsible for her." If now Greenwich is reduced to the position of saying that its lunar observations have not the weight and value which so far have attached to them, it will be a terrible blow to the reputation of the Royal Observatory and also to our existence as a scientific country. Another difficulty is that disputes as to boundaries between countries are mainly settled by astronomical observation as to the position of the moon, and as the moon is being constantly watched at Greenwich Observatory, applications are frequently received from foreign countries as to the error of the moon at such an hour on such a day. This also shows how extremely importanr it is that the observations at Greenwich should be trustworthy.

The suggestion that the observatory should be moved from Greenwich was considered by Lord Kelvin to be a most undesirable solution of the difficulty. He added :—

Even at present we may look forward to possible changes in the arrangement of the works by which the electricity will not seriously disturb or practically cripple the astronomical observations at Greenwich. The disturbance caused at the observatory by the vibration from the electric works may be to some extent avoided by the substitution of steam turbines for reciprocating engines and the use of different electric dynamos. It is no exaggeration to say that the whole world outside, as well as the British Empire, would deplore anything that would injure the great and good work done in the Royal Observatory at Greenwich, and both Houses of Parliament should unite in preserving it.

As further development of the machinery equipment must increase the effects shown by the tests already made, Earl Cawdor considered that powers should be obtained, or set in action, to prevent the County Council from carrying out works that injure the observatory, and that the half a million pounds expended by the Council is a small sum compared with the matter at stake.

Replying on behalf of the Government, Lord Tweedmouth, First Lord of the Admiralty, made the following statement of the case; and his remarks, with those contained in the recent report of the Astronomer Royal to the Board of Visitors, are the only official comments available upon the subject :—

Since the subject was raised it has been closely considered at the Admiralty. As to the origin of this generating station, in 1901 the London County Council resolved on it, and in 1902 a Bill was passed through Parliament. In this Bill was inserted a clause, known as the Observatory clause, which gave to the Board of Trade the power, if any use of electrical power was likely to affect injuriously the instruments used in the observatory, to require reasonable and proper precautions to be taken. This proposal was made public and approved by Parliament. It is a pity that the County Council did not more closely apprehend the possibility of danger in choosing this particular site, but some responsibility must also be attached to the various departments and to Parliament. At present, at any rate, no absolute damage has been done, but there is an apprehension of it when the station is developed to its fullest power. It will be almost the biggest generating station in the world when completed. Eight engines will work up to 52,000 horse-power, and the electricity generated will be sufficient to work the whole of the London tramway system. At the present time the Astronomer Royal said that no serious effect has as yet arisen in the working of the principal meridian instrument. The Astronomer Royal, however, says that the instrument which has been affected is the portable transit instrument used for determining longitude. From the large generating station at Deptford no damage has resulted, and there is no indication of any disturbance. What the authorities have to do is to take very careful observation as to what is exactly going on at Greenwich. At present the station is never worked up to more than 3000 horse-power. A trial has been made of two engines, but the experiments are neither complete nor satisfactory. It is proposed to ask Prof. Ewing to represent the Admiralty in the observations to be taken, which must extend over a considerable time. The disturbances vary very much, and there is a great deal to be said as to the possibility of meeting the difficulties by reducing the high chimneys, though the Astronomer Royal does not think that the vapour of the chimneys seriously interferes with the observations. It is proposed also to ask the County Council to appoint a representative of its own for observation in order to have an independent report as to the exact amount of disturbance that might arise. The London County Council will not go on with the two chimneys, which are now only partly erected. Before doing anything it is necessary to discover whether by any re-arrangement of the machinery the threatened damage can be averted. Every effort will be made to make the inquiry a thorough one, and one which should command everyone's respect.

The position then, as stated by Viscount Goschen, is that a mistake has been made—a mistake by the Admiralty, by the Astronomer Royal, by the County Council, and by Parliament. The matter affects, not only the Royal Observatory, but the whole world; and the best scientific knowledge available should be utilised to avert any danger which imperils the useful existence of the observatory or interferes with its work.

THE SEA-SERPENT.

THE narrative of an encounter with the "sea-serpent" on December last off the coast of Para, given by Messrs. Nicoll and Meade-Waldo at the meeting of the Zoological Society held on June 19, has once more awakened interest in the question as to the possibility of the existence of a large unknown marine vertebrate animal. The appearance of the so-called "sea-serpent" has been recorded from time to time by quite a number of witnesses. Many of these alleged appearances were evidently based on objects other than vertebrate animals unknown to science, but others, as being witnessed by trustworthy and educated observers, are evidently worthy of more serious consideration. The importance of the recent case—of which more anon—is that it was witnessed by two gentlemen who have undergone a long training in the observation of animals, and are therefore far less likely to be mistaken than persons who have not specially devoted themselves to the study of natural history.

To attempt to record on the present occasion all the trustworthy cases of the alleged appearance of the sea-serpent (for the sake of convenience we may discard the inverted commas) would much exceed our limits of space, and we may therefore refer our readers to the volume by Mr. A. C. Oudemans entitled the "Great Sea Serpent," published in 1892, where all the more important ones up to that date will be found mentioned. It may be profitable to refer, however, to a few of the published opinions of naturalists on the sea-serpent question. In his *Challenger* book, the late Prof. H. N. Moseley wrote as follows:—

"The sea-serpent, however, is always open to criticism. This wonderful animal has hardly ever been seen alike by any two observers. It is nearly always easy to a naturalist to understand the stories told. Sometimes it is a pair of whales that is seen; sometimes a long mass of floating seaweed deceives the distant observer; sometimes the serpent has large eyes and a crest behind the head; then it is a ribbon-fish. I myself am one of the few professed naturalists who have seen the serpent. It was on a voyage to Rotterdam from the Thames. . . . It was a flock of cormorants, which were flying in line behind the waves, and which were viewed in the intervals between them with a sort of thaumoscopic effect."

Clearly Mr. Moseley was not "on the side of the angels"; neither was Sir Richard Owen, who attempted to explain the undermentioned appearance seen by the officers of the *Daedalus* by the seaweed theory; and that some of the appearances can be explained by Moseley's suggestions, or by a school of porpoises, may be candidly admitted.

Mr. F. A. Lucas, on the other hand, in his "Animals of the Past," although confessing himself an "agnostic" in regard to this subject, takes up a somewhat less uncompromisingly hostile attitude.

"Like the 'fossil man,'" he writes, "the sea-serpent flourishes perennially in the newspapers, and despite the fact that he is now mainly regarded as a joke, there have been many attempts to rehabilitate this mythical monster and place him on a foundation of firm fact. The most earnest of these was that of M. Oudemans, who expressed his belief in the existence of some rare and huge seal-like creature whose occasional appearance gave rise to the reports of the sea-serpent. Among other possibilities it has been suggested that some animal believed to be extinct had really lived to the present day. Now there are a few waifs, spared from the wrecks of ancient faunas, stranded on the shores of the present, such as the Australian ceratodus and the gar-pikes of North America. . . . If a fish of such ancient lineage as the gar-pike is so common, why may there not be a few plesiosaurs or a mosasaur in the depths of the ocean? The argument was a good one, the more that we may 'suppose' almost anything; but it must be said that no trace of any of these creatures has so far been found outside of the strata in which they have long been known to occur, and all the probabilities are opposed to this theory."

The event recorded by Messrs. Nicoll and Meade-Waldo took place in the forenoon of December 7, 1905, when they were on board the yacht *Valhalla* off the coast of Para. At a distance of about 100 yards from the vessel the two observers saw what appeared to be the vertical dorsal fin of some large animal, and a short time afterwards the head and neck of an animal was raised above the water some distance in advance of the fin. The head was compared to that of a turtle, while the neck appeared to be about 6 feet in length. The description, so far as we can judge, suggests a creature of not more than about 20 feet or 25 feet in length. Although the vessel was subsequently put about, no further signs of the sea-serpent were seen during daylight. It is, however, noteworthy that during the night two of the ship's officers became aware of the presence of some large animal swimming alongside the yacht at a rapid pace; the two officers, it is stated, had no cognisance of the events of the morning.

A most significant feature in this circumstantial account is that it tallies to some extent with the narrative given by the officers of H.M.S. *Daedalus* of the appearance of the sea-serpent seen by them in the year 1848 in the Atlantic.

In the figures given by Oudemans the (double) back-fin is very low, and the neck seems relatively short and ill-defined. Revised restorations, however, give a longer neck and no back-fin. It is possible, if a fin was present, that its apparent difference in height in the two instances was due to the animal swimming faster in one case than the other. *Megophias megophias*, it appears, is a name which has been suggested for the creature. In 1903 Prof. Racovitza (Bull. Soc. Zool. Paris, xxviii., p. 11) gave an account of a sea-serpent seen by Lieut. Lagresille in 1898 in Along Bay, Tonkin, and in 1904 M. Vaillant (Bull. Mus. Paris, x., p. 217) mentioned another apparition of an apparently similar creature in the same locality. In this second account the animal is described as being probably scaled, with a head like that of a turtle or a seal, and as "spouting" from terminally placed nostrils. It was also stated to move in undulations—at one time vertical, at another horizontal. Two occurrences in the same locality are very noteworthy.

In each of these four instances it can scarcely be doubted that the object seen was a living creature (or creatures) of some kind, and that it (or they) was of the same general type. If the object were formed by more than one animal, *cadit quaestio*. If, on the other hand, it consisted of a single individual, furnished with a dorsal fin, a long, snake-like neck, and a head like a turtle, it could scarcely be any known living animal. Neither, it may be suggested, could it be even an unknown type of seal, especially since all the known members of that group come ashore to breed. The next question is, Could it have been a survivor of some Mesozoic reptilian? Two arguments, so far as they go, are against this. Firstly, the one referred to by Mr. True as to the absence of the remains of any such creature in Tertiary deposits, and secondly (on the hypothesis that it is an air-breathing vertebrate, and if not, why should it come to the surface at all?), the rarity of the sea-serpent's appearance, the latter argument being applicable whether the creature is considered to belong to a supposed extinct group or not.

With regard to the fossil theory, it might be urged that the creature is an inhabitant of the deep sea, and consequently that its remains should not be expected to occur in Tertiary deposits, which belong for the most part, at any rate, to more or less shallow water. For what it is worth, it may be mentioned in reply that no traces of the creature have been found on the ocean bottom, where sharks' teeth and cetacean ear-bones are common. A more forcible objection is that, if the creature is in the habit of coming to the surface (as on the hypothesis of its existence it must), it cannot be a denizen of the abysses, no animal (despite the old belief in regard to whales) being able to live under such diversities of pressure. *Ergo*, its remains ought to occur in Tertiary deposits. Its stranded carcase ought also to have been found. If the creature be a "living fossil," the plesiosaurian group has the strongest claim to its ownership, as, although the zeuglodont cetaceans are the latest in time of possible extinct representatives, the smallness of its head prevents the reference of the sea-serpent (as described) to that group. As to the rarity of its appearance, it can scarcely be urged that only two or three (or even half a dozen) examples of the creature are in existence.

Without offering any suggestion as to what the nature of the object seen by Messrs. Nicoll and Meade-Waldo really was, it may be pointed out that the testimony of two such trained observers (supplemented by that of the officers of the *Daedalus* and by the two "apparitions" off Tonkin) cannot possibly be brushed aside in the light-hearted manner with which Prof. Moseley treated the evidence available in his time.

R. L.

THE ROYAL SOCIETY CONVERSAZIONE.

MANY of the exhibits of scientific apparatus and objects at the second, or ladies', conversazione held at the Royal Society on June 20 were the same as those shown at the gentlemen's conversazione on May 9. As these have already been described (May 17, p. 59), it is only necessary to refer now to the new exhibits. During the evening demonstrations, with lantern illustrations, were given by Dr. Tempest Anderson, Sir William Crookes, and Mr. Fred. Enock. Dr. Tempest Anderson described the recent eruption of Vesuvius, his photographs showing the phenomena during the later stages of the eruption, as well as some of the results. In several cases the views afforded a comparison with the conditions of the same places as previously observed. Sir William Crookes gave a short address with experiments in illustration of some properties of the diamond; and Mr. Fred. Enock described slides showing by means of colour photography (Sanger Shepherd process) the adaptability of lepidopterous insects to their environment.

In the subjoined summary of the official catalogue, the exhibits are arranged roughly in groups of related subjects.

Dr. H. Forster Morley on behalf of the International Catalogue Committee: A map of the world was shown upon which thirty-one countries or regions were coloured. Each of these has established a Regional Bureau for indexing its scientific literature. The literature indexed is that published since January 1, 1901. Each annual issue of the catalogue contains seventeen volumes, dealing with seventeen sciences. A copy of the second annual issue was shown. The Regional Bureaus for France, Germany, and that for Polish literature employ the material prepared for the International Catalogue for the compilation of bibliographies of their own scientific literature. Specimens of these bibliographies were shown.—*Prof. H. McLeod on behalf of the Committee of the Royal Society's Catalogue of Scientific Papers:* An exhibit illustrating the course of operations in the preparation of the catalogue, which was fully described in an appendix to the descriptive programme of the conversazione.

Sir James Dewar, F.R.S.: (1) New charcoal calorimeter and thermoscope. Charcoal at the temperature of liquid hydrogen that has absorbed at atmospheric pressure considerable quantities of helium or hydrogen—or alternatively of nitrogen, oxygen, or air at their respective boiling points—is utilised in this instrument as a material that, by reason of changes in the volume of the occluded gas, exhibits great sensibility to heat and light radiation, and can be used in calorimetry at the temperature of solid hydrogen. (2) Charcoal vacua. Electric discharge tubes showing gradual gas absorption by charcoal cooled in liquid air until, after the Röntgen radiation stage, the electric resistance becomes so great that a discharge will not pass. (3) Spectrum tubes. (*a*) The less condensable gases of the atmosphere—helium and neon. (*b*) The more condensable gases of the atmosphere—krypton and xenon, each set of gases being separated by the charcoal method. (4) Some scientific uses of liquid air. (*a*) Electric ice crystals. (*b*) Rough measures of relative thermal conductivities in metals and alloys, by observing the height of the deposited ice cap when similar wires are placed alongside each other and the ends immersed in liquid air. The relative conductivities are as the squares of the height of the ice columns. (*c*) Spheroidal state of liquid air on the surface of different fluids and solutions, showing changes of volatility from the varying amount of vapour condensation; at the same time exhibiting interesting rotatory and translatory movements.—*Department of Applied Mathematics, University College, London:* (1) Investigation into the stresses in masonry dams, Prof. Karl Pearson, F.R.S., and Mr. A. F. C. Pollard. The investigation suggested that the shear distribution should in each case be found from a model dam, before the stresses are determined by graphical methods. The existence of stretch in the tail of dams of ordinary type is confirmed by the experiments illustrated. (2) Solution of the problem of the random walk, Prof. Karl Pearson, F.R.S., and Mr. J. Blakeman. The diagrams shown give the sections of the frequency surface for two, three, four, five, six, and seven stretches or flights, and show the passage of the discontinuous function into Lord Rayleigh's continuous surface. The problem is of considerable importance from the standpoint of the migration of species, and was suggested by Major Ross's investigations into the infiltration of mosquitoes into a cleared district. The solution has been obtained by successive mechanical integration from the first case by using the functional relation between successive flights.—*Mr. A. A. C. Swinton:* Visibly luminous electrical discharges *in vacuo* obtained with comparatively low electrical pressures. Edison, Fleming, and others have shown that the passage of the electric discharge *in vacuo* is much facilitated by heating the kathode. Owen and Wehnelt have proved that this effect is enormously increased if the heated kathode be coated with oxides of the alkaline metals. The present experiments show that similar results can be obtained by coating the kathode with radium, and that the effect will be greater when the kathode is heated than obtains without heating.—*Mrs. Watts-Hughes and Mr. Richard Kerr:* Floral, geometric, and other forms produced by the human voice in singing. Moistened water-colour is spread on paper attached to an india-rubber disc stretched over a cup-shaped vessel. The sound vibrations are communicated to the under side of the india-rubber through a tube in the side of the cup.—*Mr. Oliver S. Dawson:* Photographic prints in natural colours (Smith-Merckens process).—*Messrs. Carl Zeiss, Jena:* Photomicrographic apparatus for ultra-violet light (designed by Dr. A. Köhler).

Mr. R. G. Durrant: Evidence to show that ionic separation occurs when solutions of acids or of salts are allowed to diffuse into sensitised jellies or solutions.—*Dr. O. Silberrad and Dr. R. C. Farmer:* Stability test for cordite. This exhibit illustrated a method recently devised at the Chemical Research Department, Royal Arsenal, Woolwich, for the determination of the stability of cordite and other propellant explosives. It is well known that these explosives decompose gradually on storage, and may eventually ignite spontaneously, if their stability be not tested from time to time. The principle of the new test is based upon the results of several thousand experiments, and is the only method known which gives trustworthy results with cordites. The test has been adopted by the Service, and will shortly be made use of as a safeguard against spontaneous explosions in powder magazines, particularly in the tropics, where the deterioration takes place most rapidly. In examining cordites the procedure is briefly as follows:—50 grams of the explosive are maintained at 70° C. in a glass vessel fitted with a mercury manometer; the alteration in pressure is measured at intervals. A contraction takes place at first owing to the absorption of oxygen from the air; subsequently a gradual expansion occurs; the former of these phenomena has never previously been observed.—*Dr. F. D. Chattaway:* Copper mirrors obtained by the deposition of metallic copper upon glass. The method of silvering glass by depositing the metal in a thin film by reduction of some soluble silver compound has long been employed in the production of mirrors, but hitherto no method of similarly depositing copper in a brilliant film has been discovered. The exhibit showed a number of glass vessels on which copper had been thus deposited by a slow reduction of the black oxide. The metal being protected from the air, such mirrors retain their lustre permanently.

Mr. G. F. Herbert Smith: Precious stones and simple methods for their identification. This exhibit illustrated the variety of precious stones which are available for ornamental purposes. A gem stone must be hard enough to resist the abrasive action of ordinary dust, and at the same time be either transparent or; if opaque, of pleasing colour. The number of mineral species suitable for the purpose is not so restricted as popularly supposed. The names employed by jewellers frequently differ considerably from the scientific nomenclature, being often associated with certain colours rather than particular species, *e.g.* topaz (yellow), sapphire (blue), ruby (red), emerald (green), and amethyst (violet). The colour, though the most obvious character of a stone, is the least trustworthy; and the hardness, while of immense importance as regards its durability, is of little discriminative value. On the other hand, the optical characters (refractivity, double refraction, and dichroism) and the specific gravity may be easily and accurately determined, and lead to the precise identification of the stone. In the case of practically all faceted transparent stones the refractivity and double refraction are sufficient for the purpose, and the stone need not be removed from its setting.—*Sir William Crookes, F.R.S.:* (1) Occurrence of the diamond. (*a*) Example of "blue ground" in which diamonds are found, from the 1320-feet level, De Beers Mine; (*b*) diamantiferous gravel from the Pulsator, De Beers Mine; (*c*) selected stones from the Pulsator, De Beers Mine. (2) Models of crystals of diamond. (3) Cut and polished section of a piece of silicified wood found about twelve years ago in the untouched "blue ground" of the Du Toits Pan Diamond Mine, Kimberley. (4) Polished section of the Cañon Diablo meteorite in which diamonds have been found.—*Prof. W. Gowland:* (1) Portion of a meteorite containing diamonds found near Cañon Diablo, Arizona, and specimens of diamonds extracted from it. (2) Alloys of copper and calcium. A series of alloys ranging from 0·8 per cent. to 61·5 per cent. of calcium. All are brittle, and those containing 6 per cent. to 7 per cent. calcium extremely hard. The higher alloys decompose water, and are readily oxidised in the air. Specimens were also exhibited showing the effects of calcium on lead, tin, bismuth, aluminium, and coinage bronze.—*Miss Rhodes:* Stereoscopic views of the Victoria Falls and the Batoka Gorge of the Zambezi, and of the Batoka country east of the Falls. Photographed by the late Colonel F. W. Rhodes.

The Director, Royal Gardens, Kew: Sturt's desert pea (*Clianthus Dampieri*). A prostrate herbaceous plant, native of West Australia, first collected by Captain William Dampier. Under cultivation it is very delicate, but when grafted on the bladder senna (*Colutea arborescens*) it grows with vigour and flowers freely.—*Dr. F. E. Fritsch:* Method of colonisation of free surfaces by subaërial Algæ (Cyanophyceæ) in the tropics.—*Mr. E. A. Newell Arber, Miss M. Benson, Miss W. Brenchley, Prof. F. W. Oliver, F.R.S., Dr. D. H. Scott, F.R.S., and Prof. F. E. Weiss:* Fossil plants from the English Coal-measures.—*Mr. W. Saville-Kent:* Stereoscopic and other natural-colour photographic transparencies illustrating the fauna of the Polynesian coral reefs. This series of natural-colour photographs was more particularly illustrative of the coral-frequenting fishes of Polynesia. A notable genus of mostly minute percoid fishes, Tetradachnum, represented in the series, habitually make isolated bushy coral stocks their headquarters. They cruise around these coral growths in sport and in search of food, retreating within the coral's ramifications to rest or to escape from any enemy.

The Solar Physics Observatory, South Kensington: Recent photographs of some British stone circles.—Dr. *W. M. Flinders Petrie, F.R.S.:* (1) Hyksos fortress model, and pottery, 2000 B.C., Egypt. (2) Model of the temple and city of Onias, Egypt. (3) Photographs, enlarged, from Sinai. The Egyptian turquoise mines were worked from 5000 B.C. The oldest rock sculptures are those of the middle of the first dynasty of kings. Both centres of mining, Wady Maghara and Serabit el Khadem, were shown.

NATIONAL PHYSICAL LABORATORY.

OPENING OF NEW BUILDINGS FOR ELECTROTECHNICS AND PHOTOMETRY.

THE new buildings of the National Physical Laboratory for electrotechnics and photometry were opened on Monday, June 25, by Mr. Haldane, Secretary of State for War. A large company assembled at the invitation of Lord Rayleigh and the general board, and among those on the platform were Lord Rosse, Lord Kelvin, Sir John Wolfe Barry, Sir J. Lawrence, M.P., Sir John Brunner, M.P., Sir William White, Mr. Gavey, M. Hospitalier, Herr W. von Siemens, Prof. Semenza, M. Gerard, Sir Thos. Wrightson, and Sir Chas. Tupper.

Among the audience, numbering nearly six hundred, were representatives to the International Electrical Congress, now being held in London, from the American, German, French, Swiss, Italian, and other electrotechnical societies.

Lord Rayleigh presided, and in opening the proceedings said that the gathering marked another stage in the evolution of the institution, and they all hoped the new buildings would play a considerable part in the science of electrotechnics in this country.

The director, Dr. Glazebrook, then made a statement concerning the new extensions, and detailed the gifts which had been made towards equipment by numerous firms and individuals. The Chancellor of the Exchequer had asked Parliament for a grant of 5000*l*. last session for new buildings, and this year's grant towards the cost of the further extensions in the engineering, chemical, and metrological departments was 10,000*l*. The building in which they were assembled had cost only about 7000*l*., largely owing to the liberal treatment accorded to the laboratory by the contractors, Messrs. Mowlem, and by Messrs. Mott and Hay, who gave their services as architects. The director expressed his indebtedness to the members of the staff, who had helped in designing and fitting up the building, especially to Mr. Paterson, Mr. Rayner, and Mr. Melsom, who had all given much time and careful thought to the plans.

Mr. Haldane then addressed the meeting and declared the laboratory open. The meeting terminated with votes of thanks to Mr. Haldane, proposed by Sir John Wolfe Barry and seconded by Sir John Brunner, M.P., and to the chairman, proposed by Mr. Gavey.

The objects of the new building are the provision of suitable accommodation for the rapidly extending work of the laboratory in electrotechnics and photometry. In the old building will remain all the fundamental-standard work relating to measurements of current, electromotive force, resistance, capacity, and inductance. The main portion of the new extension consists of a top-lighted shed, 120 feet by 50 feet, divided into two bays, each 25 feet wide. The southern bay is divided transversely, forming two rooms, each 60 feet by 25 feet. The inner of these has a glass ceiling, and the lights above are glazed with double glass, and face north. The space between the ceiling and the roof can be heated, and by means of a large fan artificial ventilation is provided. It is hoped by this means to maintain the temperature fairly uniform. This internal room is intended for resistance measurements. The other half of the same bay is designed for heavy-test work. Two bed-plates are provided for machine testing, and arrangements have also been made for addition of a travelling crane.

The large bay to the north side, in which the ceremony was held, is for general electrotechnical testing. At the west end of this is the main switchboard, receiving power from the dynamo room, and also from the mains of the supply company, and distributing it to the machines in the building and to the batteries.

Near by is provided space for the special electrotechnical machine equipment. This includes a 5 kilo-watt motor-generator set for single or three-phase current, the frequency of which can be widely varied, another motor-generator of specially high efficiency for life-tests on lamps, and a third for transformer and high-tension experiments. The rest of the bay is assigned to experimental work, the western portion being reserved for alternating-current experiments, and the eastern portion for direct-current. The batteries are on the top floor of an annexe to the east of the main block, above the rooms reserved for photometry; thus the direct-current work requiring heavy currents will go on in the extreme eastern portion of the main bay.

Four new accumulator batteries are provided, and to charge these and furnish the additional power necessary for general work a 50 kilo-watt motor-generator has been provided in the power-house, driven from the supply mains of the local company. For ammeter-testing, currents up to 6000 amperes for an hour can be obtained by paralleling of one of these batteries, and 10,000 amperes for short periods. A special 300-volt battery is reserved for photometric experiments.

The remainder of the new building is intended for photometry. On the ground floor is a large room for life-tests of electric and gas lamps, and, above, a room for standard photometry and a specially arranged gallery for arc-lamp testing. A length of 90 feet is available for photometry of specially high candle-powers, and in the arc-lamp room a height of nearly 35 feet.

FIG. 1.—New Buildings of the National Physical Laboratory.

No money has been spent on unnecessary adornment of the buildings, marble and granite being conspicuous by their absence, but already the grounds have been planted with flowers and creepers, and the exterior, though plain, is by no means an eyesore.

After the opening ceremony the visitors proceeded to the old buildings and the garden, and inspected the various laboratories, where the assistants in charge explained the work of their own departments. The objects which appeared to attract most attention were the new ampere balance in the main electrical room, the various electric furnaces, the radiation pyrometers in the thermometric department, and the new measuring machines in the department of weights and measures.

A summary of the *Times* report of Mr. Haldane's address is subjoined.

The Government is keenly interested in the development of science, and a donation by the Chancellor of the Exchequer on a scale of double what was anticipated last year is an earnest of what it means. A contrast may be made between the German and the British attitude towards science. Prussia began her emancipation by founding a university as an answer to the conqueror. Germany became the victor by the sheer might of thought and by the wonderful organisation which that might of thought enabled her to make the foundation of her future power. We, on the contrary, have always made the effort after material prosperity first, and when prosperity has been attained have strained after science. This is rather an outcome of the Anglo-Saxon temperament. There is an aversion in this land from anything that is abstract, a desire to do as much as possible by individual effort, and finally to turn to science and to the aid of thought and organisation for the completion rather than the foundation of the edifice. It is a good sign that brotherhood of science brings men of different races and different temperaments together. The possession of common conceptions and intellectual instruments, the passion for, and fascination of, common problems, the fact that the minds of men of the most varying temperaments and the most differing races are making toward a common point, has brought about a great intellectual common ground, and united men for the effort to accomplish a common task. The functions of the State are becoming more and more recognised, and more and more people in different parts of the world are beginning to feel that it is not merely the State, but the great individualities of which we are proud—individualities which form a common heritage. It is not merely Frenchmen who are proud of Laplace and Lavoisier, nor merely Germans who rejoice in the names of Weber, Helmholtz, Gauss, and Riemann, nor merely Englishmen who speak with pride of Newton and of Darwin. These and many other names belong to the world at large, are the inheritance of those who have drawn in the breath of the Time-Spirit to see it come forth again in the concentrated form of genius in conspicuous individuals too great to be the representatives of any one race, satisfied with being nothing less than the embodiment of the finest genius of humanity. In an ideal State, the ruler would take thought, not merely for the day, but for the morrow; but there is very little thought taken for the morrow in the government of almost any nation. What an infinite amount of friction would have been avoided, what an enormous quantity of waste would have been obviated, had there been only thinking organisation, plain principles not hurriedly to be departed from, at the root of policy! In the National Physical Laboratory we have a sign, a portent of the times, the evidence that we are advancing. But a few years ago and such an institution would have been impossible. We may look at it as a sign that we are coming into line with the rest of the world, and recognising that it is to science, and science in the main, that we must look for the means of maintaining ourselves in the vast competition of the world.

NOTES.

THE programme of events in connection with the international celebration of the coal-tar colour jubilee has now been definitely arranged. The steps leading up to the celebration have been described in these columns already (vol. lxxiii., p. 419). The celebration will be held on July 26 and 27. On the first day a meeting will take place at 11 a.m. at the Royal Institution for the presentation to Dr. W. H. Perkin of his portrait and bust, and in the evening a banquet has been arranged at the Whitehall Rooms, Hotel Metropole, when many distinguished guests are expected to be present. On July 27 a visit will be paid to the original works at Greenford Green, where mauve was first manufactured, and a garden-party will be held at Dr. Perkin's house. In the evening a soirée will take place at the Leathersellers' Hall, at the invitation of Dr. and Mrs. Perkin. The international committee arranging the ceremony includes distinguished representatives of science, especially chemical science, in France, Germany, and Switzerland, as well as in this country. Applications for tickets and invitations should be made to Dr. J. C. Cain, 28 Pembury Road, Clapton, N.E., who is acting as assistant honorary secretary to the executive committee.

WE learn from the *Chemist and Druggist* that the Chemists' Club of New York has also decided to honour Dr. Perkin. At a meeting held on May 28 the committee (of which Prof. Chandler is chairman) reported in favour of the establishment of a library, probably to be known as the Perkin Library, and to cost 10,000*l.*; the appropriation of 1000*l.* for a Perkin medal and a token to Dr. Perkin; and a dinner on October 6, at which Dr. Perkin is expected to be present. The proposals were adopted. The Perkin medal is to be awarded annually to an American chemist for distinguished work in technical chemistry.

MUCH correspondence has appeared in the *Times* and other journals during the past week with reference to the Wireless Telegraphy Bill which has just passed its third reading in the House of Lords. The Bill is merely to extend the Act of 1904, a summary of which appeared in our columns at the time (vol. lxx., p. 349). The original Act expires in July of this year, but will now be extended to 1909. The extreme importance of wireless telegraphy for the purpose of national defence has been recognised from the very first, and in consequence exercise of control had to be placed in the hands of the Government, especially in view of the fact that—all claims to the contrary notwithstanding—it cannot be said that any system has yet been perfected which is completely immune from interference or cannot interfere with other systems. It is outside our province to enter into the legal dispute between the Marconi Company and Lloyd's, but it is to be hoped that a settlement will be arrived at which will give the public the full advantages in connection with shipping that wireless telegraphy affords.

PARAGRAPHS have appeared in the daily papers alluding to a "new disease" which was said to have appeared in Essex about ten days ago. Some children at Highwood, near Chelmsford, were found to be suffering from a rash on the hands, face, and neck, accompanied with great irritation of the eyes and skin. On inquiry it was found that the children had been playing with some caterpillars taken from the hawthorn hedges. Much amusing "newspaper science" has appeared, and the name *Plusia gama* (sic) has been applied to the insect. The caterpillars were undoubtedly those of the Gold-tail Moth (*Liparis auriflua*), which is now common on the hedges. It is a pretty creature, but the hairs which cover its body are very easily detached, and, being exceedingly fine, readily enter the soft skin of children, and thus set up inflammation. It is doubtful whether any poisonous secretion accompanies the hairs, or whether the painful injury is purely mechanical. The malady is well known to practical entomologists, most of whom have learnt by experience to banish Liparis from their breeding-cages. An allied species, *Liparis chrysorrhoea* (the Brown-tail Moth) is in some seasons abundant on bushes on the Essex coast, and is even a greater irritant than its congener, but it is one of our immigrant moths, and is not seen every year.

A VIOLENT shock of earthquake was felt yesterday, June 27, at 9.45 a.m. over the whole of South Wales. At Swansea a chimney was thrown down, while at Cardiff the Exchange and other big buildings were shaken. The shock lasted about three seconds. The earthquake was felt at Knighton at 9.46 a.m., and tremors were also experienced at Llandrindod Wells and in South Shropshire. A slight shock was felt at Abergavenny and Carmarthen, and at Bridgend people walking in the street were nearly thrown down. At Newport (Mon.) also the disturbance was felt distinctly.

A BANQUET was given by the Institution of Electrical Engineers on Monday night in honour of the delegates from kindred institutions in Canada, France, Germany, Italy, Switzerland, and the United States who are visiting this country. Mr. John Gavey, C.B., president of the institution, presided, and there were about 450 guests and delegates present. The toast of the visiting delegates, proposed by the president, was responded to by Prof. J. L. Farny, representing the Association Suisse des Électriciens; Mr. P. J. B. E. Auzépy, Consul-General of France; Prof. E. Budde, president, Verband Deutscher Elektrotechniker; Dr. Emil Naglo, representing the president of the Elektrotechnischer Verein; Mr. S. S. Wheeler, president of the American Institute of Electrical Engineers; and Mr. Guido Semenza, hon. general secretary of the Associazione Elettrotecnica Italiana, who during his response presented to the institution, in the name of the Associazione Elettrotecnica, a bust of Alessandro Volta. A conversazione in honour of the visitors was held at the Natural History Museum on Tuesday evening.

DR. T. P. ANDERSON STUART has been elected president of the Royal Society of New South Wales for the current year.

THE Guy medal in silver of the Royal Statistical Society has been awarded to Dr. W. N. Shaw, F.R.S., for his paper entitled "The Seasons in the British Isles since 1878," read before the society in March, 1905.

THE presidency of the Yorkshire Naturalists' Union for 1907 has been offered to, and accepted by, Mr. C. Crossland, of Halifax, joint author of the recently-published "Fungus Flora of East Yorkshire."

A SPECIAL meeting of the Faraday Society, to which the public is invited, will be held at the Society of Arts on Monday, July 2, when Prof. Kr. Birkeland, of Christiania, who is at present on a visit to England, will read a paper on the oxidation of atmospheric nitrogen in electric arcs. At the same meeting Mr. F. W. Harbord will communicate a paper, by Dr. Eugen Haanel, of Ottawa, describing the recent experiments on electric iron and steel smelting that were made at Sault Ste. Marie on behalf of the Canadian Government.

SIR DANIEL MORRIS, K.C.M.G., the Imperial Commissioner of Agriculture for the West Indies, has arrived in this country on a short visit, and will attend the forthcoming International Conference on Hybridisation and Plant Breeding to be held in London under the auspices of the Royal Horticultural Society at the end of July. Sir Daniel will read a paper on the hybridisation of the sugar cane, a subject with which he has been actively associated for many years.

BY the regretted death of Lieut. Forbes Tulloch, R.A.M.C., last week, another name is added to the honoured roll of the martyrs of science. Lieut. Tulloch, in association with Lieut. Grey, had been for the past year investigating sleeping sickness at Entebbe, Uganda. In March, while making a *post-mortem* on an inoculated rat, he accidentally scratched his finger. In a short time fever developed, and an examination of his blood showed the presence of the dreaded trypanosome. Although at once invalided home, the disease ran a very acute course and ended fatally as stated. Lieut. Tulloch had, in cooperation with Lieut. Grey, made the important observation that trypanosomes multiply in the tsetse fly, and was regarded as a worker of great promise. His untimely death is much to be deplored.

ON Thursday last, June 21, a paper was read before the Royal Society of Antiquaries by Dr. Jonathan Hutchinson, F.R.S., and Mr. E. W. Swanton, on prehistoric remains found during recent years in the neighbourhood of Haslemere. The authors commented on the large number of Neolithic implements which had been found, chiefly by Mr. Allen Chandler. Many were obtained from the site of a Neolithic flint factory on Blackdown, 912 feet above sea-level, and ten miles away from the nearest chalk-with-flints bed. Among the objects from this spot were rubbing stones and perforated circular hammer stones of quartzite, also a very fine series of the so-called "pigmy flints." The second part of the paper detailed the discovery of a Celtic urn-field adjacent to Haslemere town. Crude flint chips, and in one case a fragment of a bronze fibula, occurred among the fragments of calcined bone in the cineraries. No iron was found, and but one piece of bronze. A hole in the base of one of the cineraries had been repaired by inserting a plug of lead. Many accessory vessels had been placed around some of the urns; several in almost perfect condition were exhibited, they were of various shapes and sizes, and the paste was of several qualities. In the discussion which followed it was agreed that the pottery belonged to the later Celtic period or early Iron age, B.C. 50 approximately. The vessels and flints from this urn-field have been presented to the Haslemere Museum.

MR. GEORGE JAMES SNELUS, F.R.S., who died on June 18, was the first to eliminate phosphorus during the Bessemer process by the use of a basic lining to the converter. He took out a patent for the idea in 1872, and subsequently made five tons of steel by this method. The process was, however, not brought into commercial operation until after the work of Thomas and Gilchrist. Mr. Snelus's share in the invention was recognised by the Iron and Steel Institute, which in 1883 awarded him, jointly with Sidney Thomas, the Bessemer gold medal. Mr. Snelus, who was born on June 25, 1837, in London, was educated at St. John's College, Battersea, and at Owens College, and subsequently obtained a scholarship at the Royal School of Mines, where he took the associateship in metallurgy and in mining, and received the De la Beche medal for mining. His first appointment was as chemist to the Dowlais Ironworks. In 1871 he went as expert for the Iron and Steel Institute to the United States to report on the Danks rotatory puddling furnace. He was elected a Fellow of the Royal Society in 1887. He wrote a large number of papers on the metallurgy of iron, which were contributed to the Proceedings of the Iron and Steel Institute, of which society he was an original member, and at the time of his death occupied the position of vice-president. He possessed unusual talents for experimental research.

IN place of the usual autumn meeting, the Iron and Steel Institute will this year hold a joint meeting with the American Institute of Mining Engineers in London on July 23–26. Under the chairmanship of the Lord Mayor, an influential reception committee has arranged an attractive programme of entertainments, visits, and excursions. The King will receive a deputation of the institute's American guests. There will be a banquet in the Guildhall of the City of London, evening receptions by the president and by the Lord Mayor, and entertainments at the Earl's Court Exhibition and at the Crystal Palace. Technical interests have not been neglected, the programme including visits to the National Physical Laboratory, to the power stations at Greenwich and Chelsea, to the Wellingborough blast-furnaces, to the Dover Harbour works, and to various engineering, shipbuilding, and cement-manufacturing works. The Iron and Steel Institute has down on the programme for reading a list of twelve papers, and the American society eleven more. These have all to be dealt with in three morning sessions. The papers likely to prove of chief interest are communications on blast-furnace gas engines, by Prof. H. Hubert (Liége), Mr. K. Reinhardt (Dortmund), and Mr. T. Westgarth (Middlesbrough); on the crystallography of iron, by Mr. F. Osmond (Paris); on high-speed tool steels, by Dr. H. C. H. Carpenter (National Physical Laboratory); and on segregation in steel ingots, by Mr. H. M. Howe (New York). For the week following the London meeting a tour to York, Middlesbrough, Durham, Newcastle-upon-Tyne, Glasgow, and Edinburgh has been arranged for the institute's American guests by a committee of which Mr. R. A. Hadfield, president of the institute, is chairman, and Mr. Bennett H. Brough secretary.

The latest issue to hand (March) of the Proceedings of the Philadelphia Academy contains the completion of Dr. B. Smith's communication on the phylogeny of *Volutilithes petrosus* (already noticed in our columns), and an article by Mr. H. W. Fowler on the fishes and reptiles of the Florida keys.

Two papers bearing on the Mendelian doctrine, more especially as regards the theory of pure gametes, have been recently published by the Carnegie Institution, one, by Messrs. Castle and Forbes, on the heredity of hair-length in guinea-pigs, and the other, by Mr. W. E. Castle, on the origin of a polydactylous race of these rodents. Considerations of space alone prevent fuller notice.

Limitations of space must likewise be our excuse for not noticing in detail an important paper on the germ-cells of Aphides, by Mr. N. M. Stevens, also published by the Carnegie Institution. The present classification of aphides is considered imperfect, and reference to the cytology of the germ-cells will probably be necessary before an improvement can be made. Special attention is directed to the fact that while in some species parthenogenetic and sexual modes of reproduction alternate irregularly, in others parthenogenesis continues throughout the summer.

The contents of the fourth part of vol. lxxxi. of the *Zeitschrift für wissenschaftliche Zoologie* are entirely devoted to invertebrates. In the first article Mr. W. Mayer discusses the dermal sense-organs of leeches; spermatogenesis in earthworms forms the subject of the second article, by Mr. Depdolla; in the third Dr. M. Nowikoff has remarks on the median eye and frontal organ of the crustacean Artemia; while in the fourth Mr. E. Martini describes certain superficial structures in nematode worms.

The report for 1905 of the Marine Biological Association of the West of Scotland has just been received. "At no time has the station been so efficient as an instrument of research, of organised education, or of general instruction as it now is. At no time, either, have its prospects of growth in usefulness and efficiency on all these lines been so promising." At the same time, if the work is to be properly carried on, a large increase in the endowment fund is essential, and for this a special appeal is made in the report. Provision must likewise be made for the upkeep and working of the *Mermaid*, the five years' fund generously provided by Mr. J. Coates having now come to an end. An increase of the staff by the addition of a trained assistant is also a matter of urgency, but for this no funds are at present available.

In the Oregon University Bulletin (vol. iii., Supp., No. 3, May) Mr. T. Condon describes, under the new generic and specific title of *Desmatophoca oregonensis*, the skull of a seal, referable to the family Otariidæ, from the Miocene of the Oregon coast. The author claims this as the first Miocene seal yet described. Evidently he is unacquainted with the seal-skull, referable to the same family and from the same formation (at Empire City), described by Mr. True in the quarterly issue of the Smithsonian Miscellaneous Collections for May, 1905, under the name of *Pantoleon magnus*. Although Mr. True's specimen is considerably the larger of the two, there is no apparent reason why it should not be the male of the skull described by Mr. Condon. The latter author urges that the Miocene age of the Oregon seal is a bar to the view that the Pinnipedia are descended from the bears.

Vertebrate osteology constitutes the main item in the contents of the first three parts (issued in one fasciculus) of vol. xix. of the Bulletin of the Imperial Society of Naturalists of Moscow. In the first article, for instance, Mr. L. P. Kravetz discusses the development of the mammalian sternum and presternum, more especially in relation to the conflicting views which have been expressed in regard to the origin of these structures. The skeleton of the cat-fishes (Siluridæ), as exemplified by the skull of the Old-World genus Clarias, forms the subject of a long communication by Mr. G. Schelaputin, in which the author revives the view that the fully ossified and sculptured cranial roof indicates some kind of affinity with the Palæozoic Coccosteus. The skeleton of the cat-fishes (inclusive of the American Loricariidæ) forms the subject of another article, by Mr. D. N. Koschkaroff, constituting a portion of a dissertation on teleostean osteology in general. A phylogenetic tree of the silurids and loricarids is included in this paper.

The results of experiments in Barbados for the seasons 1903–5 with new seedling canes and manurial experiments on sugar-cane plots have been published in the pamphlet series, No. 40, issued by the Imperial Department of Agriculture for the West Indies. One or two of the varieties have now been under trial for six years, while others are newer and have only been tried for two or three seasons; one of the latter is B 1529, that with the highest quotient of purity takes the first place among plant canes. The manurial experiments confirm the results obtained in previous years, pointing to the value of nitrogen and potash and to the detrimental effects of phosphatic fertilisers.

Mr. H. H. Cousins contributes a third article on cassava trials at the Hope Experiment Station to the Bulletin (April) of the Department of Agriculture, Jamaica. The object has been to compare the yields of different varieties when grown for different periods. It was found in one instance that the yield of starch per acre was increased from $3\frac{1}{2}$ tons at the end of a year to $7\frac{1}{4}$ tons after cultivation for twenty-one months, so that as far as cultivation alone is concerned a biennial crop would be the most profitable. On the subject of oranges, Mr. Fawcett offers some practical advice on the treatment of trees to produce early ripening of the fruit, recommending root pruning and timely clearance of all fruit at the end of the season.

The regulations governing the training of probationers at Oxford for the Imperial staff of the Indian Forest Service naturally arouse keen interest in India, and an editorial article in the *Indian Forester* (April) compares the course of studies prescribed at Oxford with the course given to recruits for the subordinate executive service at the Imperial Forest School, Dehra Dun. The opinion is expressed that the course at Oxford requires stiffening, and the immense advantage of obtaining practical experience at Dehra Dun under Indian forestry conditions as contrasted with those in European forests is emphasised. An article on felling timber in Bashahr, contributed by Mr. G. S. Hart, in which the felling of trees uphill is advocated, is accompanied by some interesting photographs.

In the *Naturwissenschaftliche Wochenschrift* (June 17) there is an excellent summary of what is known respecting the structure of the reproductive cells, illustrated with a number of particularly good figures. The author is Dr. C. Thesing.

The Bulletin of the Johns Hopkins Hospital for June (xvii., No. 183) contains articles on the use of quinine during the Civil War, by Dr. J. W. Churchman; on an experimental study on the regeneration of lymphatic vessels, by Dr. A. W. Meyer; and various medical papers.

The Livingstone College "Year-book" for the current year contains the annual report, extracts from letters of former students, &c. The college is doing a useful work in giving to those about to become missionaries elementary training in medicine, surgery, and hygiene.

The New Jersey State Legislature has recently passed an Act for the extermination of mosquitoes. The title of the Act is as follows:—"An Act to provide for locating and abolishing mosquito-breeding salt-marsh areas within the State, for assistance in dealing with certain inland breeding places, and appropriating money to carry its provisions into effect." The full text is given in *Science* (June 1).

The preservation of brains for anatomical and anthropological investigations is the subject of an elaborate paper by Mr. Ales Hrdlicka (Proc. U.S. National Museum, xxx., p. 245). It is found that the best preservative is a mixture of formalin, water, and 95 per cent. alcohol in varying proportions according to size: formalin 3 parts, distilled water 45–25 parts, alcohol 52–75 parts; less water and more alcohol being used for the larger sized brains.

The Local Government Board has published a further report on the destruction of rats and disinfection on shipboard with sulphur dioxide, by Dr. John Wade (No. 232). It is found that rats and insects are destroyed in less than two hours by air containing 0·5 per cent. of sulphur dioxide, a condition easily realised in cabins, empty holds, spaces round cargo, &c., but for adequate penetration of closely packed cargo, air containing 3 per cent. of the gas must be circulated around the cargo for eight to twelve hours. Non-sporing pathogenic bacteria are also killed by this treatment. Textile fibres and fabrics, metal and furniture, are not affected by sulphur dioxide, but are liable to injury by the accompanying sulphuric acid when the gas is generated by burning sulphur, unless they are protected. Meat, fruit, vegetables, and wheat in bags are deleteriously affected. Liquid sulphur dioxide may be employed as a source of the gas, but burning sulphur, as in the Clayton process, is on the whole preferable on the ground both of convenience and of economy.

In the *Engineering Magazine* (vol. xxxi., No. 3) Mr. J. A. Macdonald gives an interesting account of twelve months' prospecting and surveying in northern Ontario, and also a detailed account of the occurrence of cobalt ore and of the development of the deposits. These deposits, which contain silver, cobalt, nickel, and arsenic, are among the most remarkable now engaging the attention of the mining world.

We have received from the director, Prof. G. Gerland, a circular summarising the work of the Central Bureau at Strassburg of the International Seismological Association. The bureau was founded in 1903 by the second International Conference of Seismology. The observatory or central station in connection with the bureau is furnished with a triple horizontal pendulum with photographic registration, a Rebeur pendulum for recording photographically two components, a Milne pendulum, a Wiechert pendulum, a Vicentini microseismograph, Omori and Bosch horizontal pendulums, and a trifilar gravimeter. The apparatus and records are always at the service of foreign observers. The bureau and the station have distinct organisations, but work together. The director hopes that seismologists in other countries will transmit regularly to the central bureau accurate observations of any seismological disturbances in their respective districts. The most practical way, Prof. Gerland suggests, would be for observers at the various stations to send copies of important earthquake records to the bureau at Strassburg, where they would be available for inspection by students of seismology.

With the advance of refractometry in chemistry, Messrs. Carl Zeiss, of Jena, have introduced several forms of refractometers suitable for special purposes, and have issued pamphlets descriptive of these. Their "dipping refractometer" is specially applicable in analysis, particularly in ascertaining the proportion of alcohol and extract in beer. For scientific purposes it gives very accurate values between the ranges of $\mu_D = 1·325$ and 1·366, and is especially adapted for the examination of aqueous solutions. The firm has issued in pamphlet form a bibliography of papers dealing with their well-known Abbe refractometer, and the refractometers used in examining milk and butter respectively.

In continuing their studies in luminescence, Messrs. E. L. Nichols and Ernest Merritt in No. 5 of the *Physical Review* investigate the law of decay of the phosphorescence of Sidot blende. In previous experiments in this connection the decay of the total light has been measured, the assumption being made that all portions of the light decay at the same rate. In the present investigation the decay of light of a definite wave-length in the phosphorescence spectrum has been observed, and it is shown that in such a case the intensity of the light diminishes according to the law originally proposed by H. Becquerel, $I^{-\frac{1}{2}} = a + bt$, where a and b are constants. This law can be deduced from different theoretical conceptions from those originally suggested by Becquerel. It is only necessary to apply Wiedemann's hypothesis of the cause of photoluminescence and to assume a law of recombination of the dissociated parts of the substance similar to that which has been applied to the case of ionisation of gases. With such an assumption it is deduced that the quotient a/b should be the same for different wave-lengths when the excitation and other physical conditions are the same. The measurements given in the paper show that between the limits $\lambda = 483\ \mu$ and $\lambda = 547\ \mu$ this is very approximately true.

We have received from Messrs. W. and A. K. Johnston, Ltd., a convenient pad of sectional paper ruled in inches and tenths. The size of the sheets is 8 inches by 10 inches, and the price of the pad 1s. 6d. net.

Mr. John Murray has published a fourth edition of Mr. W. C. Clinton's "Electric Wiring." The first issue of the primer was reviewed in Nature for October 23, 1902 (vol. lxvi., p. 629). Of the present edition it will suffice to say that in its revision an effort has been made to bring it up to date without increasing its size unduly.

The current issue of *The Central*—the magazine of the Old Students' Association of the Central Technical College —commences the third year of publication of what has become an enterprising periodical. Some impressions of South Africa, by Prof. O. Henrici, F.R.S.; with the British Association in South Africa, by Dr. E. F. Armstrong; Mr. Freeman's account of the Witwatersrand, and Mr. Ashcroft's description of a lecture-table testing machine are all interesting contributions; and there are numerous first-rate illustrations.

A second edition of Dr. W. D'Este Emery's "Handbook of Bacteriological Diagnosis for Practitioners" has been published by Mr. H. K. Lewis under the new title "Clinical Bacteriology and Hæmatology for Practitioners." Though the general scope of the book remains unaltered, several additions have been made. The additions to the bacteriological portion are mostly concerned with the examination of materials from special parts of the body. The hæmatological portion is almost all new, and provides a practical guide to blood examinations, especially their application to the diagnosis of disease. The price of the new edition is 7s. 6d. net.

OUR ASTRONOMICAL COLUMN.

Astronomical Occurrences in July:—

July 2. 7h. 55m. to 8h. 52m. Moon occults γ Libræ (mag. 4·1).
,, 12h. Neptune in conjunction with the Sun.
5. 15h. 15m. to 16h. 15m. Moon occults ξ^2 Sagittarii (mag. 3·5).
6. 12h. 2m. Minimum of Algol (β Persei).
15. 3h. Mercury at greatest elongation (26° 39′ E.).
,, 8h. Mars in conjunction with the Sun.
,, 13h. 34m. to 14h. 31m. Moon occults Tauri (mag. 4·3).
,, Venus. Illuminated portion of disc = 0·760; of Mars = 1·000.
16. 7h. Ceres in conjunction with Moon. Ceres 0° 38′ S.
,, 14h. 10m. to 15h. 2m. Moon occults γ Tauri (mag. 3·9).
17. 0h. 40m. Moon approaches near to α Tauri (mag. 1·1).
18. 14h. 0m. Jupiter in conjunction with Moon. Jupiter 3° 21′ N.
19. 14h. 0m. to 16h. 40m. Transit of Jupiter's Satellite III. (Ganymede).
21. 1h. 14m. Partial eclipse of the Sun invisible at Greenwich.
24. 7h. Venus in conjunction with Moon. Venus 1° 23′ S.
29. 10h. 33m. Minimum of Algol (β Persei).

The Figure of the Sun.—In his discussion concerning the variable figure of the sun, which was referred to in these columns on January 18, Dr. Poor included the heliometer measures of the polar and equatorial diameters made by Messrs. Ambronn and Schur at Göttingen during the period 1890 to 1902, and found from them a confirmation of his previous conclusions.

The validity of the conclusions thus obtained is now questioned by Dr. Ambronn in No. 4, vol. xxiii., of the *Astrophysical Journal*. He points out that the variation, if it exists, cannot, according to the heliometer measures, exceed 0″·1 by any appreciable amount, and suggests that the measurement of the earlier photographic plates could not produce results accurate to this figure. Further, the measurements for 1894 furnish, for the more recent photographs, a proof that the oscillations adduced by Dr. Poor are not present.

After several other explanations Dr. Ambronn states that the most thorough investigation of the large amount of data collected at Göttingen has convinced him that this furnishes no justification for the suggested periodicity.

Discovery of Algol Variables.—Circular No. 117 from the Harvard College Observatory announces the discovery that the star H1236 (−30°.16169 C.DM.) is an Algol variable having a range of about one magnitude and a period slightly exceeding two days.

This variable was discovered by Mrs. Fleming on a plate taken in accordance with the multiple-image method described in a previous Circular, and by which it is hoped to discover all the short-period variables of magnitude 10·0 and brighter. In this method a dozen or more exposures, each of thirty minutes' duration, are made on the same plate moved by a small amount between each exposure.

Plates covering nearly the whole of the sky have now been obtained under these conditions, but only a few have so far been examined; nevertheless, this is the second Algol variable thus discovered by Mrs. Fleming.

An Interesting Minor Planet.—A recently-discovered minor planet (T.G.) proves to be of exceptional interest owing to its great mean distance.

Elliptical elements recently deduced by Dr. Berberich indicate that the mean distance of this asteroid is slightly greater than that of Jupiter, whilst its aphelion distance is nearly one unit beyond Jupiter's orbit. This discovery extends the limits of the asteroids so that they now include a distance of 1·1, the perihelion distance of Eros, and one of 6·0 units, the aphelion distance of the newly-discovered T.G. (the *Observatory*, No. 371).

Observations of Jupiter in 1903 and 1905–6.—In continuation of his record of the observations of Jupiter made during the years 1898–1902 inclusive, which was published in vol. lxiii. of the Monthly Notices, Mr. Denning now publishes (in vol. lxvi., No. 7) his results for the oppositions of 1903 and 1905–6.

During 1903, 1388 transits were observed, and of these 1188 were utilised in determining the rotation periods of the different zones as given in the present paper. The periods determined vary from 9h. 55m. 54·3s. for the N. temperate markings to 9h. 50m. 27·9s. for the equatorial; only the latter, however, gives a value less than 9h. 55m. 6·0s. In the 1905–6 apparition the mean period of rotation of the equatorial spots had increased to 9h. 50m. 32·7s., a value which is a few seconds in excess of that exhibited during the previous eight years. Mr. Denning also gives a number of notes on the apparition of 1905–6, dealing with the appearance and the variations of the different markings in detail. He also states that the best time for examining details on Jupiter is near the time of sunset.

The results of a number of micrometer measures of Jupiter's diameter and of the various belts, made at the Copenhagen Observatory during the recent opposition, are published in No. 4098 of the *Astronomische Nachrichten* by Dr. H. E. Lau.

Photometric Observations of Saturn's Satellites.—In No. 4098 of the *Astronomische Nachrichten* Dr. P. Guthnick publishes the results of a series of photometric observations of Saturn's six brightest satellites. The observations were made during the summer and autumn of 1905 at the Bothkamp Observatory, and the results for Tethys, Dione, Rhea, Titan, and Japetus are set out in tabular form so as to show the anomaly of the satellite and the corresponding apparent magnitude at the time of observation.

New Double Stars.—Forty-two newly-discovered double stars are described by the Rev. T. E. Espin in a catalogue which appears in No. 7, vol. lxvi., of the Monthly Notices (R.A.S.).

The stars are all situated between 30° and 40° N. declination, and the author gives in the catalogue the position (for 1900), the separation, the position-angle, and the magnitudes for each pair.

THE INTERNATIONAL CONGRESS OF ANTHROPOLOGY AND PREHISTORIC ARCHÆOLOGY.

THE International Congress of Anthropology and Prehistoric Archæology held its thirteenth session at Monaco, on the generous invitation of H.S.H. Prince Albert, "Protecteur" of the congress, on April 16–21. The place of meeting was the Grande Salle of the beautiful and now nearly completed Museum of Oceanography in course of erection by this Royal savant. More than 400 members, of whom upwards of thirty were British, assembled under the distinguished presidency of Prof. Hamy, of the Institute of France. To the sincere regret of all the members, the Prince was prevented by illness from opening the proceedings as he had intended, and, indeed, from being present at any of its meetings. He was, however, represented by his son, the Crown Prince, who, accompanied by the high officers of the Principality, attended at the opening seance and read the address which his father was unable to deliver, and from which we quote the following sentences:—"Je me félicite de ce que mes efforts pour le développement de l'anthropologie m'aient permis de réunir, sur ce point de l'Europe où les vestiges de l'Humanité remplissent la terre, une assemblée comme la votre choisie entre les savants de plusieurs pays avancés. Je suis certain, d'ailleurs, que votre Congrès laissera au domaine scientifique, des notions importantes sur l'histoire de notre espèce, car les travaux tout récents de MM. Boule, Verneau, de Cartailhac, de Villeneuve suffisent à lui constituer un monument. . . . C'est dans le Palais de la mer que l'Anthropologie trouve accueil aujourd'hui; et l'union de toutes les sciences alliées contre l'ignorance . . . que l'Océanographie peut déjà relier certaines conquêtes de la Science. Car l'étude des lois physiques et chimiques de la mer conduit a l'explication des remaniements géologiques de notre planète et des luttes successives entre les continents et les mers. Les progrès de la Biologie et de la Zoologie marines permettent d'utiliser les révélations de la Paléontologie pour constituer l'échelle des transformations infiniment nombreuses par lesquelles une force que nous appellons la vie a fait passer la matière organique. Et la Météorologie, si intimement liée avec l'Océanographie par des rapports incessants, nous aide à comprendre les fluctuations, les migrations, et la distribution géographique des êtres, y compris celle de l'homme. Parmi les Congrès précédemment réunis ici même, il en est un, celui de la Paix, dont j'évoquerai le souvenir aujourd'hui, parce que la Science et la Paix sont inséparables et que l'Anthropologie, comme tous les Sciences, doit contribuer au bien-être des hommes. . . ." The congress was formally welcomed also by H.E. M. Ritt, the Governor-General of the Principality, in a most courteous speech, which was acknowledged by representatives of the foreign delegates, Sir John Evans replying on behalf of Great Britain. The inaugural address of the president on the objects of the congress, the importance of its work, and the present position of prehistoric archæology concluded the first day's proceedings.

By an ordinance of the congress, French is the only language permitted in verbal or written communications, a restrictive regulation, we believe, enforced at no other international convention. A proposition was, however, early submitted to the council at Monaco that other languages should be admissible, but it met with favour only so far as regards written communications, which, it was resolved, may now be presented also in English, Italian, or German. All verbal communications, however, must still be in French. This change concedes practically little; for while it may be easy to prepare and read a paper in a foreign language, it is extremely difficult to express on the spur of the moment, in a language with which one is not very familiar, exactly what one wishes to convey. The chief privilege of members is the right to express their views on questions before the congress, but this rule practically disfranchises all those unable to speak French. Considerable dissatisfaction was felt at the severity with which the regulation was enforced. Indeed, many foreigners thus compelled to speak in French were less intelligible even to those acquainted with that language than if they had been permitted to use their own tongue! It is sincerely to be hoped that at the next session, which has been fixed to meet in Dublin in 1909, this harsh bye-law will be entirely abrogated, and that members of all countries may be allowed, equally with their French colleagues, to address the congress in their own language.

The dominant subject of the second seance was the genuineness of the implements known as "eoliths." A series of mill-modelled flint nodules was exhibited, among which there was certainly a number closely resembling many Prestwichian types, but conspicuous by their absence were the decidedly purposeful and rationally usable Kentian forms. A small collection exhibited by Prof. Girod, obtained near Aurilliac, affirmed to be out of a bed of Tortonian (Miocene) gravels containing Hipparion, underlying a massive stratum of basalt, contained at least one "eolith" unquestionably of human manufacture. The occurrence was vouched for, by M. Rutot, of implements of a particular silex identical in form with those from Kent in pre-Glacial beds in Belgium in which no other silex pebbles of the same character and composition were present, and the manufacture and introduction of which could be due only to man. Prof. Ray Lankester submitted that he had recently placed on exhibition in the British Museum a considerable series of specimens selected from Prestwich's collection, all borer-like in form, too identical in shape and so obviously of rational utility for any possibility of their being the result of fortuitous natural collisions. The congress was, however, divided in opinion on the subject. At a later meeting a telegram from Prof. Schweinfurth, in Egypt, was read announcing full confirmatory evidence of the occurrence of eoliths in the Nile Valley. The most important part of the day's programme was the visit paid to the Grimaldi caves at the Red Rocks, between Mentone and Ventimiglia, the inspection commencing with the most easterly—the Grotte du Prince. This cave has been most systematically and scientifically explored by a trio of distinguished archæologists, Prof. Marcellin Boule, the Abbé de Villeneuve (director of the Archæological Museum of Monaco), and Prof. Verneau. With much trouble and no little risk to limb, the grotto-walls had been marked by labels and lines of paint to indicate the limits of the various horizons in correspondence with those on a diagram of a longitudinal section of the cave distributed to members. From an elevated crag the Abbé de Villeneuve gave an account of the method of excavation and of the discoveries made at the various levels, while Prof. Boule detailed the sequence of events from the geological and palæontological point of view. So lucid were both these demonstrations that no one could fail to carry away a perfectly clear comprehension of the original contents of the cave, and form their own opinion on the evidence for man's antiquity in this region afforded by its exploration. No human osseous remains were met with in this grotto, but worked implements occurred in abundance from the lowest to the highest layers. Those from the lowest beds, which were roughly worked and chiefly Mousterian in type, occurred in association with bones of *Rhinoceros merckii*, *Elephas antiquus* and hippopotamus, and with specimens of *Cassis rufa*, an Indian Ocean mollusc which may perhaps have been acquired by barter. The contents of this cave have been transported to the Archæological Museum in Monaco, and arranged with such care by the Abbé de Villeneuve in the order of succession of the various strata, and so accurately labelled, that it is impossible to overestimate the importance to anthropological science of this comparatively small collection.

The Barma (=Grotte) Grande next claimed attention under the special guidance of Prof. Verneau, by whom the greater part of its exploration had been carried out. As is well known, this cave yielded several human skeletons, all of the Cro-Magnon type, the most deeply interred lying in association with bones of the reindeer. Several of these have been left *in situ* preserved under glass; while in a small museum erected, close by the mouth of the grotto, at the expense of Sir Thomas Hanbury, are arranged the bones and other objects discovered in it. After a hasty visit to the Grotte du Cavillon the congressionists proceeded to inspect the famous Grotte des Enfants under the same excellent guidance. The two celebrated skeletons from the lowest *foyer* of this cave, the types of Verneau's negroid *Race Grimaldi*, are safely preserved in the Monaco Museum. These discourses *sub divo* were necessarily succinct, but they were supplemented by fuller addresses of extreme interest during the following forenoon by the Abbé de Villeneuve, Profs. Boule and Verneau, and M. Cartailhac, under whose joint authorship a beautifully illustrated volume on the results of their exploration of these caves will shortly be published by the generous provision of the Prince of Monaco.

The next day's programme was reserved specially for papers on the engravings and frescoes on the walls of prehistoric caverns. The Abbé Breuil presented a communication on the process of the evolution of art during the Reindeer age, a *résumé* of a large work on which he is engaged, resulting from his laborious copying of the wall pictures of many caverns in collaboration with his colleagues Cartailhac, Capitan, Peyrony, and Bourrinet. The most important as well as most attractive item, however, was the exhibition by Dr. Capitan of a long series of lantern-slides of mural, engraved, and polychrome pictures—the latter in colour—most carefully copied by himself, the Abbé Breuil, and their associates named above, under the most trying and difficult conditions in the grottoes—more frequently than not far in their dark, damp, and cramped recesses—of Mas-d'Azil, Combarelles, Marsoulas, Bernifal, Les Eyzes, de Freye (Dordogne), la Mouthe, Altamira, Font de Gaume, de Teyjat, La Greze, and others. The number and variety of subjects depicted indicates powers of accurate observation and a mastery of hand in the arts of sculpture and drawing at that early age which are really astonishing, and it is evident that this wonderful capacity for art was the common heritage of Palæolithic man in all parts of Europe. *Rhinoceros merckii* and some dozen other extinct quadrupeds appear to have been his favourite studies. *Bison priscus*, however, was the species most frequently and most characteristically represented, being perhaps the commonest or the most dreaded member of his fauna. The human figure was less frequently, and always rudely, portrayed, and usually with monstrous or grotesque faces, suggesting that actors in some ceremonial were intended to be depicted in masks, recalling the dance-masks of the Chiriqui and Arizona Indians. Further papers on the same theme occupied also a great part of the following morning's sitting, at which the most interesting exhibition was a series of burins and scrapers of flint from the Grotto of Eyzes, exquisitely manufactured of every degree of fineness—some of them worked at both ends—to serve the manifold purposes of the artist. They were unquestionably the very tools by which the wall pictures beside them had been executed. With the exception of a short note by Dr. Arthur Evans (who on rising was very warmly greeted by the congress), on the Ægean, Minoan, and Mycenæan epochs, the remainder of the communications on the day's programme dealt with the Bronze and Iron age in Europe.

The sitting of the forenoon of Saturday, April 21, was given up chiefly to the archæology of northern Africa. The most important communication was M. Flammaud's, on his discovery in the Sahara of megalithic monuments of new shapes and of peculiar sculpture, and on the numerous evidences he had obtained of contact between the interior of Lybia and Egypt in the Neolithic age. The afternoon was spent on an excursion through beautiful scenery *viâ* the well-known *Tropaea Augusti* at La Turbie to the mysterious prehistoric entrenchments occupying the summit of Mont Bastide, as that of many of the other foot-hills of the Maritime Alps. The congress assembled on Sunday afternoon for the formal closing ceremonies usual on such occasions, the Prince of Monaco being again represented by his son, who, at the palace previous to the meeting, had, on his father's behalf, conferred the decoration of St. Charles on the presidents, the secretaries, and several of its more distinguished members, of whom Sir John Evans received the cross and ribbon of the Order.

Several social entertainments were given during the week "en l'honneur des congressistes," including, besides a reception at the palace, an evening performance of *Méphistofèles* and a *matinée* concert, both in the beautiful Casino Theatre.

For those—and they proved a goodly company—who could spare the time, a whole-day excursion, under the able leadership of M. Paul Goby, to the prehistoric monuments—dolmens, tumuli, and entrenchments—in the neighbourhood of Grasse was arranged by the excellent committee of organisation as a pleasant termination to a very successful and profitable session of the congress.

SUMMER TEMPERATURES OF THE NORTH SEA.

THE "Bulletin Trimestriel" of the International Council for the Exploration of the Sea, for the period July to September, 1905, has just been issued. As the observations are for the summer months, they are naturally more numerous than in other seasons of the year, and an immense amount of material is dealt with. The increase in the number of surface observations, and the extension of the area from which they have been obtained, are specially noteworthy; a plate of nine charts showing the variations of mean temperature in the North Sea for ten-day periods, from July 1 to September 30, 1905, is added to the usual quarterly maps. These charts have been prepared by dividing the area into squares of 1°, and ½° close to the coast, and the results checked by mean values from Dutch observations, worked up by a different method.

The sections drawn from the observations of the special steamers sent out by the different countries are very numerous in the narrower seas, forming a close network in the Baltic and the North Sea. A line north-eastward from Scotland defines the conditions across the northern entrance to the North Sea, but it is unfortunate that, except for some very useful lines running seaward from the coast of Ireland, and one section from Iceland to Færöe, information from the western section of the area is somewhat deficient, notably in the Færöe-Shetland Channel. It would be a great matter if observations in the depth could be carried further seaward to the southwest of the British Isles with the view of ascertaining the precise limit to which waters of Mediterranean origin penetrate northward, and in this connection an increase in the number of gas samples analysed would be of value.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The following is the text of the speech delivered by Prof. Love in presenting Prof. J. Milne for the degree of D.Sc. *honoris causa* at the Encaenia on June 20:—

In terrae motibus cognoscendis nemini profecto cedit Ioannes Milne. Hic ille est qui nova eademque plurima quaerendi instrumenta commentatus, quibus vim terrae motuum longinquis in locis redundantem emetiretur, ostendit tribus quibusdam momentis rem agi: duobus enim tremoribus medium terrae globum concutientibus succedere tertium latius patentem et in summo volitantem, sicut undam mare supereminentem. His repertis illud etiam consecutus est ut interioris terrae naturam et compagem certius cognosceret. Nullas profecto regiones non peragravit vir acerrimus, dum telluris superficiei studet, praecipuam vero laudem adeptus est quod rei publicae Iaponicae viginti annos inservit, Geologiae doctor insignis, fodinarum publicarum curator peritissimus. Ibi etiam sexcentas stationes disposuit omnia quae ad terrae motus pertinent et observantium et litteris mandantium. His etiam diebus patriae redditus in insula Vecti tale laboratorium constituit vir strenuus, eorum antesignanus qui hanc sectam secuti id agunt ut omnibus in terris eandem ipsi diligentiam praestent. Tantis tot strenuorum virorum laboribus nonne id aliquando fieri potest ut de caecis horum motuum causis paullo certiores fiamus?

CAMBRIDGE.—The Quick professorship of biology is vacant. The professor is to devote himself to the study of the Protozoa, especially such as cause disease. The stipend is 1000*l.* a year. The election will take place on July 26. Candidates are to send their names and references to the Vice-Chancellor by July 19.

Mr. R. A. Herman and Mr. H. W. Richmond have been appointed university lecturers in mathematics.

The Raymond Horton-Smith prize, for an M.D. thesis "On Changes in Sensation Associated with Gross Lesions of the Spinal Cord," has been awarded to Mr. H. Theodore Thompson, of Christ's.

The Gordon-Wigan prize of 50*l.* for a research in chemistry has been awarded to F. E. E. Lamplough, Trinity.

EARL CARRINGTON, President of the Board of Agriculture, will open the new buildings at the South-Eastern Agricultural College, Wye, and distribute the diplomas and prizes, on Wednesday, July 18, at 3.15.

THE Court of the University of Manchester has decided to confer the following honorary degrees:—D.Sc. on Prof. Emil Fischer, professor of organic chemistry in the University of Berlin, and on Prof. Adolf von Baeyer, professor of organic chemistry in the University of Munich; M.Sc.Tech. on Mr. Ivan Levinstein, and M.Sc. on Mr. James Grier, lecturer in pharmacognosis.

PROF. A. MELVILLE SCOTT, late 1851 Exhibition scholar from the University of Toronto, has resigned his position as professor of physics and electrical engineering at the University of New Brunswick to accept the office of superintendent of schools for the city of Calgary, Alberta. His successor will be Prof. W. H. Salmon, a graduate of Cambridge, now of King's College, Windsor, N.S.

NEW science buildings, built and equipped at a cost of 7000*l.*, were opened at Repton School on the occasion of the speech day, June 21, by Sir Oliver Lodge, F.R.S. The buildings are largely the result of the munificence of Lord Burton, until recently the chairman of the governing body. In the course of his address, Sir Oliver Lodge spoke of the importance of the study of science, and particularly of astronomy, in order that a better conception of the universe, of its magnitude, and man's place in it might be obtained.

IT is announced in *Science* that the Woman's College of Baltimore has now received gifts amounting to 116,000*l.* Of this amount 100,000*l.* was needed to clear the college of debt, and 16,000*l.* will be added to the endowment fund. Mr. Andrew Carnegie gave 10,000*l.*, the Massey estate 10,000*l.*; other gifts range from small amounts to 6000*l.* We learn from the same source that Governor Higgins has approved a Bill appropriating 16,000*l.* for a school of agriculture at St. Lawrence University, with an additional 2400*l.* for maintenance. This school, it is understood, will be managed in cooperation with the authorities of the State College of Agriculture at Cornell University. By the will of Catherine L. R. Catlin, of New York, 2000*l.* is left to New York University.

IN the House of Lords on Monday Lord Barnard asked the President of the Board of Agriculture whether he has been able to consider the representations made to the secretary of the Board, on December 5, 1905, by a deputation from universities, colleges, and agricultural institutions, and whether there is any prospect of an increased grant to such institutions. In the course of his reply, Earl Carrington said no money could be better spent than that which is applied to helping farmers to meet the fierce and growing competition which they have to encounter from all sides. Some time ago 4500*l.* was voted towards this object, and in 1906 the vote has risen to 11,500*l.* The sum is small, it is true, when compared with the amounts voted in other countries, but the country has received the full value of the grant owing to the cordial cooperation and good work of the different county councils. He suggested that some inquiry should be held into the system of agricultural education. There has been no inquiry since 1888—nearly twenty years ago. If it should appear that there is good ground for an increase of grant, those who advocated such an increase would find their hands strengthened very considerably.

A MEETING of university extension students and others is to be held at Cambridge on August 2–28. The principal subject of study will be the eighteenth century, especially the period 1714–1789. Among the lectures arranged, the following, dealing with subjects of science, may be mentioned:—Cloud problems in astronomy, by Mr. A. W. Clayden; a total eclipse of the sun, by the Rev. T. E. R. Phillips; great astronomers of the eighteenth century, by Mr. Arthur Berry; the Milky Way and the clouds of Magellan, by Mr. A. R. Hinks; the dawn and progress of modern geology, by Dr. R. D. Roberts; great botanists of the eighteenth century, by Prof. W. B. Bottomley; great zoologists of the eighteenth century, by Mr. L. A. Borradaile; and the beginnings of the steam engine, by Mr. E. K. Hanson. Besides these purely scientific lectures, others of interest to students of the methods of science occur in the programme, such as those by Mr. H. Yule Oldham on the teaching of geography, and by Mr. E. A. Parkin on hygiene in schools. Practical courses in chemistry and botany, primarily for teachers, will also be held. Forms of entry and further information will be supplied by the Rev. D. H. S. Cranage, Syndicate Buildings, Cambridge.

IN the May issue of the Transactions of the Oxford University Junior Scientific Club is a thoughtful paper by Mr. M. H. Godby on the place of natural science in education. The spirit of the paper provides an encouraging sign of appreciation of the value of scientific studies, and serves to show that a generous recognition of the importance of a training in the methods of science is producing a beneficial effect upon the present generation of Oxford students. Mr. Godby first indicates the influence on British education exerted by Bacon in directing the attention of speculative thinkers to the importance of founding theories on knowledge gained from the senses, and subsequently refers approvingly to Herbert Spencer's insistence upon the necessity of training the body and the value of a scientific education. As indicative of modern tendencies at Oxford one or two of the writer's remarks may be cited:—"The man of science perhaps alone of all men understands and appreciates the value of working hypotheses, even when they are wrong." "A great charm, too, of science is that one can always appeal against the decisions of tutors and authorities to Nature herself, and so there is produced a freedom from the awe of authority which must tend to develop self-respect and to encourage independence and originality." "Science is more capable of arousing the interest of its students than other subjects. There is a sort of spirit of antagonism, a feeling that you are pitting yourself against Nature and trying to unravel her secrets, and this feeling is just what will always appeal to the sporting instincts of English boys." It is satisfactory to find that young Oxford is alive to the responsibility of the University for the growth of scientific knowledge.

REPLYING to a question in the House of Commons on Tuesday as to the action which the President of the Board of Education proposes to take on the report of the Departmental Committee on the Royal College of Science, &c.; and as to whether any reorganisation of the University of London is contemplated, with a view to the association with it of the proposed Technological College, Mr. Lough said:—The Board is at present engaged in the preparation of a scheme for the establishment of a new institution on lines corresponding as closely as possible to those recommended by the departmental committee. The Board agrees with that committee in regarding it as of first importance that there should be no delay in the organisation of the institution, and with the recommendation of the committee that its relation to the University of London should, in the first instance, be that of a "school of the University"—a recommendation in which the senate of the University has informed the Board that it concurs. In considering the constitution of the new institution the Board has had under consideration the suggestion of the departmental committee (No. 94, p. 27) that, without delaying the commencement of the new institution's work, a Royal Commission should be appointed to consider whether changes could advisedly be made in the character and constitution of the University which may make it desirable and possible to amalgamate the two institutions. It has also had before it the resolution of the senate of the University deprecating the appointment of such a Royal Commission within so short a period after the reorganisation of the University, and expressing the desire that opportunity should be afforded for conference between the Board and the Senate as to any changes of the kind suggested. In the course of the conference, which took place on March 9, between the Board of Education and a deputation from the University senate upon these matters, the suggestions thrown out by the University deputation seemed to be contingent, practically, upon the incorporation of the new institution within the University. As this would necessitate a prolonged delay in the starting of the institution, which the committee specially recommended should be avoided, the Board has found it impracticable to proceed on those lines, but is hastening as much as possible the preparation of a draft charter on the lines of the report of the departmental committee.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 5.—"On a Method of Obtaining Continuous Currents from a Magnetic Detector of the Self-restoring Type." By L. H. **Walter.** Communicated by Prof. Ewing, F.R.S.

Magnetic detectors for wireless telegraph purposes have proved satisfactory for telephonic reception, but have not hitherto been capable of furnishing continuous currents suitable for use with recording instruments. The author has devised a new form of magnetic detector which is capable of furnishing both continuous and alternating currents, the former for recording purposes and the latter for telephonic reception. The apparatus consists of a form of differential dynamo, having two similar armatures on the same shaft. The armature cores are of iron or steel wires. The electromotive forces generated by the two armatures are opposed to each other and normally balance, so that no potential difference is detectable at the commutator brushes. Oscillations set up in the receiver aërial as a result of signals are led through the magnetic wire forming one armature core, causing it to take up a higher induction, and thus disturbing the balance, a continuous current being obtainable from the brushes so long as the oscillations persist. This current is utilised for actuating the recording instrument or relay. For simultaneous reception of the signals on the telephone, the alternating current generated as a result of the action of oscillations is taken off, by means of slip-rings and brushes, before it is commuted into unidirectional current.

May 17.—"Some Stars with Peculiar Spectra." By Sir Norman **Lockyer,** K.C.B., F.R.S., and F. E. **Baxandall.**

This paper relates to a few stars the spectra of which show certain peculiarities that make them not altogether conformable to any common type. The most notable of these stars are α Andromedæ, θ Aurigæ, α Canum Venaticorum, and ϵ Ursæ Majoris. They are all on the descending side of the Kensington curve of stellar temperature, the first three being of the Markabian type and the last of the Sirian type. A short account is given of the spectrum of each of these stars.

α Andromedæ has recently been found by Slipher, of the Lowell Observatory, to be a spectroscopic binary with a period of about 100 days. Prior to this, an investigation of the various Kensington spectra of α Andromedæ, taken in the years 1900–4, appeared to indicate slight changes in the relative intensity, position, and definition of some of the lines in the various photographs. There does not, however, seem to be any regularity in these changes, either in the lines themselves or in the manner in which they are affected, so that it has not been possible to come to any conclusion as to their real significance. Additional photographs will be necessary to test whether the changes in the spectrum bear any relation to the period established by Slipher. The spectrum of α Andromedæ also shows a set of well-marked strange lines which do not occur in any other celestial spectrum, and for which records of terrestrial spectra afford no satisfactory clue as to origin.

θ Aurigæ and α Canum Venaticorum show several strange lines nearly identical in the two spectra, but entirely different from the strange lines of α Andromedæ. No terrestrial equivalents have been found for these stellar lines.

In ϵ Ursæ Majoris, the chief deviations from the Sirian type are the weakening of the silicium (group ii.) lines and the strengthening of the enhanced lines of chromium.

Entomological Society, June 6.—Mr. F. Merrifield, president, in the chair.—*Exhibits.*—Specimens of *Lomechusa strumosa*, F., taken with *Formica sanguinea* at Woking on May 26 and 29: H. St. J. **Donisthorpe.** Only two other British examples are known, one taken by Sir Hans Sloane on Hampstead Heath in 1710, the other found by Dr. Leach, in the early part of the last century, while travelling in the mail-coach between Gloucester and Cheltenham.—A case to illustrate a large number of the life-histories of Coleophorids, notes on which have appeared in the society's Proceedings or in the Entomological Record: H. J. **Turner.**—A few butterflies from Majorca, captured between April 8 and April 20: H. **Lupton.**—A specimen of *Crambus ericellus*, Hb., taken at Loughton, Essex, August 8, 1899, not previously recorded from further south than Cumberland; two specimens of *Nola confusalis*, H.S. ab. *columbina*, Image, taken in Epping Forest, May 5: S. **Image.** The first examples of this aberration were taken by the exhibitor at the same locality, May 22, 1905, and a specimen of *Peronea cristana*, F., the ground colour of upper-wings abnormally black, even more intensely black than in the ab. *nigrana*, Clark, also taken in Epping Forest, August 19, 1905.—The type of *Spathorrhamphus corsicus*, Marshall, from Vizzavona, Corsica: J. H. **Keys.** This fine Anthribid was supposed by some coleopterists to have been an accidental importation into the mountainous regions of the island, but was no doubt endemic. Mr. G. C. Champion remarked that he had taken *Platyrrhinus latirostris*, in numbers, at the same locality, in the beech and pine forests (*Pinus laricio*) along the line of railway, above the tunnel.—Specimens of African Pierinæ found by Mr. C. A. Wiggins on February 2 settled on damp soil near the Ripon Falls, Victoria Nyanza, and caught, to the number of 153, at a single sweep of the net: Dr. F. A. **Dixey.** Eight species were represented; the examples were all males, and, with one exception, belonged to the dry-season form of their respective species.—Notes on Natal butterflies, received from Mr. G. H. Burn, of Weenen, and the four individuals of *Euralia wahlberghi*, Wallgr., and *E. mima*, Trim., captured by Mr. G. A. K. Marshall, near Malvern, Natal: Prof. E. B. **Poulton.** Prof. Poulton then exhibited Mr. Marshall's latest demonstration of seasonal phases in South African species of the genus Precis, the proof by actual breeding that *P. tukuoa*, Wallgr., is the dry-season phase of *P. ceryne*, Boisd. Prof. Poulton further showed 325 butterflies captured in one day by Mr. C. B. Roberts, between the eighth and tenth mile from the Potaro River, British Guiana, and directed attention to the preponderance of males.—*Papers.*—Some bionomic notes on butterflies from the Victoria Nyanza region, with exhibits from the Oxford University Museum: S. A. **Neave.**—The habits of a species of Ptyelus in British East Africa: S. L. **Hinde,** illustrated by drawings by Mrs. Hinde.—(1) Mimetic forms of *Papilio dardanus* (*merope*) and *Acraea johnstoni*; (2) Predaceous insects and their prey: Prof. E. B. **Poulton.**—Studies on the Orthoptera in the Hope Department, Oxford University Museum, i., Blattidæ; and a note on a feeding experiment on the spider *Nephila maculata*: R. **Shelford.**

Physical Society, June 8.—Prof. J. Perry, F.R.S., president, in the chair.—The solution of problems in diffraction by the aid of contour integration: H. **Davies.** The method adopted is to obtain a solution for unbounded space as a contour integral. The special boundary conditions are then accounted for by adding terms to the previous expression. When the complete expression has been obtained it is then evaluated in the form of a series by the aid of Cauchy's residue theorem.—J. Goold's experiments with a vibrating steel plate: **Newton** and Co. The phenomena peculiar to this plate may be classified under two heads:—(1) beats, simultaneously audible and visible; (2) dispersion figures. In addition to these, vortex-vibration, resonance-effects, and many other experiments may be exhibited by using suitable clamps, &c. The dispersion figures are due chiefly to the interaction of two systems of vibrations of the same pitch working at right angles to each other.—Fluid resistance: Colonel R. **de Villamil.** Prof. Hele-Shaw, in a paper on the motion of a perfect fluid, remarks that one of the most perplexing things in engineering science is the absence of all apparent connection between the higher treatises on hydrodynamics and the vast array of works on practical hydraulics. The reason for this appears to be the immense difference between the flow of an actual liquid and that of a perfect one, owing to the property of viscosity. According to the author, this is not the only reason. There appear to be two fundamental difficulties to be got rid of before they can be reconciled. Engineers assume that a liquid can be "pushed" in any rectilinear direction. This, though a very popular notion, is not correct. The other difficulty is the assumption that in a perfect fluid there can be no resistance of any kind to any body moving in it at any velocity. It is only in an infinite ocean of perfect fluid that there would be no resistance.

Society of Chemical Industry (London Section), June 11.—Mr. A. G. Salamon in the chair.—Purifying and stabilising guncotton: Dr. R. **Robertson.** This communication—published by permission of the War Office—deals with large-scale experiments having for their object the best means of obtaining a pure and stable guncotton by a boiling process. For the elimination of impurities from the guncotton and the rapid attainment of a stable product, boiling in dilute acid at the beginning of the process is superior to an alkaline treatment, which has the additional disadvantage of tending towards an undue hydrolysis of the ester itself. The acid hydrolysis must not be unduly curtailed, or elimination of the impurities will be rendered difficult.—The determination of indigotin in commercial indigo and in indigo-yielding plants: C. **Bergtheil** and R. V. **Briggs.** The authors have investigated the standard methods of estimating indigotin in commercial [illegible]. It is shown that all the methods dealt with are trustworthy when applied to pure indigotin, but that in application to commercial indigo the impurities present lead to errors; only those methods depending on the oxidation or reduction of solutions of sulphonated indigo are found to be applicable in this case.—Recent progress in the cement industry: B. **Blount.** The author compares the condition of the cement industry in 1886 and at the present time, pointing out that at the former date somewhat crude methods of manufacture were in use, whereas now improved processes are in operation under scientific control. The world's production of Portland cement has increased from 2,500,000 tons to some 11,000,000 tons in the last twenty years, and the centre of the industry has shifted from Europe to the United States. The second part of the paper deals with improvements in controlling the quality of cement in the works and by the user which have been made during the last twenty years.

Royal Meteorological Society, June 20.—Mr. Richard Bentley, president, in the chair.—The mean prevalence of thunderstorms in various parts of the British Islands during the twenty-five years 1881–1905: F. J. **Brodie.** The author gives the mean number of days on which thunderstorms, or thunder only, occurred in each month, each season, and in each year at fifty-three stations situated in various parts of the United Kingdom. July is the month with the largest number of thunderstorms over Great Britain as a whole, and August at some places in the north of Scotland and north-west of England, while June is the stormiest month at nearly all the Irish stations. For the whole year the largest number of thunderstorms is over the northern and eastern parts of England, where more than fifteen occur, while there are less than five in the west and south of Ireland and at most places in the north of Scotland. The summer distribution of thunderstorms is very similar to the annual distribution, while the winter distribution is quite different, when the largest numbers occur along the west coasts of Ireland and Scotland and extreme south-west of England.—Typical squall at Oxshott, May 25, 1906: W. H. **Dines.** During the morning there was a steady wind from the south-west of more than ten miles per hour until 11 a.m., when there was some falling off for fifteen minutes, then a rise to more than twenty miles per hour, accompanied by a sudden increase of barometric pressure and a fall of a few hundredths of an inch of rain. After the squall the wind dropped suddenly, and there was almost a dead calm for about twenty minutes. The author, who was flying a kite at the time, gave some account of the changes in the wind at a considerable altitude above the earth. At 11.26 a.m. the squall struck the kite, which was then at a height of 2400 feet. Two minutes later the velocity at the kite had risen to fifty-eight miles per hour, and the wire broke under a strain of 180 lb. Three minutes later the kite fell at a spot $2\frac{1}{4}$ miles distant from Oxshott.

EDINBURGH.

Royal Society, June 4.—Dr. R. H. Traquair, F.R.S., vice-president, in the chair.—Recherches sur la Glauconie: Drs. Léon W. **Collet** and Gabriel W. **Lee.** The paper contained a careful examination of the chemical composition of the mineral glauconite, which was found in what Sir John Murray called, in the *Challenger* expedition reports, the blue and green muds of the ocean beds. It was shown that glauconite was ferric silicate, and not ferrous silicate, as had been stated by Calderon and Chaves, of Madrid.—A rare dolphin, *Delphinus acutus*, recently stranded on the coast of Sutherland: Sir William **Turner,** K.C.B. There were very few previous records of this species having been found in the vicinity of the Scottish shores.—Contributions to the craniology of the people of the Empire of India, part iii., natives of the Madras Presidency, Thugs, Veddahs, Tibetans, and Seistanis: Sir William **Turner,** K.C.B. Among the skulls exhibited were those of some of the famous Thugs who practised highway murder with such skill and secrecy as to elude for long the authorities in India. Their crimes were regarded by themselves as a religious duty. The skulls were all well formed, with no resemblance to what some have called a criminal type. Of the two Tibetan skulls, one was of Mongolian type, but the other was that of a Kham warrior from eastern Tibet, and its dolichocephalic form supported Grierson's theory of the Tibeto-Burman stock. The three skulls from Seistan, in south-west Afghanistan, belonged to two types, one approximating to the Afghan and the other to the Beluchistan type.—Interpolation for a table of fractions, with a notice of synthetic division and its use: Dr. James **Burgess,** C.I.E. All fractions with denominators under 100 and numerators less than 50 were tabulated in order of magnitude. The formulæ $q=n/d=(n+q)/(d+1)$ suggested a simple and rapid way of dividing by any number differing by unity from a simple multiple of 10, 100, 1000, &c.—The length of the normal chord of a conic: Prof. **Anglin.**—The hydroids of the Scottish National Antarctic Expedition: James **Ritchie.** The collection brought home by the *Scotia* was very large. There were forty-five specimens giving one new genus, nine new species, and several new varieties. The new genus had been named Brucella, in honour of Mr. W. S. Bruce. The *Scotia* collection also extended our knowledge of the geographical range of hydroids, especially towards the Antarctic regions.—Prof. D. J. **Cunningham** exhibited a photograph taken from a bridge of a large number of salmon resting in the Corrib River, Galway.

Paris.

Academy of Sciences, June 11.—M. H. Poincaré in the chair.—Some points relating to the study of the specific heats and the application to these of the law of corresponding states: E. H. **Amagat.** It has been shown in a previous note that the specific heat at constant volume, following an isotherm, undergoes a discontinuity at each intersection of this isotherm with the saturation curve. In the present paper the question is discussed as to whether this discontinuity persists in the neighbourhood of the critical point.—The products of the reaction, at a high temperature, of sodium isobutylate and propylate of camphor: A. **Haller** and J. **Minguin.** Camphor, heated at about 230° C. with sodium isobutylate, gives sodium isobutyrate and isobutylcamphol, various derivatives of which have been prepared. The general action of sodium propylate on camphor at a high temperature is similar to that of sodium isobutylate, but the yields are not so good.—Some attempts made in the German Navy to utilise photography in voyages of exploration: A. **Laussedat.**—The orthography of the word *caesium*: M. **de Forcrand.**—Vaccination against tuberculosis by the digestive tracts: A. **Calmette** and C. **Guérin.** The authors summarise the views put forward by them in previous papers as to the exact mechanism of tuberculous infection, laying stress upon the fact that the tubercle bacilli are probably absorbed by the digestive tube, and find their way to the lungs indirectly, and not directly as usually assumed. It has been found that it is possible to vaccinate young calves by the simple intestinal absorption of tubercle bacilli modified by heat, and that this method of vaccination is quite free from danger.—Remarks by M. Emile **Roux** on the preceding paper. The results of experiments carried on by M. Roux since November, 1905, are in general agreement with those described in the preceding paper; it is possible to give immunity to cattle against tuberculosis by means of the digestive tracts.—The problem of the elliptical cylinder: Mathias **Lerch.**—Specific inductive power and conductivity. Electrical viscosity: André **Broca.**—The aurora borealis: P. **Villard.** A complete theory of the aurora is given, and, using this as a guide, it is shown that the characteristic features of the aurora can be reproduced by means of a large spherical bulb placed between the conical poles of an electromagnet.—The liquefaction of air by expansion with external work: Georges **Claude.** Details are given of the arrangements for "compound" liquefaction, this constituting an advance on the previous results. Whereas spontaneous liquefaction under atmospheric pressure gave the author only 0·2 litre of liquid air per horse-power hour, the second step, liquefaction under pressure, gave 0·66 litre per horse-power hour, whilst the compound liquefaction raises the yield to 0·85 litre per horse-power hour.—The magnetic properties of the compounds of boron and manganese: Binet **du Jassonneix.** Of the two manganese borides MnB and MnB_2, the former alone possesses magnetic properties, and the permeability of ingots of manganese boride obtained from the electric furnace is proportional to the amount of MnB present.—The iodomercurates of magnesium and manganese: A. **Duboin.** These salts give rise to solutions of densities approaching 3·0, and various crystalline double iodides were separated and isolated.—The reduction of antimony selenide: P. **Chrétien.** The determination of the fusing points of mixtures of antimony and selenium in various proportions indicated the existence of three new compounds of selenium and antimony, SbSe, Sb_4Se_5, and Sb_4Se_4.—The attack of platinum by sulphuric acid: L. **Quennessen.** In the case of the sulphuric acid of the usual strength sold, it is the oxygen of the air which intervenes as the oxidising agent. In the absence of free oxygen with acids of high concentration, the necessary oxygen for the solution of the metal is furnished by the sulphur trioxide in solution in the acid.—The chlorination of wool: Leo **Vignon** and J. **Mollard.**—The estimation of albuminoid and gelatin materials by means of acetone: F. **Bordas** and M. **Touplain.** The authors have shown that egg-albumin, casein, and fibrin are completely insoluble in pure acetone. Diastases and peptones are also precipitated by acetone. In all cases the aqueous solutions separated by centrifugal action from the precipitate gave on analysis no trace of nitrogen, showing the separation to be complete. Details are given for the processes recommended for the analysis of butter, cheese, and milk.—Researches on the development of *Botrytis cinerea*, the cause of grey rot in grapes: J. M. **Guillon.**—Note on the bathypelagic Nemerteans collected by the Prince of Monaco: L. **Joubin.**—Impregnation and fertilisation: E. **Bataillon.**—The motility of the echinococcic scolex: J. **Sabrazès**, L. **Muratet**, and P. **Husnot.**—The graphitic schists of Morbihan: M. **Pussenot.**—The local winds in the neighbourhood of the Canaries: H. **Hergesell.**

DIARY OF SOCIETIES.

THURSDAY, June 28.

Royal Society, at 4.30.—Sex-determination in Hydatina, with some Remarks on Parthenogenesis: R. C. Punnett.—On the Julianiaceæ, a New Natural Order of Plants: W. B. Hemsley, F.R.S.—On Regeneration of Nerves: Dr. F. W. Mott, F.R.S., Prof. W. D. Halliburton, F.R.S., and A. Edmunds.—The Pharmacology of Ethyl Chloride: Dr. E. H. Embley.—The Alcoholic Ferment of Yeast Juice, part ii., The Co-ferment of Yeast Juice: Dr. A. Harden and W. J. Young.—Total Eclipse of the Sun, August 30, 1905, Account of the Observations made by the Solar Physics Observatory Eclipse Expedition and the Officers and Men of H.M.S. *Venus* at Palma, Majorca: Sir Norman Lockyer, K.C.B., F.R.S., and others.—Researches on Explosives, part iv.: Sir Andrew Noble, Bart., K.C.B., F.R.S.—Tidal Regime of the River Mersey as affected by the Recent Dredgings at the Bar, in Liverpool Bay: J. N. Shoolbred.—The Refractive Indices of Water and Sea-water: J. W. Gifford.—The Ionisation produced by Hot Platinum in Different Gases: O. W. Richardson.—The Action of Plants on a Photographic Plate in the Dark: Dr. W. J. Russell, F.R.S.—On the Ultra-Violet Spectrum of Ytterbium: Sir William Crookes, F.R.S.—On the "Kew" Scale of Temperature and its Relation to the International Hydrogen Scale: Dr. J. A. Harker.—Note on the Production of Secondary Rays by "α" Rays from Polonium: W. H. Logeman.—The Hygroscopic Action of Cotton: Prof. Orme Masson, F.R.S., and E. S. Richards.

THURSDAY, July 5.

Chemical Society, at 8.30.—Saponarin, a New Glucoside, Coloured Blue with Iodine: G. Barger.—The Constitution of Umbellulone: F. Tutin.—Electrolytic Oxidation: H. D. Law.—The Action of Ethyl Iodide and of Propyl Iodide on the Disodium Derivative of Diacetylacetone: A. W. Bain.

CONTENTS.

THURSDAY, JULY 5, 1906.

SOME RECENT PHILOSOPHY.

(1) *The World's Desires, or The Results of Monism.* By Edgar A. Ashcroft. Pp. xii + 440. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1905.) Price 10*s.* 6*d.* net.

(2) *The Scientific Temper in Religion, and Other Addresses.* By the Rev. P. N. Waggett. Pp. xii + 286. (London: Longmans, Green and Co., 1905.) Price 4*s.* 6*d.* net.

(3) *The Reconstruction of Belief.* By W. H. Mallock. Pp. xii + 314. (London: Chapman and Hall, Ltd., 1905.) Price 12*s.* net.

(4) *The Unit of Strife.* By E. K. Garrod. Pp. v + 194. (London: Longmans, Green and Co., 1905.) Price 3*s.* 6*d.* net.

(1) THE first of these volumes need not detain us. The work is dedicated, by permission, to Prof. Haeckel, and Mr. Ashcroft emulates his master in the range and discursiveness of his work. One would have thought that the "Riddle of the Universe" had settled, at least for a modern monist or realist, the majority of the topics here discussed unless, indeed, the presence of two books in many ways so similar is a part of the riddle to which it is desirable to direct attention. We note that Mr. Ashcroft is able to tell us that "the system of Plato displays few living qualities."

(2) Mr. Waggett's work is one of the very best of its type, viz. of the books that seek to reconcile religion and science. The author's chief characteristics are his boldness and his anxiety that there should be no nervousness or hysteria among the religious-minded when their faith is confronted by the facts of science. "We ought to be positively alarmed at any appearance of unbroken agreement between religion and science." "There is not in the Bible ever any contrast between reason and faith. . . . In point of fact, faith is a kind of knowledge, and not only so, but it is the model and type of all sure knowledge." There is no theological interest, Mr. Waggett maintains, in weakening any particular theory about the physical world. In regard to the gulf between the organic and the inorganic—the classical treatment of which is a famous chapter in "Natural Law in the Spiritual World"—Mr. Waggett has already made terms even with Mr. Burke's radium experiments on sterilised bouillon, experiments on which, at the same time, he passes some acute criticisms. "Our faith would not be shaken if the gulf which lies for thought between organic and inorganic matter were for thought to be bridged; for it has never rested upon this or any other interval." Mr. Waggett is suggestive, too, in dealing with the problem of freedom, pointing out that without freedom there can be no error and no knowledge.

(3) A small part of Mr. Mallock's work was dealt with in the "Notes" columns of this journal when it appeared in the pages of the *Fortnightly Review*. Both the clerical and the philosophical attack on the negative conclusions of science have failed, Mr. Mallock declares. On the other hand, current science has no influence on practical life, and all that is best in modern civilisation is to be traced to the three beliefs of theism, viz. the belief in human freedom, in God, and in human immortality. But if the principles of science be only carried to their logical conclusion, it is clear that everything that now happens must have been pre-arranged in all previous molecular conditions of things, and that this pre-arrangement is due to mind and purpose. The last part of the work deals not unsuccessfully with the difficulties generally urged against a belief in the goodness of the Deity, and the author concludes his suggestive volume with forecasting the difficulties which Christianity has still to face—most of all, the difficulty of competing with a new religious eclecticism. Mr. Mallock is to be congratulated on a work which will undoubtedly add to his reputation.

(4) The strife of which the title of this work speaks is the struggle for existence. The title is the one ambiguity, perhaps the one defect, of what is, on the whole, a very clear and suggestive book. Its writer is concerned mainly with the problem that in man as compared with the lower creation "the quality of fitness to survive has in some way become modified"; "an agency has come into play which had not asserted itself on the same lines in the struggle for life before the appearance of man." What are the modification and the agency referred to? The answer seems to be that in man most clearly of all living things the unit in the struggle is not the individual, but the community, gradually expanding from the family to the tribe, the nation, the empire, and that in close correspondence with this development and expansion there has gone the increasing recognition of law and of some higher power, which is the kernel of all religion.

But this brief analysis almost does injustice to the closeness of the argument and the excellence of the illustrations by which the argument is enforced. The scientific analogies are not overdrawn—the great defect of some similar works not even in one amusing passage where the author compares the walls of Babylon to the external defences of the crustacean, and points out that at a more advanced stage of development protection is given rather by moving masses acting on the offensive, just as for the most part the vertebrate organisms have abandoned the methods of the crustaceans and of insects protected by a horn-like covering.

One statement on p. 90 appears somewhat inexact. The author, showing how an ideal may lose the power of expansion by being enclosed and case-hardened, writes thus:—"Thus to the Israelite, while they retained their lofty monotheistic conception, Jehovah became the Deity exclusively of their own race. He was the Lord of Hosts who warred always on their side against their enemies." On the whole it seems wise to distinguish some things which are here confused, the *henotheism* (as it is called) of the earlier period of Jewish history which regarded Jehovah only as one among many Gods, the one who fought on the side of the Israelites, and who ought to be worshipped by them; and, contrasted with it, the later and truly monotheistic ideal of the prophets, which emphasised the *solity* of Jehovah. It would, at any rate, be difficult to harmonise our author's account with any of the accepted readings of Jewish history, traditional or critical. Part of the page ought probably to be re-written.

TIDES AND WAVES.

A Practical Manual of Tides and Waves. By W. H. Wheeler. Pp. viii+201. (London: Longmans, Green and Co., 1906.) Price 7s. 6d. net.

THE author of this book is a well-known civil engineer, whose practice has been largely concerned with works on the sea coast and tidal rivers. The practical side of the subject treated has consequently required and received from him long and close study; his intention in this volume has been "to give as practical an account as possible, free from all mathematical demonstration, of the action of the sun and moon in producing the tides: and of the physical causes by which the tides are affected after their generation, and of their propagation throughout the tidal waters of the earth." To these subjects the principal portion of the work is devoted; in a comparatively short section the author deals also with wave phenomena, in a manner likely to be useful to practising engineers, and not lacking in interest to a much wider circle of readers. Mr. Wheeler has given much time and thought to the production of the work, and the bibliography of his subjects (contained in an appendix) indicates a wide range of reading. In the text itself a great mass of useful information and data is summarised; this is supplemented by several valuable appendices giving results of tidal and wave observations as well as formulæ of use in engineering practice. A good index makes reference easy to the principal features of the book, and adds much to its value to readers for whom it has been chiefly designed. In one particular the scheme of the author is open to criticism: he has aimed at making "the subjects dealt with in the separate chapters complete," and this has involved some repetition of statement. Probably the explanation is that in some cases papers prepared for separate publication have been embodied in the book; but although the repetition (as the author says) may have "been avoided as much as possible," his scheme for completeness in individual chapters necessarily involves it, and in a book such as this is the result is not altogether satisfactory. This is a small drawback, however, to a work of considerable merit that will undoubtedly be welcomed by the engineering profession as a book of reference bringing together within small compass a great mass of useful information drawn from widely-scattered sources.

A historical sketch of the development of tidal science is first given ranging from the work of Copernicus to that of Sir George Darwin and Mr. Moxly. Next come descriptions in popular language of "the making of the tides," the "propagation of the tidal wave," and the mean level of the sea and range of the tides. All these subjects are illustrated by facts and figures drawn from actual observations. The effect of wind and atmospheric pressure on the tides is considered at some length, as a matter of considerable importance to engineers. Mr. Wheeler has endeavoured to formulate a rule as to variations to be expected with a given force of wind and height of tide; and considers that roughly "the effect of a moderate gale is to raise or lower the tide according to its direction as many inches as it would rise in feet under normal conditions." He gives some striking instances of abnormal tides due to gales of long continuance, the heights attained in some cases exceeding the tide-table heights by six to eight feet. In December, 1904, for example, at Grimsby, the morning tide was raised nearly seven feet, and at Hull, as well as on the Thames, about five feet above normal level by a heavy gale from the north-west. An investigation is also made of the recorded observations of variations in tides accompanying variations in atmospheric pressure, and the conclusion is reached that "it is not possible to lay down any general law applying to all parts of tidal waters." Mr. Wheeler considers that "although variation in pressure may be a primary cause of the alteration in the height of tides . . . yet the wind is a safer and more ready guide for the immediate purpose of navigation."

The chapter dealing with "River Tides" is one of the most interesting in the book, and from the nature of the case is chiefly based on actual observations. Mr. Wheeler traces the progress of the ocean tidal wave up a river channel, and shows how the distance to which the wave action reaches depends on the condition of the channel and the depth of the low-water stream. He describes the "ponding back" of the current in the river by the advance of the tidal wave, and demonstrates the necessity for the duration of the flood tide in rivers being less than that of the ebb. The phenomena of "double flow" are explained, and a distinction made between the propagation of a tidal wave up a river and the tidal current. These movements of river water are accompanied by transport of material carried in suspension, and from the engineering side this is a question of great importance which Mr. Wheeler discusses fully.

Closely related to tidal currents are tidal "bores," which occur in certain rivers. These are very fully described by the author, who summarises the conditions necessary for the full development of a bore as follows:—A considerable rise of tide, a converging channel with a rising bed, the depth of water decreasing as the channel is approached, or a sand bar over which there is not sufficient depth of water to admit of the passage of the approaching tidal wave. Under these conditions, in place of a gradual rise of the water at the entrance to the river, the arrival of the tide is accompanied by a breaking wave with a crest several feet in height, which when formed advances rapidly up the channel. In the Tsien-Tang-Kiang River, China, the range of spring tides is about twelve feet at the mouth; but the tidal wave becomes compressed in advancing towards the head of the estuary, and reaches twenty-five feet in height at ordinary springs and thirty-four feet when an onshore gale is blowing. The bore is said to enter the river at the rate of 14½ miles an hour, and during the first hour the rise of tide is ten feet. Its approach can be heard for a distance of fourteen or fifteen miles. The Severn bore is too well known to need description. Its height has been estimated at three to four feet, and velocity at seven to eight miles an hour.

In another section the author deals with wave motion: first with wind waves and secondly with seismic and cyclonic storm waves. As a civil engineer, his chief interest is with the effects of wave motion upon harbour works, coast defences, and other constructions; but these chapters also give an excellent summary of the theory of deep-sea waves and the results of observations on their dimensions and speeds. Some of the facts recorded as to damage done by wave action are very striking. During the construction of Plymouth breakwater, blocks of stone weighing from seven to nine tons were carried over the top through a distance of 138 feet and deposited inside the breakwater. At Bilbao a solid block of the breakwater weighing 1700 tons was overturned. The partial destruction of the north pier at Tynemouth furnishes another illustration; in that case there can be no doubt that the depth below still-water level to which wave disturbance was likely to go in that locality had been considerably underestimated. As to earthquake and cyclonic waves, Mr. Wheeler has collected a large amount of information of an interesting character, and he deals at some length with "solitary" ocean waves, which he thinks are chiefly due to submarine disturbances. The great majority of the solitary waves that have been observed in the North Atlantic were in a line between places subject to volcanic activity. One of the latest examples of the destructive effect of a solitary wave occurred in October, 1905, to the Cunard liner *Campania* on her outward voyage to New York. A fresh gale was blowing on the Grand Banks of Newfoundland when the ship was suddenly struck by an enormous wave; she lurched over, the water swept over the deck several feet deep, five passengers were washed overboard and twenty-nine others seriously injured. This wave was said to have reached as high as the funnels, but in the circumstances accurate estimates could hardly have been made.

The final chapter deals with tides as a source of power. The author gives full accounts of applications of the principle that have been made at various times, but his conclusion is that the attempt to utilise tides on a large scale with existing mechanical appliances cannot be considered as coming within the lines of commercial economics. In this conclusion he has the support of general engineering opinion.

On the whole, Mr. Wheeler has succeeded in the object he had in view, and has "produced a handbook that will be of interest and practical service to those who have neither the time nor the opportunity of investigating the subject for themselves." W. H. W.

ELECTRICITY METERS.

Electricity Meters. A Treatise on the General Principles, Construction, and Testing of Continuous Current and Alternating Current Meters for the Use of Electrical Engineers and Students. By Henry G. Solomon. Pp. x+323. (London: Charles Griffin and Co., Ltd., 1906.) Price 16s. net.

UNTIL a few months ago the literature on the subject of electricity meters was entirely confined to articles in text-books on electrical engineering, and the advent of a book dealing exclusively with this subject is therefore a matter of importance to those interested in the distribution of electrical energy. In the book just published by Messrs. Griffin, Mr. H. G. Solomon has written a clear and comprehensive treatise on the principles and construction of this most important piece of electrical apparatus.

The first chapters are introductory, and deal mainly with the theory of action of the more important types. In chapter ii. an important section on the behaviour of three-wire energy meters is deserving of attention. The errors in reading due to want of balance, both as regards pressure and current on a three-wire system, when the shunt coils of a three-wire meter are connected respectively across the outers, and between the middle wire and the outer, have been worked out. In the appendix figures are given which show the percentage error in different cases, and the advantage of connecting the shunt coil directly across the outers is clearly proved. The fact that there is any error at all with this arrangement has hardly been recognised, though for switchboard meters the matter is certainly one of importance. The following chapters contain descriptions of the various types of quantity and energy meters for continuous current circuits, and are largely reminiscent, as writing of this kind must always be, of manufacturers' pamphlets.

Mr. Solomon has very wisely excluded all historical and out-of-date meters from this part of his book, and the section contains a clear description, fully illustrated by many excellent drawings, of the meters which the central station engineer has to use and to test. The author is to be congratulated on having almost entirely eliminated illustrations of the outer cases of the instruments which he describes, a type of illustration, unfortunately, all too common in some other works on kindred subjects. Chapter vi. contains a description of continuous meters for special purposes. The last section deals with tramcar meters. The practical importance of this type of meter is hardly yet well recognised. As Mr. Solomon says:—"The careless manipulation of the controller and brake is a matter of serious importance, resulting in a considerable loss of energy. By properly recording the actual energy taken by the cars, and keeping records of the motor men, a saving amounting to from 10 to 20 per cent. of the total used can be effected." The descriptions of the best known types of meter for this purpose are somewhat disappointing.

The chapters dealing with the theory of single phase and polyphase meters is complete and satisfactory. All the best known methods of measuring alternate current power are described. A matter of some importance is the effect of wave shape on the accuracy of registration; errors due to this cause may amount to 5 per cent. or more with meters of the induction motor type when running on non-inductive load, while the same meters record quite accurately when supplied with a sine wave of potential difference. The chapter dealing with tariff meters is full of useful information for the central station engineer, and the subject is well treated. The Hopkinson doctrine (one might almost call it an axiom) that "the charge for a service rendered should bear some relation to the cost of rendering it" is fundamental, but one of the chief disadvantages in its application in the Wright maximum demand system is, as Mr. Solomon says, that "the average consumer experiences considerable difficulty in understanding it, and the attitude of the consumer cannot be ignored."

Chapter xi. gives a description of a large number of pre-payment meters, and in the next chapter tariff and hour meters are dealt with in the same way. In the penultimate chapter some special mechanical features in meter design are described, for the obvious reason that "the proper working of a meter depends on its mechanical as well as its electrical design." The subject of meter testing is discussed at some length in the last chapter.

The book should be of great value both to students and to central station engineers who wish to know something about the instruments in use on their supply systems.

A NEW VOLUME OF THE "FAUNA OF BRITISH INDIA."

The Fauna of British India, including Ceylon and Burma. Published under the authority of the Secretary of State for India in Council. Edited by Lieut.-Colonel C. T. Bingham. Rhynchota, vol. iii., Heteroptera-Homoptera. By W. L. Distant. Pp. xiv+503; figs. 266. (London: Taylor and Francis, 1906.)

THE present series of works was initiated and carried on for upwards of twenty years under the able editorship of the late Dr. W. T. Blanford, and as this is the first volume issued under the supervision of his successor, Lieut.-Colonel C. T. Bingham, this seems to be a fitting opportunity to summarise the progress that has already been made. In Vertebrates eight volumes have appeared—one on Mammalia, by W. T. Blanford; four on Birds, by Eugene W. Oates and W. T. Blanford; two on Fishes, by Francis Day; and one on Reptilia and Batrachia, by G. A. Boulenger. In Invertebrates ten volumes have appeared—one on Butterflies, by C. T. Bingham; four on Moths, by G. F. Hampson; two on Hymenoptera, by C. T. Bingham; one (half-volume) on Arachnida, by R. I. Pocock; and two on Rhynchota, by W. L. Distant.

Respecting future arrangements, Colonel Bingham announces that four volumes on Beetles (including a volume on Phytophaga, by M. Jacoby), a second volume on Butterflies, by Colonel Bingham, and a volume on Land Shells, by the late Dr. Blanford and Colonel Godwin-Austen, are in preparation, of which it is hoped that the volume on Butterflies and a half-volume on Longicorn Beetles may be issued during the current year.

Turning from this highly satisfactory record of progress to the volume before us, we find that it concludes the suborder Heteroptera (the true Bugs), with families 17 to 24, Anthocoridæ, Polyctenidæ, Pelogonidæ, Nepidæ, Naucoridæ, Belostomatidæ, Notonectidæ, and Corixidæ, including collectively sixty-two species; and commences the suborder Homoptera with the families Cicadidæ and Fulgoridæ, of which collectively 570 species are described. There still remain three families of Trimerous Homoptera—Membracidæ, Cercopidæ, and Jassidæ—to be dealt with in a future volume, as well as the Dimera and Monomera, comprising the families Psyllidæ, Aphididæ, Aleurodidæ and Coccidæ. With the exception of the Anthocoridæ and the curious bat-parasite *Polyctenes lyrae*, Waterh., the Heteroptera described in this volume are all aquatic, including the curious water-scorpions, water-boatmen, and the great *Belostoma indicum*, Lep. and Serv., which attains a length of three and a half inches, and is perhaps the largest heteropterous insect found in India, though some of the allied South American species are larger.

Our British species of the suborder Homoptera, of which the froghoppers may be taken as typical, are all small insects, the largest, our only British representative of the true Cicadidæ (*Cicadetta montana*, Scop.), a scarce and local insect, only measuring an inch and a quarter across the wings. But many of the Indian species of Cicadidæ and Fulgoridæ are much larger, the largest Indian Cicada, *Pomponia intermedia*, Dist., measuring seven inches across the wings.

Although many species of Cicadidæ are more or less spotted, and more or less opaque towards the base, yet the tegmina and wings are, in most instances, almost entirely transparent. In a few species, however, they are opaque, and brightly coloured. But in the Fulgoridæ, or Lantern-flies, many of which are of considerable size, measuring two or three inches in expanse, the wings are often opaque, and varied with such bright colours that they might easily be mistaken for butterflies or moths by persons ignorant of entomology. Indeed, one species, *Aphana caja*, Walk., has received its name from its superficial resemblance to a tiger-moth.

Many Fulgoridæ exude a white waxy substance, which is sometimes very abundant and conspicuous. Others, such as the true Lantern-flies or Candle-flies, are conspicuous both for their bright colours and for the long projection on the head of many of the species. Some have short wings, others very long and narrow ones. Mr. Distant's figures are without colour, but they give a very good idea of the wingvenation and curious forms of a very interesting but still much neglected group of insects. These figures have been drawn by Mr. Horace Knight in his usual admirable style.

We have much pleasure in commending this volume (in which a large number of new genera and species are figured and described) to all entomologists who are interested in exotic insects. W. F. K.

OUR BOOK SHELF.

Plants and their Ways in South Africa. By Bertha Stoneman. Pp. ix+283. (London: Longmans, Green and Co., 1906.) Price 3s. 6d.

THE schools in Cape Colony and in other South African colonies are already indebted to the publishers of this volume for several useful educational books. Although this book, and one on geology, are the only ones issued under the title of the "South African Science Series," Messrs. Longmans have previously published an elementary botany and a book on South African flowering plants. The present volume by Miss Stoneman is written for younger children than the two former. The treatment of the subject on an elementary physiological and ecological basis is quite the most suitable, and the author displays considerable originality, although at times she develops a crudity of expression.

A chapter on seeds forms the introduction to the physiological considerations of growth; leaves and their functions are then discussed, and four ecological chapters precede the morphology of flowers, fruits, and seeds. The latter half of the book is devoted to classification, limited wisely to a description of the principal orders, and the writer has drawn up tables for differentiating all the genera mentioned; these are exceedingly useful, but the key for distinguishing the orders according to Bentham and Hooker's system, and the synopsis based on Engler's arrangement, would be more suitable for advanced students.

One of the chief merits of the book lies in the natural manner in which rather difficult subjects, such as the law of correlation of growth, are introduced; also every opportunity is taken to base instruction on practical experiment. Certain mistakes or mis-statements occur that might have been avoided with a little more circumspection, and the mis-spellings are more numerous than is consistent with careful reading; but these defects are slight, whereas the author has succeeded in giving plenty of character to the book, and has written with the object of stimulating observation and inquiry on the part of the reader. The book is well supplied with illustrations, of which a fair proportion has been specially drawn or prepared.

Lectures on Compass Adjustment. By Captain W. R. Martin. Pp. 98; with three charts. (London: George Philip and Son, Ltd., 1906.) Price 5s. net.

IN this book is reproduced a series of eight lectures on compass adjustment in iron and steel ships, delivered at the Royal Naval College, Greenwich, to the classes of senior officers as well as to navigating officers up to the year 1902. There can be no question that these lectures, profusely illustrated by diagrams and supplemented by practical instruction by means of models, were in many ways of great value to officers whose career was bound up with the navigation of ships, where the compass might be either a treacherous guide or a means of safety when adjusted and cared for as the author describes. No doubt the lecturer was able to answer questions asked by his audience and to enlarge upon difficult points to their mutual advantage, but now, when these aids are absent and the student has to read lectures with modified diagrams, it is incumbent on the author of them to write clearly and with precision.

Turning, however, to the text, it can hardly be said that the author has succeeded in making his meaning sufficiently clear in many places. Among the more important of these the following require mention:—"The magnetic force of the earth is of course everywhere acting in only *one* direction" (the italics are the author's), a very misleading assertion. The expression "the line of dip is horizontal at the magnetic equator" is unsatisfactory. Again, what is the student to understand from the words, "the compass, may be regarded as a north seeking particle"?

In lecture vi., following wrong premises, it is stated that at a steering compass in H.M.S. *Powerful* the coefficient $\lambda=0.790$ would be increased to 0.968 after correction by spheres. To obtain such an increase of directive force has long been eagerly sought after in vain, but, unfortunately, observation in the present case shows that a value of about 0.830 is near the truth after correction. Again, the results of observations made as described on p. 70 could not be used in constructing chart No. 1 with any degree of accuracy. With the large number of observations from observatories and results obtained with absolute instruments in the field, as well as relative observations at sea, there is no need to trust to inferior results.

The last lecture is devoted to the methods of adjusting a compass with large errors, but it must be remarked that the directions given are not generally agreeable with the practice of recent years. For example, for all purposes connected with the heeling error, the dip circle has long been discarded in favour of the heeling-error instrument.

Finally, it will be observed that the equipment of torpedo-boat destroyers and torpedo-boats with the liquid compass is not referred to. This is probably an unintentional omission which may be remedied in future editions of this work. E. W. C.

Lotus Blossoms. A Little Book on Buddhism. By Maung Nee. Pp. vi+103. (Rangoon: Printed Privately, 1906.)

A DAINTY booklet in which a number of passages from various Buddhist writings have been gathered together under different headings. As indicative of the high tone and lofty character of the teaching in the Buddhist writings, the following sentences may be quoted: "Strive with all your strength, and let not sloth find a place in your hearts." "The wise man does not remain standing still where he has made a beginning, but ever reaches forward towards fuller enlightenment." "Idleness is a disgrace." These are classed under the heading "correct aim," but equally sound morality can be read in all the sections.

Hydrographic Surveying. Methods, Tables, and Forms of Notes. By S. H. Lea. Pp. 172. (New York: Engineering News Publishing Company; London: Archibald Constable and Co., Ltd., 1905.) Price 8s. net.

THIS is an excellent volume, and thoroughly describes the more complicated branch of hydrographical work, such as rivers, lakes, &c. The book touches very lightly on ocean surveying, and apparently is not intended as a work on this subject. Several of the terms used are not often met with in English works, being American technical terms; but these soon become familiar, and, as usual, are very descriptive and to the point. H. C. LOCKYER.

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.*]

Osmotic Pressure.

IN the issue of NATURE for May 17 (p. 54) appears a communication by Mr. Whetham in which he attempts to consign actual experimental work on osmotic pressure to the humble *rôle* of showing how far the assumptions made in so-called thermodynamical proofs can be realised experimentally. Among other things, the attempts to apply thermodynamic reasoning to osmotic processes involve the assumption of a membrane which is semi-permeable and which at the same time is quite passive, that is to say, which shows no selective action. Now in my paper (referred to in NATURE for May 3, p. 19) I have demonstrated conclusively by experiment that in actual osmotic processes the selective influence of the membrane is always present, and is the determining factor as to whether osmosis will take place at all, and, if so, in what direction. In studying that paper, the reader will also see that *the more nearly a membrane is semi-permeable in character in practice, the greater is its selective action. In fact, it is the pronounced selective action of the membrane which makes it approximately semi-permeable.* This being the case, it is evident at once that thermodynamic reasoning cannot be applied to actual osmotic processes, and that the experimental work on osmotic pressure does not play that humble *rôle* to which Mr. Whetham would consign it.

Mr. Whetham sees perfect semi-permeable membranes (1) in the surface of growing crystals of pure solvent which separate from a solution when it freezes, and (2) in the free surface of a solution of a non-volatile solute as it evaporates, and states that "from these two facts follows the validity of the thermodynamic relations between osmotic pressure on the one side and freezing point and vapour pressure on the other." Now I must insist that the formation of crystals from a solution, or the concentration of a solution by evaporation, are not osmotic processes. There are, in fact, no actual membranes or septa involved in these processes, and to regard them as "osmotic" in character only causes much confusion, for they have nothing in common with an actual osmotic process, in which a membrane—an additional phase with specific selective action—is always present as a determining factor.

In how far it is allowable to apply thermodynamic reasoning to the evaporation of a solution or the formation of crystals from a solution I shall not attempt to discuss here, for it is quite outside the main subject with which my paper deals, namely, the nature of osmosis and osmotic pressure. For the same reason I shall not enter upon a discussion of Mr. Whetham's contention that the theory of electrolytic dissociation "rests upon electrical evidence, and by such evidence it must be tried." In this connection it may suffice to refer the reader to the paper which I have prepared at the request of the Faraday Society (see Trans. Faraday Soc., vol. i., also *Phil. Mag.* for February, 1905), in which I have directed attention to the fact that in creating the theory of electrolytic dissociation, the actual phenomena of electrolysis have played a minor part.

Concerning the remarks made in NATURE of May 17 (p. 54) by Lord Berkeley and Mr. Hartley, I should like to state that, so far as I am aware, the only direct measurements of osmotic pressure which they have made are some preliminary results published in vol. lxxiii. Proc. Roy. Soc., pp. 436–443. In their article in vol. lxxvii. Proc. Roy. Soc., p. 156, I find no direct measurements of osmotic pressure, but simply results of vapour-tension measurements from which osmotic pressures have been computed by means of a modification of a formula of Arrhenius. Of the results given in the two papers mentioned, there is but one case that is comparable, namely, that at concentration 420 grams sugar per litre, the other determinations having been made at different concentrations, so that they are not comparable. Furthermore, all their direct osmotic-pressure measurements were made without stirring, and they are consequently not at all final. I have also in my paper directed attention to the fact that copper ferrocyanide membranes imbedded in porous porcelain are particularly unsuitable for making conclusive direct measurements of osmotic pressure. In these circumstances, it appears that their claim that they have shown experimentally that aqueous solutions of cane sugar give the same osmotic pressure, whether observed directly or deduced indirectly from their vapour-pressures, is not well founded.

As to the computation which Lord Berkeley and Mr. Hartley make concerning one of my experiments, I would state that they assume as a basis for their calculation that the slight amount of sugar found in the outer liquid occurs there because the solution, as such, has passed through the septum. Now this assumption is entirely untenable in the light of the numerous experiments given in my paper illustrating the nature of the osmotic process, and their criticism is consequently worthless. LOUIS KAHLENBERG.

University of Wisconsin, Madison, June 15.

The Olfactory Sense in Apteryx.

ABOUT a year ago I stated in your columns (May 18, 1905, p. 64) that I was trying to have experiments carried out with the object of ascertaining whether the olfactory sense of the kiwi is perceptibly developed, as one would suppose it to be from certain structural peculiarities in which the bird is unique, viz. the great relative size of the olfactory lobes of the brain and the great size of the olfactory capsule as seen in the skull.

I wrote to the curators of Little Barrier and Resolution Islands, which are reserved as sanctuaries for birds, asking each of them to try certain experiments for me with the object, first, of finding out whether the kiwi exhibited any preference for particular species of earthworm, and, if so, whether any difference in odour, or noticeable difference in colour, was perceptible to them (the curators). I asked whether it was possible to deceive the kiwi in any way by appealing to its sense of smell, while excluding those of sight, hearing, and touch, and formulated a few simple experiments with this end in view.

I recently received a reply from the curator of Resolution Island, in Dusky Sound, who is a careful observer of the habits of birds. Mr. Richard Henry experimented with the larger South Island bird, *Apteryx australis*, usually termed the roa-roa, in opposition to the other South Island bird, the small grey kiwi, *A. oweni.* The former feeds chiefly on earthworms, the latter on grubs of various kinds. Mr. Henry placed a number of earthworms at the bottom of shallow buckets and covered them with four inches of earth. When such a bucket was placed on the ground the roa got quite excited in its hunt through the earth, probing to the bottom for the worms. It must be borne in mind that, according to several good observers, the roa (and kiwi) is practically blind during the day time, and, moreover, the bunch of hair-like feathers at the base of its snout intervenes between its eyes and the ground in this operation, while Mr. Henry states that it makes such a "sniffling noise" that it would be unable to hear a worm, even if the latter made any disturbance in the soil. There remains, therefore, the possibility that the tip of the beak is highly sensitive, and that it finds the worms by touch.

But Mr. Henry writes that the bird seemed readily to be aware whether worms were below the earth without touching the soil, for "when I put down a bucket of earth without worms in it, the bird would not even try it; but the moment a bucket containing worms (covered with earth) was put down the roa was full of interest in it," and commenced to probe at once with its long beak.

Further, Mr. Henry took several dead worms that had been severely pressed by the spade in digging them up the previous day, and put them at the bottom of a bucket of earth, and at the end of half an hour the roa had not left a scrap of worm behind. He tried the roa with a bucket of earth that had been searched by it on the preceding day, but the bird "would not even look at it." Then he placed a couple of worms under the earth at the bottom of the bucket, and again allowed the roa to have access to it;

this time the bird went to work promptly, "as if he knew the worms were there."

I had suggested, amongst other experiments, that he should rub a living worm over some substance that the kiwi does not usually eat, such as bread, so that it should be flavoured and scented by the earthworm juice, and then conceal it; but he has not yet, apparently, carried out the experiment.

Previously to my request Mr. Henry had experimented with a roa that he had trained to eat meat. He "planted" pieces of meat in drills three or four inches deep, and next day found them gone, "though the ground was not raked over by the bird, but probed where the meat had been hidden. This was in an enclosure whither other creatures had no access. If, when the bird was at rest, though hungry, he threw a piece of meat or an earthworm near it, it seemed at once aware of the presence of food, would wake up and reach in the right direction, touching the ground from time to time with the tip of its beak until it came in contact with the meat.

Although other and more crucial experiments are needed —and these could more readily be made in England (at Tring, for instance) under careful supervision—yet I think the above affords a certain amount of evidence for the existence in Apteryx of a keen sense of smell.

I may add that Resolution Island is quite an un-get-at-able place; it is visited about three or four times a year, twice by the Government steamer on its round-trips to supply lighthouses, &c., and occasionally by other vessels at irregular times, so that four or five months may intervene before a reply is received to a letter. For instance, in reply to my letter dated April 30 I only received an answer in October. I once tried to arraoge to visit the island, but the uncertainty of getting back to the mainland in any reasonable time was so great that I had to give up the idea. I hope someone in England will undertake further experiments in this direction.

W. B. BENHAM.

Otago University Museum, Dunedin, N.Z., May 6

Molecular Changes in Nickel Steel

MR. MILNE, chronometer maker in Manchester, has kindly given me permission to send you the following interesting information. About two years ago he made a clock having a rod pendulum of Dr. Guillaume's invar steel (iron nickel alloy). It was carefully adjusted, and was recording time in a most satisfactory manner. Recently the gut of the driving weight tore, and the clock received a shock whereby the rate was altered a few seconds per day. This might be due to some mechanical movement. After re-adjustment had been effected, it was found that the pendulum was undercompensated for changes of temperature, and it appears as if the coefficient of expansion, which was said to be 0.0000008 per 1° C., had increased.

The second case is a watch the balance wheel of which was made of invar steel and brass. In March, 1904, it was rated by the National Physical Laboratory, when it was found that there was no middle temperature error. Now, after two years' working, this error is +1.08 seconds per day, ordinary steel and brass balances having a middle temperature error of about $2\frac{1}{2}$ seconds per day. The details are as follows:—

Temperature	1904 Rate	1906 Rate
40°	+0.6	+1.08
90°	+1.6	+0.36
Mean	+1.1	+0.72
65°	+1.1	+1.80
Middle temp. error . .	0.0	1.08

C. E. STROMEYER.

"Lancefield," West Didsbury, June 28.

MANX ARCHÆOLOGY AND NATURAL HISTORY.

IN the year 1886 the House of Keys passed an Act entitled "The Museum and Ancient Monuments Act." I well remember hearing of it, because in the course of that year I visited the Isle of Man for the first time, in order to see some newly discovered Ogam inscriptions. It proved for me the first of a series of visits to the island with the view chiefly of studying Manx Gaelic and Manx folklore. I got to know the island and its people, and noticed among other things the efforts made by two or three men with taste and zeal for archæology and history to interest the Manx people in the relics of antiquity for which the Isle of Man is famous. On one of my rambles, which led me to a public school, I remember being much struck by finding hung on the walls drawings of hatchets, hammers, and other instruments of the ages of Stone and of Bronze, accompanied with letterpress descriptions of them. They were intended to interest the more intelligent of the children in such objects, and especially to help them to recognise them when accidents exposed such treasures to view. It struck me how desirable it was that the same thing should be done in the public schools of this country, but I am not aware that it has ever been done. This example of the Isle of Man is well worth following, but I fear that the present is not a favourable moment for recommending anything so far removed from the burning question of the day. But the present war of creeds and dogmas will, it is to be hoped, be followed by a period of peace when the promoters of education may be allowed to devote more attention to some of the historical aspects of its more secular side.

The first Manx archæologists I came in contact with were Canon Savage and Mr. A. W. Moore, who has since not only become Speaker of the House of Keys, but established the right to be considered the historian of the island. I found them inspired and led by the experienced hand of Prof. Boyd Dawkins. They have been since joined by other and younger men, such as Mr. Kermode, who has made the study of the runic crosses of the island his own. He published a valuable book on them in 1892, but he chose to call it a catalogue of them and of the inscriptions, and now a larger work of his on the same subject is passing through the press, and will contain as illustrations numerous plates and a great number of outline figures. The list of the trustees of the Manx Museum and ancient monuments includes other men of light and leading in the island, such as Mr. Ring, the Attorney-General, not to mention that they have always had the Bishop on that body, and enjoyed the support of successive Governors of the island, including among them the well-known historian, Sir Spencer Walpole. These men have always endeavoured to interest the Manx people in their ancient monuments, and they have succeeded to a great extent, but a great deal still remains to be done in the same direction. The pride of ownership is very strong in a Manxman: perhaps it is in all small nationalities—at any rate, I have noticed it not only in Man, but also in my own country, the Principality of Wales. What may be the explanation I do not know, but a member of a small nationality is a more considerable portion of that nationality than if he belonged to a larger nationality, and perhaps that has something to do with the greater difficulty which he finds in rising to the idea of giving up to the nation anything of which he is the exclusive owner. That is, however, not what I was coming to, but to the fact that, in spite of the pride of ownership, the safe keeping of the object owned is by no means guaranteed either in Man or Wales. But to confine my remarks for the present to Man, I may say that I have known a sad case of perversity of this kind in the matter of a piece of most valuable antiquity, which I abstain from describing more minutely. This is within my own knowledge, and I think no superstitious feeling entered into the matter; but in a case I have heard of it is possible that an element of superstition mixed itself with the mere sense of ownership. I was told years ago that an ancient burial urn had accidentally been exposed partially to sight, but that the owner could not be persuaded to allow it to be carried away to a museum. At the same time he would do nothing to protect it from being damaged by boys shying stones at it or from other dangers. Here there may have been a superstitious fear of removing anything supposed to be connected with the dead. At all events, it will serve to illustrate one of the grave difficulties which those have to face who want to see the relics of antiquity brought to places of safety.

This leads me to mention the last "Report of the Manx Museum and Ancient Monuments," which lies before me, dated March 6, 1906, signed by the chairman, Mr. Moore, and the hon. secretary, Mr. Kermode. It shows very clearly how far the trustees have got with their scheme, and what its objects are. These, as the title suggests, are two—the safe keeping of the ancient monuments, and the exhibition of them for the education of the Manx people, or rather of a wider public still; for nobody can, for instance, be said to have completed his study of runic crosses and Scandinavian epigraphy without visiting the series in the Isle of Man, the most central spot in the British Isles, and one most easily accessible from Liverpool and the north of England. Under the first heading a "Scheme for the Better Preservation of the Manx Sculptured and Inscribed Stones" has been adopted by the trustees, subject, of course, to alteration in detail where found necessary, and to the consent of the rectors and vicars of the parishes concerned. This scheme seems really to consist of so many separate schemes as there are parish churches with important monuments of antiquity near them. Even had there been a spacious museum ready to receive all the stone monuments of the island, no Manxman would probably entertain the notion of removing thither the more important runic crosses such as the group at Kirkmichael. So the arrangement which finds favour is that of constructing sheltered places for them near or within the churchyards where they stand. The work has been done already in some instances, and it may all be expected to be completed in the course of the summer. The Tynwald Court has unanimously voted, for the carrying of it out, 250*l.*, and 150*l.* more are expected from voluntary contributions.

Thus far of the protection of the larger of the ancient monuments in their respective localities. The smaller objects of antiquarian interest ought to find their safe keeping in a museum, but to meet this want less progress has been made. It is now some ten years since the trustees adopted a memorandum to the effect that the Manx Museum should consist of local objects to illustrate fully the archæology and natural history of the island, and the buildings requisite for the purpose should have a minimum area (including galleries) of 5000 square feet, and cost no less than 5000*l.* They also agreed that such an institution, being purely national, not municipal, should be provided partly by public subscription, partly by a grant from the revenue, and partly by the rates of the town in which the museum was to be established. The town, they thought, should be Douglas, and the cost of maintenance, estimated at 250*l.* per annum, should come out of the revenue, not out of the rates. The question of ways and means was in due time discussed, but nothing seems to have been done even by the town of Douglas, which was at one time eager to have the museum. In the meantime Governor Henniker placed a portion of Castle Rushen, at Castletown, at the disposal of the trustees for the purpose of a temporary museum. In fact, the nucleus of a collection had been stored there since the time of Governor Loch. Other articles, however, had been stored at the Government Office in Douglas and in Peel Castle; but the former have been added since to the Castle Rushen collection, which has been still further increased by the generosity of benefactors, especially Canon Savage.

So for the present Castle Rushen, a famous mediæval fortress, is the insular museum, and it is curious to read that the banqueting hall, that had witnessed scenes "of revelry by night," has the fine and very perfect example of the "Irish elk" from Poortown standing in the middle of the floor—it is, if I am not mistaken, not the only "Irish elk" found in the island; I have heard it said that one was presented by one of the Scottish kings of Man to Edinburgh. Among contents on a less colossal stage are the valuable casts of the early sculptured stones and inscribed monuments found in the island, a hundred and twelve in all—and the casts are already too few, for at least two more cross slabs have been discovered since the drafting of the report. In fact, this is one of the most encouraging aspects of the whole business. The collection is steadily increasing as the result of gifts, purchases, or loans, as the catalogue testifies. But here comes the difficulty, for, as the trustees point out, even for the purposes of a local archæological collection making any approach to completeness the space is insufficient for the methodical exhibition of it to the best advantage. This leaves out of consideration other aspects of the museum question, for the trustees are forced to add that though they are very willing to receive and store geological and local natural history objects, they are at present unable to exhibit them. Manx archæologists are only just in time to save the crosses of the island, but every year much is being lost for ever for the want of a museum, and the loss is not only that of Man, but of the archæology of the British archipelago as a whole.

But how is the museum to be provided? There seems to be no prospect of the island setting one up, even at the modest expense of 5000*l.*, and as to that figure I should guess that the bare building required would cost that sum, not to mention the furnishing, which would probably cost another 5000*l.* Before all I ought to have mentioned the site, for which, if it is to be at Douglas, I would rather not indicate any sum. Suffice it to say that the money difficulties are such that I can only make one suggestion, and that is, that the Imperial Government should take the matter in hand. What it has done for the island of late besides affording it and its herring fleet general protection I know not; but it is understood that the island, besides paying the expenses of its own Government, pays direct to the imperial exchequer 10,000*l.* annually, besides a very large income from royalties and other sources of revenue which discharge perennially into the coffers of the Crown. Having alluded to these disbursements, it is needless to point the moral. All lovers of fair play will agree with me that it would be but reasonable for the central Government to come to the help of the Manx people in the matter of its antiquities and natural history, and the sooner the better.

JOHN RHYS.

THE SOUTH AFRICAN MEDAL OF THE BRITISH ASSOCIATION.

WHEN the members of the British Association were in South Africa last August and September, it occurred to someone of the party that it would be well to commemorate our visit by founding a medal for South African students. I am sorry that I cannot remember to whom the credit of this admirable suggestion is due, but the officers at once adopted it with enthusiasm. Papers explaining the proposal were first circulated through the special trains on our way from Durban to Johannesburg, and a substantial sum was promised in a very short time. The proposal was subsequently laid before those who did not happen to be travelling in the special trains, and ultimately before all the members of the British Association.

On our return to England, a meeting of the subscribers was summoned, and a committee was appointed to consider the manner in which the fund should be applied. It was resolved that the South African Association for the Advancement of Science should be asked to accept the trusteeship and administration of the fund, and to undertake the annual award of the medal which was to be struck.

Mr. Frank Bowcher's Designs for the South African Medal of the British Association.

The income of the fund was to be in aid of scientific research among South African students, and it was thought that the medal would commemorate appropriately the fact that the recipient of the award was of such promise as to have been deemed worthy of the confidence placed in him.

The South African Association has cordially accepted the duties in question, and a medal, shown in the illustration, and to be struck in bronze, has been designed by Mr. Frank Bowcher.

The total sum subscribed by the members of the British Association amounts to 859*l*., but the fund will receive a further substantial augmentation, as I shall now explain.

Before the meeting of last year, the several South African colonies subscribed a large sum in aid of the expenses of the members intending to come out to South Africa, and this sum was supplemented, although on a less liberal scale, by a subscription in England. The total of this special South African fund was a little more than 9000*l*. It is expected that, when all the accounts are settled, the unexpended balance will come to about 500*l*. It is clear that this balance ought to be returned to South Africa in some way, and a resolution has been passed by the council of the association that the unexpended balance shall be devoted to the augmentation of the medal fund. The expenses attendant on the design of the medal have amounted to about 100*l*., and it is hoped that more than 1200*l*. will remain for transmission to South Africa. As a higher rate of interest on safe investments is obtainable there than here, a substantial annual sum will be provided in aid of research.

The cordiality of our reception in South Africa surpassed all that could possibly have been foreseen, and we in England are glad to be able to establish this small foundation as a memorial of the most remarkable of the many annual meetings of the British Association.

G. H. DARWIN.

THE EARTHQUAKE IN SOUTH WALES.

THE earthquake which occurred in South Wales on June 27 at about 9.45 a.m. ranks among the strongest shocks of which we have had any experience in this country. It was felt over the whole of Wales, and throughout the greater part of the west and south-west of England. Judging from the accounts which I have already received, the disturbed area must extend some distance to the north of Liverpool; towards the east it includes Northampton and Maidenhead, and approaches to within about twenty miles of London, while the southern boundary lies in the English Channel to the south of Dorset, Devon, and Cornwall. I have not yet obtained any observations from Ireland, but there can be little doubt that the shock was sensible over most of the counties of Wicklow and Wexford. A first rough estimate makes the disturbed area nearly circular in form, about 280 miles in diameter, and about 60,000 square miles in area.

The shock, which affected a region greater than the combined areas of England and Wales, was naturally of considerable strength within the central district. It is too early to make any estimate of the total damage to buildings, but the first reports show that a very large number of chimneys were thrown down, especially in Swansea, where the number is said to amount to several hundred. From Kidwelly on the west to beyond Neath on the east, and from Glanamman on the north to beyond Swansea on the south, it will probably be found that few towns and villages have escaped some injury. The isoseismal line of intensity 8, or the curve which bounds the area of slight damage to buildings, seems to be roughly elliptical in form, about twenty-eight miles from east to west and eighteen to twenty miles from north to south, or a little more than 100 square miles in area.

Nearly all the strongest British earthquakes belong to the class which have been called "twin" earthquakes. They originate within two foci, which are nearly or quite detached, with their centres, as a rule, about eight or ten miles apart. But the chief peculiarity about them is that the two impulses which cause them take place almost simultaneously, or, if not quite so, that the second impulse occurs before the vibrations from the first focus have time to reach the other, the two impulses being thus due to a single generative effort.

From the descriptions which have been given there can, I think, be no doubt that the recent shock was a typical twin earthquake. Many hundreds of observations will be required to determine the positions of the twin foci, and to ascertain which focus was first in action. But, so far as the evidence already collected allows us to judge, the foci appear to have been situated along a nearly east and west line, and are probably coincident with an east and west fault, passing close to Llanelly, Swansea, and Neath. It would be useless at present to attempt a more exact definition of the originating fault, but it is clearly connected with the great Armorican system of crust-movements, which attain their maximum in Brittany and mid-Devon, and, as they enter South Wales, begin to die away. In this district, as Mr. Aubrey Strahan remarked in his address at the Cambridge meeting of the British Association, the chief disturbances are of post-Carboniferous age. That they are still occasionally continued, though on a much smaller scale, the recent shock bears ample testimony.

It is evident from the above account that the earthquake presents several features of considerable interest to geologists. The district is also one that affords unusual opportunities for the study of the nature and effects of the shock in deep mines, and it is to be hoped that our somewhat scanty knowledge will be advanced in this respect.

I take this opportunity of stating how greatly my investigation of the earthquake would be assisted by the contribution of records from different places, and especially from the workings in the mining districts. The points on which I wish to obtain information will be found in many local newspapers, but I shall be glad to send forms on which descriptions may be conveniently entered if application is made to me at 16 Manor Road, Edgbaston, Birmingham.

CHARLES DAVISON.

PROFS. N. S. SHALER AND I. C. RUSSELL.

GEOLOGICAL science, and America in particular, has suffered a severe loss in the deaths of two university professors, N. S. Shaler, of Harvard, and I. C. Russell, of Michigan.

Prof. Nathaniel Southgate Shaler, who was born in Newport, Kentucky, on February 20, 1841, graduated at Harvard University, and served two years as an artillery officer in the Union Army during the Civil War. Subsequently he pursued the study of natural science, to which he had been attracted at the Lawrence Scientific School in Cambridge, took the degree of Sc.D. in 1865, and became in 1868 instructor in zoology and geology in that school, and also professor of palæontology in Harvard University. While retaining this professorship, he was in 1873 appointed director of the second Kentucky Geological Survey, a post he held until 1880; and in 1887 he became professor of geology in Harvard University, and occupied the chair until his death this year at the age of sixty-five. When little more than twenty years of age he discussed the age of the rocks in Anticosti, in a paper read before the Boston Society of Natural History, and in 1865 and following years he brought before the same society his views on the elevation of continental masses, arguing that sea-bottoms on which sedimentation was taking place were areas of depression, and that prominent lands undergoing denudation were areas of uplift. He discussed the formation of mountain chains (1866), and maintained that while the continental folds were corrugations of the mass of the earth's crust, the mountain chains were folds only of the outer portion of the crust caused by contraction of its underlying part, and that the formation of mountain chains would be promoted by the subsidence of the ocean's floors, fractures and dislocations being thereby produced along their borders (see G. P. Merrill's "Contributions to the History of American Geology," 1906). In a subsequent paper (1875) Shaler suggested that the transfer of weight to the land by the accumulation of an ice-sheet would influence terrestrial movements. He also discussed the possibility of the Japan current flowing at the close of the Glacial period over what is now land about Bering's Strait, and thus modifying the climatic conditions. He issued memoirs and reports on the geology of Kentucky (1876, &c.), and in later years dealt with a great variety of subjects, scientific and practical, including the classification of lavas, the fossil brachiopods of the Ohio valley, soils, the geological history of harbours, peat-deposits, road-stones, the features of the earth and moon, &c. He was author of important reports on the geology of Cape Cod district (1898); (with J. B. Woodworth) geology of the Richmond Basin, Virginia (1899); and (with A. F. Foerste) geology of the Narragansett Basin (1899). He wrote also "Outlines of the Earth's History" (1898); "Sea and Land: Features of Coasts and Oceans, with Special Reference to the Life of Man" (1895); "Study of Life and Death" (1900), and other works of a more or less popular character.

Prof. Israel Cook Russell, whose death occurred at the age of fifty-three, was born at Garrattsville, in New York State, on December 10, 1852. He graduated at the University of New York in 1872, and after further study at the School of Mines, Columbia, was appointed a member of the U.S. expedition to New Zealand (1874–5) to observe the transit of Venus. His attention, however, was given mainly to the study of physical geology. On his return from New Zealand he became assistant professor of geology at the Columbia School of Mines, and in 1878 was appointed assistant geologist on the U.S. geographical and geological survey west of the one hundredth meridian. From 1880 to 1892 he served as geologist on the U.S. Geological Survey, and in 1892 he became professor of geology in the University of Michigan. His earlier papers (1878) dealt with the physical history of the Trias in New Jersey, and with the intrusive nature of the eruptive rocks, in which he recorded the presence of a solid hydrocarbon. One of his more important works was a sketch of the geological history of the former Lake Lahontan, which in Quaternary times occupied an area of nearly 8500 square miles in N.W. Nevada (1883); he wrote also on the glaciers of Mount Rainier (1898), and on the geology of the Cascade Mountains (1900). Of later papers mention may be made of his observations on the Snake River plains, on the water-bearing strata of Idaho and Oregon, and on the volcanic eruptions of Martinique and St. Vincent. He was author of separate and more popular works on the lakes, glaciers, volcanoes, and rivers of North America.

NOTES.

ONLY a few names familiar in the scientific world occur in the long list of honours announced on Friday last in celebration of the King's birthday. Lieut.-Colonel D. Prain, F.R.S., director of the Royal Gardens, Kew, and late director of the Botanical Survey of India, has been appointed a Companion of the Order of the Indian Empire. Sir Christopher Nixon, ex-president of the Royal College of Physicians, Ireland, and the author of various papers on diseases of the heart and nervous system, has received the honour of a baronetcy. Among the thirty new knights are Mr. T. Digby Pigott, Emeritus Prof. A. R. Simpson, and Dr. A. E. Wright. Sir John Brunner, a member of the great firm of alkali manufacturers, Brunner, Mond and Co., has been made a privy councillor.

BRITISH merchants and manufacturers anticipated a great development of our trade in the Far East at the close of the Russo-Japanese War last year; but it appears from a special inquiry instituted by the *Daily Mail* that their expectations have not been realised. There has been a noteworthy expansion of trade since peace was concluded last August, but the Japanese have taken care that the chief advantages of it shall be to themselves. They have not only secured the Far Eastern market, but, according to our contemporary, the Japanese Government is laying plans for becoming our rivals as an exporter of goods to India. "The fault," we read, "is chiefly our own. Our Government neither knows what is going on nor takes any measures to protect our interests. It is quite natural that Japan should seek to take the current when it serves, but we, too, ought to have our share of the flood that leads on to fortune, and if the Far Eastern department of the Foreign Office will kindly wake up we may secure it yet." It is evident that the Japanese, with their scientific knowledge and methods, will be as strong in peace as they have proved themselves in war. This is an age when science and system are essential to progress, and the nation that realises it is best equipped for survival in the struggle for commercial supremacy. Only by insisting that the scientific spirit which permeates Japanese education and policy shall be possessed by our own statesmen can our commercial position be made secure against attack or progress be assured, either now or in the future.

IN the House of Lords last week, Lord Onslow asked whether His Majesty's Government proposed to continue to take part, after next year, in the international investigations of North Sea fisheries, and made some observations by way of criticism of the methods of investigation which the International Council has adopted. The gravamen of Lord Onslow's objection to the scheme appears to be that, whilst in his opinion the most promising method of attacking fishery problems is by the collection of statistical information from the commercial fishing vessels and at the ports of landing, in the international scheme the carrying out of accurate investigations at sea by men of scientific education and training on board specially equipped research steamers is regarded as essential to an adequate study of the very complicated problems which present themselves to those responsible for the regulation of the fisheries. The value of such collections of statistical data as Lord Onslow suggests, as an adjunct to work carried out by special research steamers, cannot be doubted, and, judging from the reports already published, appears to be fully recognised by the International Council. But no one with experience of the fundamental necessity of accurate observation and scientific method in dealing with practical problems of this character will, we imagine, for a moment be able to agree with the suggestion that such collections of miscellaneous information, the trustworthiness of which must necessarily vary greatly in different cases, can adequately supersede the observations and experiments of skilled investigators. The results already foreshadowed by the International Council seem to be of a promising character, and Lord Carrington, who replied for the Government, was well advised in postponing the consideration of the question of the continued participation of this country in the investigations until after the full reports have been received.

A MEETING was held on June 27 in support of the National Association for the Establishment of Sanatoria for Workers suffering from Tuberculosis. The secretary announced that the association is receiving the active cooperation of friendly societies. At the present time twenty-eight beds have been bespoken for the General Post Office, fifteen for the Hospital Saturday Fund, and five for the Hearts of Oak Benefit Society. Donations have been received from representatives of the participating classes, and this willingness of the ordinary public to assist men of science in their endeavours to eliminate a dreadful disease will greatly lighten their task. Mr. Chamberlain, in a speech supporting the scheme, pointed out that science has already done a good deal, and, without being too optimistic, it is likely that, from further discoveries and continued exertions of distinguished men engaged in medical research, perhaps in the near future the discovery of some definite specific remedy for the disease will be made. Cholera, diphtheria, and other diseases no longer have their terrors, and consumption may cease to be what it is at the present time. Mr. Chamberlain went on to say that he wished he could make his voice reach some of those who have, not merely too much wealth, but wealth beyond the dreams of avarice, which the possessors themselves recognise they cannot make any possible use of. He urged upon the men of great wealth that there is no possible thing they can do which will bring greater benefit to humanity at large, and give them greater satisfaction, than to endow further great schemes for medical research. While sympathising with the desire to see our millionaires emulating the example of American men of wealth in their support of scientific research, our statesmen should not lose sight of the fact that it is as much their duty to see to the protection of the people from disease as from foreign foes. The endowment of scientific and medical research is as necessary a form of national defence as a battleship, and to postpone the organisation of a State-aided campaign against a scourge like consumption until the generosity of millionaires has been developed is unstatesmanlike and a dereliction of duty on the part of Governments.

THE death of Señor Manuel Garcia in London on Sunday has deprived the worlds of science and music of a man whose work will be remembered so long as the human voice is used and studied. While the throat is capable of emitting musical sounds, and is liable to disease, the laryngoscope invented by Manuel Garcia will hold its unique place among vocalists and laryngologists. Garcia was born in Madrid on March 17, 1805, and the enthusiastic celebration of his centenary last year was described in NATURE at the time (March 23, 1905, vol. lxxi., p. 491). The King invested him with the insignia of Commander of the Royal Victorian Order, and many other tributes to his great services to mankind were presented to him. While a teacher of singing in Paris, about 1840, Garcia devoted attention to the scientific study of the problems of his art, including the anatomy and physiology of the larynx. The epoch-making paper in which he laid the foundation of the experimental study of the voice was read before our Royal Society in 1855, after he had settled in London and invented the laryngoscope. Intra-laryngeal medication and surgery, says the *Times*, soon followed the discovery of the diagnostic properties of this instrument, and its principles were extended to the elucidation and treatment of diseases of the parts situated between the nose and throat. The importance of the invention was not recognised until two years later, when the attention of the whole world was directed to the laryngoscope. Compensation for the indifference first shown by the medical profession to Garcia's discovery, was amply afforded by the centenary celebration last year, when public institutions and societies from every quarter of the globe united to honour the great teacher and investigator.

THE Longstaff medal of the Chemical Society has been awarded to Prof. W. N. Hartley, F.R.S., in recognition of his spectrochemical investigations; the presentation will be made at the first meeting of next session, October 18.

THE death is announced of M. Rayet, director of the Observatory of Bordeaux-Floirac. M. Rayet was also professor of astronomical physics at the University of Bordeaux.

THE council of the Institution of Mechanical Engineers has appointed the president of the institution, Mr. E. P. Martin, as one of its representatives upon the main committee of the Engineering Standards Committee in succession to Mr. E. Windsor Richards, past-president of the Institution of Mechanical Engineers, who has retired.

MR. G. MONTEFIORE-LEVI, of Brussels, formerly a member of the Belgian Senate, and president of the Association of Engineers, has bequeathed a portion, probably exceeding 100,000*l.* in value, of his residuary estate, to be applied for the prevention of consumption.

THE Geologists' Association has arranged a long excursion to the Yorkshire coast, extending from July 21 to July 28. The object of the excursion is to visit the Lias and Oolite sections from Robin Hood's Bay to Saltburn. Members wishing to take part should communicate at once with Mr. H. Kidner, 78 Gladstone Road, Watford. The party leaves King's Cross at 11.30 a.m. on July 21.

AT the annual general meeting held on June 28, the following were elected Fellows of the British Academy:—the Rev. R. H. Charles, Mr. W. J. Courthope, C.B., Mr. J. Fitzmaurice-Kelly, Mr. Andrew Lang, Prof. A. A. Macdonell, Dr. J. E. McTaggart, Canon Edward Moore, and Dr. G. F. Warner. The number of fellows is thus brought up to ninety-four, out of a maximum of 100 allowed by Order of Council.

AFTER the ceremony on June 25, when Mr. Haldane opened the electrical laboratory of the National Physical Laboratory, Sir John Brunner very generously placed the sum of 5000*l.* at the disposal of the committee toward the completion and equipment of the additional buildings for engineering, metrology, and metallurgy, now in course of erection.

THE past week will long be remembered by electrical engineers on account of the international meeting referred to in our last number (p. 207). We have had among us representatives of the electrical industries of France, the United States, Italy, Germany, Switzerland, and Canada, and have been enabled to return in some part the hospitality they have in past years extended to us. A good and varied programme was arranged, and our leading firms assisted by giving free access to their works and in entertaining the visitors. We trust that our guests will look back upon their visit here as no less delightful than those which many of our own electrical engineers still remember with gratitude to their respective countries.

A RAINSTORM of exceptional severity was experienced over the whole of the south-east of England during the night of Thursday, June 28, and the morning of the following day. The rainfall in and around London was as heavy as anywhere. The downpour commenced shortly after midnight, and continued without intermission for eight or nine hours. At Kew the measurement amounted to 2·36 inches, at Camden Town to 2·27 inches, and at the observing station of the Meteorological Office, in St. James's Park, to 2·07 inches. At Greenwich the measurement was 1·85 inches. Other stations reporting heavy falls were Cambridge, with an aggregate measurement of 2·3 inches; Rothamsted, 2·2 inches; Hielington, in Norfolk, and Epsom, 1·8 inches; and Oxford, 1·7 inches. Previous records only show so heavy a fall in twenty-four hours for London on three occasions during the last fifty years. This severe rainstorm was due to the passage of a shallow cyclonic disturbance across the southern portion of England, and in places the force of a moderate to fresh gale was experienced. At Greenwich the pressure of the wind was 10 lb. on the square foot, at 9 a.m., on June 29. The type of weather was peculiarly characteristic of thunderstorms, but it was only in a few isolated places that thunder and lightning occurred.

ARRANGEMENTS have now been completed for the erection of a commodious laboratory for the study of marine biology at Cullercoats, on the Northumberland coast. A much smaller laboratory, which had been provided by the munificence of Alderman Dent, the chairman of the County Council's fisheries committee, was accidentally burnt down some few years ago, and the proposed building is designed to carry out, not only fishery research, but also general biological studies. The gift of the site and the cost of erection of the building will be borne in a very generous way by Mr. Wilfrid Hudleston, F.R.S., the management being under the control of the Armstrong College at Newcastle. It is hoped that the new building will be ready for use at an early period of the next collegiate session, and that students will in this way obtain a further means of valuable training in practical biology. Cullercoats is, of course, classical ground to the marine biologist, having been the source of much of the material upon which Alder and Hancock's great work on the nudibranchiate mollusca was based.

A CORRESPONDENT writes asking for information as to self-recording instruments of the variations in the direction of the wind, and suggests that no such self-registering wind vanes are well known to the public. The information required may be found in any good text-book of meteorology, and the letter asking for it is characteristic of the general lack of knowledge with regard to meteorological matters. There are, of course, many recording anemographs which give wind direction, and our correspondent should apply to instrument makers, such as Messrs. Lander and Smith, of Canterbury, or Messrs. Negretti and Zambra, of Holborn Viaduct, E.C., for a price-list. Recording direction anemographs can be seen at work at many observing stations, such as Greenwich, Kew, Oxford, Falmouth, Fleetwood, Holyhead, Manchester, Stonyhurst, and other places.

MANY men of science will be glad to learn that it is proposed to establish some permanent memorial of the late Prof. W. F. R. Weldon, not only of the man himself, but also of the movement with which his name is especially associated, the application, that is, of exact methods of statistical inquiry to the study of variation and kindred problems in zoology. It has been suggested that the memorial should consist of a portrait—medallion or bust—in the museum at Oxford, a cast of which might be placed in University College, London, and of a prize to be awarded periodically to the author of the most valuable biometric publication of recent date. The committee will arrange that subscribers may eventually purchase a reproduction of the portrait. Contributions may be sent to Dr. G. C. Bourne, Savile House, Oxford; Dr. G. H. Fowler, 58 Bedford Gardens, W.; Prof. Karl Pearson, F.R.S., University College, W.C.; Mr. Adam Sedgwick, F.R.S., Trinity College, Cambridge; or to the Weldon Memorial Account, at the Old Bank, Oxford.

A ROYAL Commission has been appointed to consider certain questions affecting the erosion of the coasts of the United Kingdom. The commission is to inquire and report:—(a) As to the encroachment of the sea on various parts of the coast of the United Kingdom and the damage which has been, or is likely to be, caused thereby, and what measures are desirable for the prevention of such damage. (b) Whether any further powers should be conferred upon local authorities and owners of property with a view to the adoption of effective and systematic schemes for the protection of the coast and the banks of tidal rivers. (c) Whether any alteration of the law is desirable as regards the management and control of the foreshore. (d) Whether further facilities should be given for the reclamation of tidal lands. Science is represented upon the commission by Dr. T. J. Jehu, lecturer in geology at the University of St. Andrews.

A LIST of Paraguay locusts (Acrididæ), with descriptions of new species, by Mr. L. Bruner, forms the subject of No. 1461 of the Proceedings of the U.S. National Museum.

WE have received copies of two papers, by Mr. H. H. Bloomer, on the anatomy of certain species of Solenidæ, reprinted from vol. xii. of the *Journal of Malacology*. We note that the familiar name *Solen ensis* is replaced by *Ensis ensis*.

THE articles in the June issue of the *Zoologist* are all devoted to birds, Mr. E. Selous discussing sexual selection, as exemplified by the breeding-habits of the ruff, while Mr. Wesché contributes notes on the habits of cage-birds, and Mr. G. W. Kerr continues his notes on the birds of the Staines district.

AN interesting report on the leading zoological gardens of Europe has been issued by the Egyptian Department of Public Works as the result of a mission undertaken last year by Captain Stanley Flower with the view of obtaining information and hints which might prove of use in the establishment under his charge at Giza. While avoiding invidious comparisons, the author has pointed out some features in connection with buildings where particular menageries excel their fellows, and has likewise published lists of some of the more notable animals which came under his observation.

SCHIZOPOD crustaceans from the Atlantic slope, by Messrs. Holt and Tattersall, and fishes from the Atlantic slope, by Messrs. Holt and Byrne, form the subjects of the latest issues of Scientific Investigations, Fisheries, Ireland (1904, v., and 1905, ii.), both published this year. The former adds five species to the British list, of which one is new. Although, as the authors remark, the addition of new species of deep-sea fishes to the British fauna is a matter of no real importance, they are enabled to increase the list by no less than sixteen species, of which one is new. The most interesting among these is the salmonid *Bathylagus atlanticus*, previously known only by a single specimen taken off Patagonia by the *Challenger*.

Trudui St. Peterburghs. Obshch. (*Trav. Soc. Imp. Nat. St. Pétersbourg*) for March and April (vol. xxxvii., part i.) contains an illustrated account, by Mr. D. D. Pedaschenk, of a wonderful new pelagic cœlenterate from Java, for which the name *Dogielia malayana* is proposed. Measuring only from one to one and a half millimetres in length, the organism is remarkable for the possession of a complex system of paired branching outgrowths. It is considered to be a highly-specialised member of the Ctenophora. The other papers include notes on glaciation in the western Urals, on a case of artificial formation of sillimanite, and on regeneration in the polychæte worm *Spirographis spallanzanii*.

IN addition to an obituary notice, with portrait, of the late Dr. Max Kaeck, and a report on the museum and gardens for the past year, the contents of the *Boletim do Museu Goeldi* (Para) include a continuation of Dr. J. Huber's account of the Brazilian flora, a synopsis by the same author of the plants of the genus Hevea, a supplement by Mr. A. Ducke to his papers on the social wasps of Para, and a paper by Dr. E. Goeldi on the chelonians of Brazil. Exclusive of the marine forms, the author recognises twenty-one species of the latter as indigenous to the country, all but four of these belonging to the Pleurodira. Perhaps the most important part of this paper is an account of the habits of the great arrau turtle (*Podocnemis expansa*) of the Amazon, from observations made by Major J. M. da Silva Coutinho in 1868.

WITH its second (June) number, of which we have received a copy, the *Haslemere Museum Gazette* has changed its title to the *Museum Gazette*. There are several excellent illustrations in this part, among them figures of the two common British snakes and a reproduction of a photograph of the historical department in the Haslemere Museum, and a number of short articles, dealing chiefly with natural history subjects from an educational point of view. Certain items in these will be read with some surprise by naturalists. We are told, for instance, on p. 65, that "all the gnus are South African, and would appear to bear the same relation to the buffaloes of that continent that the North American bison does to the American buffalo"; while on the preceding page we are informed that "the camels and llamas form transition species between horses and oxen (ruminants and solid ungulates)." Almost equally original pieces of information occur on other pages.

In the Bulletin (May) of the Department of Agriculture, Jamaica, a new epiphytic fern, allied to the rare *Polypodium Fawcettii* and *Polypodium dendricolum*, is described by Mr. W. R. Maxon under the name of *Polypodium nesioticum*. Reference is made to a weevil attacking the camphor trees at Cinchona that has been identified as *Hilipus elegans*, a species abundant in Central America, whence it has been probably imported to Jamaica. The Bulletin also contains a note on the coagulation of Castilloa rubber, as well as an article recommending the plantation of Castilloa trees in Nicaragua in preference to Hevea.

The investigation of the fungi that prey upon scale-insects has its practical aspect, as already some of these fungi have been successfully employed in the United States as remedies against scale-pests. They are probably unimportant in temperate regions, but in the tropics they are widely spread, as may be gathered from an account contributed by Mr. J. Parkin to the Annals of the Royal Botanic Gardens, Ceylon, vol. iii., part i., reviewing the subject generally and making special reference to Ceylon forms. All the fungi so far determined fall under the Ascomycetes, and most of them belong to the Hypocreales, the best-known genus being Nectria. Other genera are classed with the *fungi imperfecti*, although they are probably conidial stages of the Hypocreales.

In accordance with the announcement that papers on systematic botany and monographs concerned with Philippine plants will be published as supplements to the Philippine Journal of Science, a supplement to the first volume contains a list of plants collected in that portion of the island of Luzon lying upon the north-west side of Manila Bay known as the Lamao forest reserve, where it is intended to investigate various forestry problems. The compilation has been prepared by Mr. E. D. Merrill, with assistance from specialists, from material recently obtained by different collectors. Out of the total of a thousand species of phanerogams, representing more than six hundred genera, 45 per cent. are classed as endemic and 54 per cent. as trees. Obviously there are few genera with many species, Ficus and Eugenia being two exceptions.

In the *Bulletin de la Société d'Encouragement* (vol. cviii., No. 4) there is an illustrated description of a remarkable testing machine of 270 tons constructed for the University of Illinois. It is 11 metres high, and will test for compression pieces $7\frac{1}{2}$ metres long, and for tension pieces 6·6 metres long, provided that the elongation does not exceed 20 per cent. There are also dimensioned drawings of the 10,000 horse-power turbine at Snoqualmie Falls. It weighs about 86 tons, and has an efficiency of 84 per cent.

The three latest Bulletins of the admirable series issued by the Peruvian Corps of Mining Engineers have been received. In Boletin No. 32 Mr. F. Malaga Santolalla describes the ore deposits and coalfields of the province of Celendin, one of the smallest but richest of the department of Cajamarca. The ore deposits are numerous, but little exploration has been carried out owing to difficulties of transport. In Boletin No. 33 Messrs. C. W. Sutton, J. J. Bravo, and J. I. Adams describe the geology of the province of Callao. An account is also given of the triangulation of the province. The base line of $2\frac{1}{2}$ kilometres at Playa Brava was measured with a 100-metre steel band, and the angles were measured with an 8-inch theodolite reading to two seconds. In Boletin No. 34 Mr. H. C. Hurd submits a report on the possibility of increasing the quantity of water available for irrigation in the valley of the Chili, in the department of Arequipa.

The current issue of the Records of the Geological Survey of India (vol. xxxiii., part iii.) is a number of more than ordinary interest. Mr. L. Leigh Fermor gives some notes on the petrology and manganese ore desposits of the Sausar Tahsil, Chhindwara district, Central Provinces, in which he puts on record petrological descriptions of certain types of rocks, chiefly of the metamorphic and crystalline series, and gives an account of the eleven manganese ore deposits known to occur in this area. Several of them are of economic importance. Six beautifully reproduced plates of rock photomicrographs accompany the paper. Mr. P. N. Datta describes the geology of parts of the valley of the Kanhan River, Central Provinces, and gives a geological map of the area. Mr. L. Leigh Fermor describes a specimen of manganite from the Sandur Hills, Madras Presidency, which is of special interest inasmuch as the occurrence of this ore in India has previously been recorded but twice. In the miscellaneous notes the occurrence of gypsum in the Vindhyan series at Satna is recorded, and accounts are given of ores of antimony, copper, and lead from the Northern Shan States; of gems from the Tinnevelli district, Madras; and of cassiterite-granulite from the Hazaribagh district, Bengal. The great increase in the exports of manganese ore from India is also noted, brought about by failure in the Russian supplies following the internal disturbances. The manganese ore exported from India in 1905 amounted to 281,735 tons, against 154,829 tons in 1904.

We have received from Prof. J. A. Pollock and Mr. S. H. Barraclough, of the University of Sydney, a reprint of an interesting paper read by them before the Royal Society of New South Wales on a hollow lightning conductor crushed by the discharge. The tube, 1·8 cm. in outer diameter, made of copper 0·1 cm. thick, was crushed in a symmetrical manner, showing the characteristic appearance of a tube which had collapsed under external pressure. The crushing appears to have been due to the electrodynamic action of the current. The material of the tube was probably plastic at the time of collapse. If so, the current is calculated to have been one of about 20,000 amperes; if not, the current would have been one of about 100,000 amperes.

Himmel und Erde for April contains an interesting article by W. Gallenkamp, of Munich, on the results of recent rainfall investigations. This paper does not deal with statistics in the usual manner, but refers to experiments by Lenard and Defant on the determination of the size of raindrops and on the velocity with which they fall. The size is determined by measuring the wet patch made on blotting paper, assuming that a drop of a given size will always produce a similar patch. The result arrived at is that the weights or volumes of the drops have a definite proportion to each other, *e.g.* if unity is taken as representing the smallest drops, the weights of the other drops are found to be 2, 3, 4, 6, &c., times that weight. *Generally speaking*, the absolute size of the drops exhibits very small differences; the smallest weigh about 0·11 mg., and the weights of the others are multiples of that value, as explained above. In a lasting downpour the largest drops weigh about 1 mg. With respect to the velocity at which the drops fall, the rate is not at all proportional to the weight; those of 0·11 mg. to 1 mg. fall at the rate of 2·7 metres to 4·4 metres per second, while those of exceptional weight, say 65 mg., only fall at the rate of about 8 metres per second. These rates only hold good during calm air; in an ascending current of 2·7 metres per second the smallest drops would remain suspended. The latter part of the article deals with Mr. Wilson's experiments on the ionisation of the atmosphere as the probable prime cause of the formation of rain. A note on the size of raindrops will also be found in vol. xviii., p. 242, of the Quarterly Journal of the Royal Meteorological Society.

An interesting contribution to the study of the nature of solution and of osmotic pressure is contained in a paper by Mr. C. S. Hudson in the *Physical Review* (vol. xxii., No. 5). The conception of Prof. Hulett that the low vapour-pressure of solutions indicates that these solutions are under a negative pressure is extended to explain the depression of the freezing point of water by the addition of a dissolved substance. It would appear at first sight that a negative pressure would occasion a rise in the freezing point, because an increase of pressure causes a lowering of the melting point of ice; but this reasoning is not correct, because the ice which freezes from a solution is under atmospheric pressure, not negative pressure, and only the solution may be regarded as being subjected to the negative pressure. By using Prof. Poynting's calculation of the change of freezing point caused by an increase in the pressure on the ice alone, it is shown that the molecular depression of the freezing point of water caused by the addition of a dissolved substance is exactly equal to that corresponding with a negative pressure exerted on the solvent, and equal in magnitude to the osmotic pressure. The osmotic pressure thus corresponds with a positive tension exerted on the liquid by the dissolved solid. A general thermodynamic investigation of the process of freezing is also contained in the paper.

A fourth edition of Mr. C. F. Townsend's "Chemistry for Photographers" has been published by Messrs. Dawbarn and Ward, Ltd.

OUR ASTRONOMICAL COLUMN.

Search-ephemeris for Finlay's Comet.—In No. 4100 of the *Astronomische Nachrichten* M. L. Schulhof publishes an approximate daily ephemeris for the coming apparition of Finlay's comet. The time of perihelion passage is taken as September 8, and the ephemeris covers the period June 18 to August 1; two contracted ephemerides are also given for T = September 4·0 and T = September 12·0. Owing to its expected close approach to the earth, the comet should be in an excellent position for observing later in the year.

The perturbations since the last apparition of this comet have not been taken into account in the present ephemeris, but a more accurate ephemeris is promised in an early publication. According to that now published, the comet is at present (July 5) apparently near to δ Aquarii, which rises about 11 p.m., but by the end of the month it will have passed into Cetus, and will be about half-way between θ and Mira Ceti.

Stereoscopic Measurement of Proper Motions.—A detailed description of the stereo-comparator method of determining the proper motions of stars is given by Prof. Max Wolf in No. 4101 of the *Astronomische Nachrichten*, where he also gives and describes the first results obtained by the method. A pair of photographs, arranged for the stereoscope, which accompany the paper show the effect of proper motion beautifully, for a star which has moved 19 seconds of arc in fourteen years appears to be considerably behind the general plane of the surrounding stars. With an especially constructed micrometer, the observer is able to determine the amount of the proper motion in right ascension and declination.

Prof. Wolf shows in a table the values measured and the results obtained for ten stars of about the tenth magnitude, and also for two other stars, Nos. 75 and 74 in Prof. Kobold's list. Comparing the meridian-observation results for the latter with the stereo-comparator values, he shows the trustworthiness of the new method thus:—

	Kobold 75 Proper motion (in secs. of arc)	Position angle	Kobold 74 Proper motion in secs. of arc)	Position angle
		°		°
Meridian circle ...	2·23 ...	162·0	0·88 ..	199·3
Stereo-comparator	2·21 ...	157·1	0·91 ...	183·2

This is very satisfactory, especially when one remembers that on the scale of Prof. Wolf's plates 1 second of arc is represented by only 0·004 mm.

Radiative Power of the Sun's Disc.—In No. 4, vol. xxiii., of the *Astrophysical Journal*, Prof. Julius describes a new method for determining the radiative power of the different parts of the solar disc. Briefly, the method consists in recording the intensity of the solar radiation at definite intervals during the progress of a total solar eclipse. Then every increment (either positive or negative) of the intensity is solely due to the radiation coming from that strip of the disc through which the limb of the moon has appeared to move during the corresponding interval. As the geometrical form of each of the strips is easily determined, the amount of each of the concentric zones (into which the disc is previously divided) contained in any one strip may be found. The total radiation from each zone is then determined by a suitable mathematical solution. This method was tried at Burgos during the last eclipse, and, despite the unfavourable meteorological conditions, the results lead Prof. Julius to hope that under suitable conditions it may be found very satisfactory.

New Forms of Astrographic Object Glasses.—In No. 4100 of the *Astronomische Nachrichten* M. Emil Schaer describes a novel method of constructing a short-focus astrographic objective. Two lenses of the usual crown and dense flint glasses are employed; the crown is placed in front of the flint, and the back surface of the latter is silvered, so that the photographic plate has to be placed in front of the combination at the combined focal distance. M. Schaer has tried this method with two discs of 280 mm. (about 11 inches) aperture, made for him by M. Mantois, and, by suitably figuring the back surface of the flint before silvering it, has obtained an objective of 89 cm. focal length which is practically free from aberration effects, and has a large light-gathering power. To obviate unnecessary reflections, the two lenses were stuck together.

Another innovation in the construction of objectives is announced in No. 597 of *Science*, where it is stated that a Hungarian chemist, after many years' experimental work, has succeeded in manufacturing perfectly satisfactory fluid lenses. The fluid is hermetically sealed between two hard glass surfaces, similar to watch crystals, the glass being chosen so that the combination is achromatic.

The inventor claims that an objective, equal in practice to any yet made, of 1·50 metres aperture can be made in a few weeks at a cost of 2000 or 3000 marks (*i.e.* about 150*l*.).

These lenses are already being manufactured, and are giving satisfactory results, in Austria, and patents are being taken out in other countries where they are soon to be introduced.

THE GREAT TYPHOON IN THE PHILIPPINE ISLANDS IN SEPTEMBER, 1905.

THE Bulletin of the Manila Observatory for September, 1905, prepared under the direction of the Rev. J. Algué, S.J., affords a striking example of the way in which any abnormal features of the weather are completely masked in monthly, or even shorter, mean values. An inspection of the latter would lead to the conclusion that the month of September was quite normal notwithstanding the occurrence of the terrible typhoon on September 25–26, which was probably the most violent of any yet experienced, not even excepting that of November 5, 1882, the worst previously on record. We gave a brief note of the storm soon after its occurrence, taken from newspaper reports, but the following further particulars from a discussion by the Rev. M. S. Mata, S.J., assistant director, may be of interest.

The disturbance appears to have originated in long. 142° E. and between lat. 11° and 12° N. on September 22, and its path over the Pacific was approximately from east to west; it reached the land on the evening of September 25, and swept across the archipelago in a south-easterly to north-westerly direction, reaching Hainan, in the China Sea, on the evening of September 28. The breadth of the storm was about 100 miles, the centre passing about twenty-four miles south of Manila; the average velocity of translation was 13·5 miles an hour. The first indication of its approach at Manila was on the morning of September 25, when the barometer registered a notable fall of pressure. On the previous day the readings were very high; an anticyclone so well defined had rarely been observed over the Philippines. On the morning of September 26 (at which time telegraphic communication to the south-eastward was already interrupted) the fall became alarming, and continued until 2h. p.m., at which time the minimum (29·21 inches) was reached, the mercury having fallen about 0·7 inch since 9h. p.m. of the previous evening; after a short pause the mercury rose again very rapidly. Between noon and 3h. p.m. the gusts of wind attained a rate of about 103 miles an hour. The rainfall in twenty-four hours amounted to $4\frac{1}{4}$ inches, of which 2·3 inches fell between 3h. and 5h. p.m., after the passage of the vortex, the wind changing from east-north-east to south-east, with rapidly rising barometer.

FIG. 1.—Meteorological Station of Legaspi, after the typhoon of September 25–26, 1905.

The s.s. *Pathfinder* was overtaken by the storm in San Bonifacio (lat. 12° 10′ N., long. 125° 30′ E.), and recorded some notable oscillations of the barometer; at 8h. a.m. on September 25 the reading was 29·78 inches, and the mercury fell rapidly until 7h. 37m. p.m., when the minimum of 27·17 inches was registered. There was a comparative lull in the wind for three or four minutes, and then it blew more fiercely than ever, with a rapid change of direction from north-by-west to west, and drove the ship ashore; in a few minutes the wind shifted to south, and by midnight the barometer had again risen to 29·61 inches. Immense damage was caused by sea and land, especially at the eastern stations. We reproduce an illustration of the destruction of the observatory at Legaspi (lat. 13° 9′, long. 123° 45′); the sea, which had not risen so high for thirty years, rushed into the town with extraordinary force, some parts being submerged to a depth of $2\frac{1}{2}$ feet to 5 feet. At many other places not a single building was left uninjured, and some of the largest trees, which had withstood all previous storms, were uprooted.

THE NEW BUILDINGS OF ARMSTRONG COLLEGE, NEWCASTLE-ON-TYNE.

THE new buildings of Armstrong College, to be opened by the King on Wednesday next, July 11, consist of the front wing of the college, together with the large public hall immediately behind the front. The imposing front block of buildings, about 100 yards in length, faces nearly west, and is on the border of the open space known as the Castle Leazes. In the middle of the college front, rising to a height of 120 feet, is the handsome Sir Lowthian Bell tower. The chief entrance is at the base of the tower, and gives access to a spacious vestibule which communicates with the north-east and south-west wings, the principal staircase, and the large public hall to be used for lectures, meetings, and examinations.

The front wing consists of four floors. On the ground floor to the north of the entrance are the principal's room, the council room, the staff common room, and a large common room for men students. To the south of the entrance are the secretary's office, the college office with strong room, and the electrical engineering department. This last consists of a lecture room, and a spacious laboratory with wide gallery on one side. On this gallery is the main electrical distribution board, to which leads are brought from every part of the building. There is a second laboratory of the same size in the basement beneath. Outside the college, on the basement level, is built a house for storage cells. Over the ground-floor corridor, in connection with this department, is a large photometric room fitted up with suitable appliances for carrying out tests in a complete manner. Access to this room is obtained from the gallery of the ground-floor laboratory.

On the first floor is the library, with a photographic dark-room adjoining, which is used for lantern-slide and other photographic work. Accommodation is also provided on this floor for the mathematics, the naval architecture, the literature, and the education departments, with their several lecture and private rooms. On the second floor there is provision for the botanical department, consisting of an elementary laboratory, an advanced laboratory, a research laboratory, lecture and preparation rooms with dark-room, and the professor's private room. There are also on this floor lecture rooms for philosophy, modern history, classics, and modern languages, as well as private rooms for the several heads of departments in these subjects. On the third floor is the zoological department, which contains a large room more than 70 feet long, one half of which, towards the front, is used as a zoological museum, and the other half as an elementary laboratory, and also advanced and research laboratories, lecture room, and professor's private room. In addition, this department has the use of the flat roof over a portion of the floor below. This open space will be utilised for maceration and similar purposes. Associated with the zoological department is the marine laboratory which is about to be erected at Cullercoats, on the coast just north of Tynemouth (see p. 228).

The ventilation of the front wing is provided for by two electrically-driven fans in the tower, which exhaust from the rooms on the several floors. The heating is by means of steam on the new so-called atmospheric system, and the lighting is by 240-volt electric lamps, which can either be supplied from the college central station or from the town supply. Electric arc lanterns are provided in several of the lecture rooms.

The large public hall, in which the chief portion of the opening ceremony is to take place, will accommodate, with the gallery at the south-west end, an audience of about 800.

The foundation-stone of the new buildings was laid by Mr. T. G. Gibson, a member of council and the most generous supporter of the college, on May 2, 1904, and the buildings have been erected to the designs and under the supervision of Mr. W. H. Knowles, of Newcastle.

FIG. 1.—New front wing (facing west) of Armstrong College, to be opened by the King on July 11. In the centre is the Sir Lowthian Bell tower.

The cost of the new buildings, together with the fittings, has been nearly 80,000*l*. The funds have been provided by public subscription, and since the buildings are intended as a memorial to the first Lord Armstrong, one of Newcastle's most distinguished citizens and benefactors, the name of the college was in 1904 changed from the Durham College of Science to Armstrong College in the University of Durham. The area of the grounds within which the college stands is between five and six acres. The present buildings occupy about two acres, and more than two acres, excluding roads, &c., are available for the extensions that are being projected. The accompanying photograph shows the front of the college, which forms the west wing.

The number of day students attending the college last session was 539, and in addition about 1100 students attended the evening and special Saturday classes. The college forms an important part of the University of the North of England. The degrees of Durham in science and letters, and its diplomas in agriculture, engineering, and mining are open to students of the college. The Warden of the University (the Dean of Durham) is the president of Armstrong College, Sir Isambard Owen is the principal, and Mr. F. H. Pruen is the secretary.

INTERNATIONAL SCIENCE.[1]

THE pursuit of science has always joined in sympathy men of different nationalities, and, even before the day of rapid letter-post and quick travelling, intercourse, especially by correspondence, exercised a considerable influence on scientific activity. Such intercourse was, however, of a personal and purely stimulating character, and only quite exceptionally was there any direct attempt to organise investigations which required a combination of workers in different localities. Within the last century, however, many problems became urgent which could not be solved without some international agreement, and special organisations came into life which have rendered a service the importance of which cannot be exaggerated.

At present we are confronted with a new difficulty. International combination has become so necessary, and organisations have in consequence increased to such an extent, that they begin to overlap, and there has been some danger of mutual interference. Fear has also been expressed that any attempt to advance knowledge by an organised combination of workers might discourage private efforts, and therefore do mischief rather than good. It must be acknowledged that this danger exists. The proper function of combination must be clearly separated from that of private enterprise, and some general regulating control is therefore called for. The time seems ripe for a general review of the situation.

We may distinguish between three types of international organisations. The first aims simply at collecting information, the second is intended to fix fundamental units or to initiate agreements on matters in which uniformity is desirable, while by the third type of organisation a more direct advance of knowledge is aimed at, and research is carried out according to a combined scheme. Generally, an international association does not entirely fall within any single one of these divisions, but it is useful to draw the distinction and classify the associations according to the main object which they are intended to serve.

The best example of an organisation formed for the purpose of collecting information is furnished by the great undertaking initiated by our Royal Society, and having for its object the systematic cataloguing of the scientific literature of the world, both according to subjects and authors. Twenty-nine countries (counting the four Australian colonies separately) are actively participating in this work by furnishing slips containing the entries which form the basis of the catalogue. A still larger number of countries assist by subscribing to the annual volumes.

The subjects included in the catalogue are classified according to seventeen branches of science as follows :—

A Mathematics	G Mineralogy	N Zoology
B Mechanics	H Geology	O Anatomy
C Physics	J Geography	P Anthropology
D Chemistry	K Palæontology	Q Physiology
E Astronomy	L Biology	R Bacteriology
F Meteorology	M Botany	

Subscribers may either obtain complete sets or any of the separate volumes. The relative popularity of the different subjects is illustrated by the following table, which gives in the different columns for each science the volumes approximately required by each country. The figures are, of course, subject to variations from year to year. The first column shows the number of complete sets subscribed

[1] Discourse delivered at the Royal Institution on Friday, May 18, by Prof. Arthur Schuster, F.R.S.

for, in addition to the separate volumes; these presumably find their way into the university or public libraries.

	Sets	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R
Russia	14	2	2	11	6	18	15	19	20	20	13	8	38	30	5	14	8	8
France	27	4	5	11	17	4	3	10	7	5	6	15	13	12	7	3	18	16
Switzerland	7																	
Canada	7																	
Holland	5	1	2	1	3	1	2	1	2	3	1	4	3	3	1	1	2	3
Greece	2																	
Hungary	4																	
Norway	3			1	1		1						2	4	1	1	2	
India	29	5	4	7	5	2	5	2	3	4	2	5	14	5	2		4	6
United States	62	11	14	17	14	10	11	8	12	10	7	9	12	10	3	3	7	9
Great Britain	29	5	7	18	17	6	8	8	8	5	4	6	6	5	6	6	7	13
Austria	4	1	2	4	2	1	4	3	5	6	2	4	4	5	1	3		1
Cape of Good Hope	6				1			2	2		2			1				
Denmark	6																	
Egypt	1																	
Finland	1	1	2	2	2	1	1	2	3	1	1	1	2	2	1	1	2	1
Germany	44	6	8	14	18	2	5	3	4	5	1	13	9	8	5	2	18	7
Italy	27																	
Japan	15																	
Mexico	5																	
New South Wales	2																	
Nova Scotia	1																	
Orange Riv. Colony	1																	
Poland	1																	
Portugal	1																	
Queensland	2																	
S. Australia	2																	
Sweden	5																	
Victoria	1																	
W. Australia	1																	
Total	315	36	46	86	86	45	55	58	66	59	39	65	103	85	32	34	68	64

The popularity of the special botanical catalogue is remarkable.

We may obtain a rough idea of the scientific activity of different countries by comparing the number of slips received from them during a certain interval. The numbers given in the report published by the International Convention held in London last summer, and referring to all slips received, are shown in the following table:—

	Slips received	Number of journals	Average number of slips per journal
Austria	13,186	535	25
Belgium	2,272	174	13
Canada	537	45	12
Denmark	2,584	40	64
Finland	1,828	33	55
France	60,401	930	65
Germany	213.545	1,397	153
Holland	9,861	70	141
Hungary	2,605	35	75
India and Ceylon	2,699	31	87
Italy	21,238	300	71
Japan	3.043	42	72
New South Wales	2,049	8	256
New Zealand	440	1	440
Norway	2 017	36	56
Poland	5,830	65	90
Russia	25 741	457	56
South Africa	1,872	15	125
South Australia	159	6	26
Sweden	1,939	63	31
Switzerland	5,140	126	41
United Kingdom	56,382	488	116
United States of America	66 671	588	112
Victoria (Australia)	2,858	23	124
Total	504 297	5,508	90

The total number up to March, 1906, has increased to 700,000.

The catalogue begins with the year 1901, but some countries send in their slips rather earlier than others, so that the time interval covered by the investigations to which the table refers is not quite the same for all. Nevertheless, the numbers shown in the table possess a certain interest. I have given in the last two columns the number of journals which different countries take into account, and the ratio of the number of slips to the number of publications. Here again it is difficult to estimate accurately how much value is to be attached to the figures, as there is no uniformity of selection as to what should and what should not be included in the catalogue. Journals which may only very seldom contain any paper which is to be included may unduly diminish the numbers in the last column, which are also affected by the interpretation given as to what is purely technical, and therefore to be excluded. Nevertheless, the comparison between the United Kingdom and France gives the somewhat striking result that, while France is slightly ahead in the number of separate entries it contributes to the catalogue, it takes account of nearly double the number of journals, and the ratio showing the number of entries per journal is therefore very small. In the case of Belgium and Canada, we find also a large number of publications as compared with the slips received. Regard must, however, be had to the fact that in the subject catalogue the same paper may furnish several entries. Especially is this the case in the biological subjects, where several species may be described, for each of which a separate slip must be written out. Hence in any country active chiefly in the discovery of new species the ratio given in the last column of the table would be abnormally large. This is probably the explanation of the figures given for New Zealand. In the opinion of the director of the Central Bureau, the standards adopted by different countries are drawing nearer together as the work proceeds, and before long we may therefore expect to obtain valuable statistical information on the scientific activity in different countries. But this is only an incidental result of the undertaking. It may reasonably be argued that the scientific investigator ought not, before he begins a research, to trouble too much about what may have been done by others in the same direction, but there is no doubt that before publication he should have made himself acquainted with the literature of his subject. A well-arranged catalogue then becomes a necessity, though its value as a means of helping students differs considerably in different subjects.

The governing body of the catalogue is an International Council composed of one representative from each of the countries taking part in the scheme. This council has appointed an executive committee, of which Prof. Armstrong is the chairman.

The Central Bureau for the publication of the catalogue is in London, under the direction of Dr. Henry Forster Morley, who has a staff of thirteen workers under him. There are, in addition, nineteen experts or referees representing the different sciences. The annual office expenses, including salaries, amount to about 2200*l.*; while the expenditure on printing, binding, and publication in the year ending March 1, 1905, amounted to nearly 4000*l.* The two items are just covered by the guarantees of the different countries, which, as already mentioned, take the form of subscriptions for copies of the catalogue, so that it may be said that the central office is self-supporting. After so short a time of working, this success must be a source of considerable satisfaction to Prof. Armstrong and those who have helped to initiate the work; but the expenses incurred in London only represent a fraction of the total cost of the work. Most of the countries establish regional bureaux, which prepare the slips and forward them to London. This really constitutes the most serious part of the work. In Germany, for instance, the Regional Bureau is under the direction of Prof. Uhlworm, one of the university librarians, who is helped by six assistants, and devotes his whole time to the work.

I pass on to an undertaking of a very different kind, but still one which must be included in the class which primarily aims at cataloguing. The accurate determination of the positions of the stars for a particular period is a work which must precede all exact investigations of their proper motions. Hence it constitutes a fundamental problem of astronomy. The multitude of stars seen on a bright night is bewildering to the casual observer. They are described in poetical writings as innumerable, but when an actual count is made, it is found that their number is really moderate, and it is doubtful if more than two thousand stars have ever been visible to the naked eye at the same time. The use of the telescope considerably increases this number, according to the size of the object-glass or reflecting mirror used. Thus Argelander in his great star catalogue included nearly 324,200 stars which he observed through his telescope of four inches aperture. The advent of photography and the manufacture of suitable lenses to be used in connection with photography increased the astronomical output of a fine night to such an extent that it became possible to make a further and very substantial advance. The International Star Catalogue which is at present being constructed owes its origin chiefly to the hard work of Admiral Mouchez, who was at the time director of the Paris Observatory, and who became converted to the feasibility of the plan by the excellent results obtained by the Brothers Henry, the pioneers in star photography. He was assisted by the energetic support of Sir David Gill, to whom the first suggestion was due. The programme of work was determined upon at an International Conference which met at Paris in the year 1887. Eighteen observatories were to take part in the work, the telescopes to be used were to have an aperture of thirteen inches, and such a focal length that a millimetre on the plate corresponded to one minute of arc. Each observatory had a certain region of the sky assigned to it, and undertook to cover this region four times, twice with plates of short exposure, twice with plates of long exposure, and to measure all the stars appearing on the short-exposure photographs. The long exposures were intended for reproduction in the form of charts, and are only taken by some of the observatories. As there are about 400 stars on each plate, and it takes about 600 plates to cover the share of one observatory once, this means that each observatory has to measure nearly half a million star places, and that the complete catalogue will give the positions of nearly $4\frac{1}{2}$ million stars. This includes all stars down to the eleventh magnitude.

The following is a list of observatories taking part in the work:—For the northern hemisphere, Greenwich, Oxford, Paris, Bordeaux, Toulouse, Potsdam, Helsingfors, Rome, Catania, Algiers. For the southern hemisphere, San Fernando, Tacubaya, Santiago de Chile, Cordoba, Cape of Good Hope, Perth (W. Australia), Sydney, Melbourne.

The work connected with the ultimate completion of the catalogue, and especially the reproduction of the star maps, requires a considerable expenditure. Each country has to make its own arrangements, which in the British Empire usually means that each body concerned has to pay its own expenses. There was, however, in this case some official help. The Astronomer Royal obtained a contribution of 5000*l.* from the Government for the reproduction of charts, and in the case of the Cape of Good Hope the necessary expenses have been met from Imperial funds. Prof. Turner, of Oxford, has obtained a grant of 1000*l.* from the Government grant of the Royal Society, and a further sum of 2000*l.* for publication from the Treasury and the University of Oxford jointly; but the Australian colonies are much hampered by the want of funds, and their work will be delayed in consequence. The four French observatories, on the other hand, are well supported. Each of them has received a Government contribution of 25,700*l.*, making a total of well over 100,000*l.* More than half this goes towards the reproductions of the long-exposure photographs as a series of charts, which, however, have proved to be so costly that they will probably never be completed. Indeed, if completed, their utility may to some extent be impaired by the difficulty of storing them in an accessible manner. Prof. Turner calculates that the series of maps will form a pile of paper 30 feet high, weighing about two tons.

I now pass on to those undertakings which are intended to fix standards of measurement, or to establish a general agreement on matters in which uniformity is desirable. The foremost place in this division must be given to the Bureau International des Poids et Mesures, which was established in the year 1873 at Sèvres, near Paris. This bureau was the outcome of an International Commission constituted in 1869, which had for its object the scientific construction of a series of international metric standards. By a convention entered into by the different countries at a diplomatic conference held at Paris in March and April, 1875, means were created for carrying out the work of verifying standards under a new International Metric Committee, and for the purpose of enabling the committee to execute its duties effectually, as well as of securing the future custody and preservation of new metric prototypes and instruments, the Permanent Metric Bureau was founded. The original cost of the bureau was 20,000*l.*, and the annual budget was fixed at 3000*l.* for the period during which the prototypes were being prepared, after which time it was expected that the expenditure could be reduced to 2000*l.* In 1901, however, it reached 4000*l.*, the maximum to which, by the terms of the convention, the annual budget could be raised. Great Britain did not join the convention until 1884, when it declared its adhesion. A first payment of 1787*l.* was made as entrance fee, and the annual contribution now ranges between 200*l.* and 300*l.* Major MacMahon, to whom I owe the above details, is at present the British representative on the International Committee.

The work carried out at Sèvres is not confined to the reproduction of metric standards, but measurements of precision in various directions have been made with conspicuous success. Scientific thermometry owes much to the International Bureau, and in some respects it may be said that exact thermometry was created there. Prof. Michelson's work, in which the length of the metre was compared directly with the length of a wave of red light, is another classical investigation carried on in the laboratories of the International Bureau. More recently Mr. Guillaume examined the physical properties of alloys, notably those of nickel steel, and proved the possibility of manufacturing a material which shows no sensible expansion with rise of temperature. The importance of metallic rods the length of which does not depend on temperature is obvious, provided they prove to be of sufficient permanence.

Time does not allow me to give an account of the conference and conventions which have led to a general agreement on the standards of electric measurements, but it is a satisfaction to know that these standards are essentially those proposed and first constructed by the British Association. The old British Association ohm no doubt was found to be wrong by more than 1 per cent., but it has remained the prototype of the present international unit, and in principle the old ohm, volt, and unit of current stand as they were given to us by the original committee.[1]

While in the case of scientific units complete agreement is absolutely essential, uniformity is desirable in other cases. There are matters of nomenclature in which confusion has arisen purely from want of general agreement. Thus the great recent improvement in the optical power of telescopes has led to the discovery of many details on the surface of the moon. Small craters or other distinctive features named by one observer were not correctly identified by another, so that at the present time the same name is applied to quite different things by different observers. It is quite clear that an international agreement in lunar nomenclature is called for.

There are other deficiencies of uniformity which perhaps appear trivial, but which yet lead to the waste of a good deal of time. Such, for instance, is the position of the index in scientific books. The index is placed sometimes at the beginning, sometimes at the end, and sometimes neither at the beginning nor at the end. Some books have no index,

[1] The original committee was appointed in 1861, and consisted of Profs. A. Williamson, C. Wheatstone, W. Thomson (Lord Kelvin), W. H. Miller, Dr. A. Matthiessen, and Mr. F. Jenkins. In the following year, Messrs. C. Varley, Balfour Stewart, C. W. (Sir William) Siemens, Prof. Clerk Maxwell, Dr. Joule, Dr. Esselbach, and Sir Charles Bright were added to the committee.

some have two, one for the subject-matter and one for names of authors. The loss of time which arises from one's ignorance as to where to look for the index cannot be estimated simply by what is spent on the search, but must include the time necessary to regain the placidity of thought which is essential to scientific work.

It is time we turned to the more serious aspect of those international associations which directly aim at an advance of knowledge. Mathematicians have drawn interesting conclusions from the contemplation of ideal beings who are confined to live on a surface and have no knowledge of anything that goes on outside that surface. Our Euclidean geometry would be unknown to them, and spiritualistic tricks could be performed by anyone possessing, even to a minute extent, the power of controlling a third dimension. It is, I think, worth while investigating the extent of the direct knowledge of a third dimension, which makes us so infinitely superior to the two-dimensional beings. We are able, no doubt, through our eyes, to penetrate the depths of space, but we should be unable to interpret the impressions of our sight if we had not some tangible knowledge of three dimensions, and had not learned to bring the sense of sight and the sense of touch into harmony. But our sense of touch is confined to a very small distance from the ground on which we stand, and independently of artificial means of raising ourselves above the surface of the earth, a layer 6 feet or 7 feet thick represents the extent of our three-dimensional knowledge. Compared with the radius of the earth, the thickness of such a layer is small enough, for it would represent only the thickness of a sheet of paper on a sphere having a radius of 250 metres; compared with the solar system, and even more so with stellar distance, a thickness of layer of 8 feet seems infinitesimal. Yet the infinitesimal is essentially different from the zero, and even were our bodies much smaller than they are we should continue to have the power to interpret three dimensions. These considerations show how important it is for us to increase our knowledge of the earth itself, and to extend it so far as possible to the depth below our feet and the height above our heads.

In passing from the arbitrary units to which we refer our terrestrial measurements of length, to the scale on which we measure the dimensions of the solar system, and from them to stellar distances, the magnitude of the earth's radius or circumference forms an all-important intermediate quantity. One of the first acts of the French Academy of Sciences, founded in 1666, consisted in organising the work of accurately measuring the dimensions of the earth, and this at once enabled Newton to confirm his celebrated theory of universal gravitation. As improvements in the methods of measuring kept pace with the work actually accomplished our knowledge steadily increased, but we are still improving on it. New problems have arisen requiring more minute study, and the measurements of the shape and size of the earth still remain a question of the first importance. The actual surveys and triangulation required for the purpose are of necessity left to the initiative of individual States or to the combination of the States primarily concerned, but the general discussion of results, so far as they apply to the earth as a whole, is entrusted to an International Geodetic Association, which at present consists of twenty-one States. These, together with their annual contributions to the general fund, are entered in the following table:—

	£		£
Belgium	80	Austria	300
Denmark	40	Portugal	80
Germany	300	Roumania	80
France	300	Russia	300
Greece	40	Sweden	40
Great Britain	300	Switzerland	40
Italy	300	Servia	40
Japan	300	Spain	150
Mexico	150	Hungary	150
The Colonies of the Netherlands	40	United States of America	300
Norway	40		

The Central Bureau of this association is attached to the Royal Geodetic Institute of Potsdam, which is under the distinguished direction of Prof. Helmert, who acts as secretary to the association.

The question of measuring the size of the earth depends to a great extent on the measurement of arcs of meridian. So long as we were confined to Europe for the measurements of these arcs they remained necessarily short, but larger and larger portions of our globe have become accessible to the theodolite, and there is especially one arc which is distinguished by the fact that it is the longest possible which can be traced along the land covering the earth's surface. It runs about 30° east of Greenwich, and a large portion of it passes through Africa. Owing to the great energy and enterprise of Sir David Gill, the work of measuring this arc is well in hand, though at the present moment want of funds threatens to endanger its completion. The Egyptian Survey entrusted to Captain Lyons will no doubt receive continued support, and by an arrangement entered into between representatives of the German Government and Sir David Gill at a conference held in Berlin in 1896, Germany undertook to carry out the triangulation through her territory in South-West Africa. I understand this work has been done, and the triangulation of the Transvaal and the Orange River Colony is also complete. There is still a gap in the southern part of Rhodesia, but there is every hope that this will soon be bridged over. The British South African Company has spent 36,000*l.* on the work and thus has very materially assisted an important enterprise. When the African arc is complete it will be connected with the Russian and Roumanian arcs so as to form a continuous chain of 105° extending from 70° north to 35° south latitude. I have to point out, however, that, in the opinion of those best able to judge, the completion of the South African arc is not the only undertaking to which this country is called upon to pay attention. The triangulation of our own island, excellent as it was when first made, has fallen below the accuracy required in modern geodetic work. Until our fundamental triangulation has been repeated, the sums which at present are being spent on the detailed survey might find a better use.

The main result of the recent work has been that, so far as present measurements allow us to judge, the surface of the ocean can be well represented by a surface of revolution, and it is not necessary to assume a more complicated shape. The mean radius of the earth is determined to about 100 metres, which means a possibility of doubt amounting to about 1 part in 60,000.

Geodetic work is, however, not confined to measurements of length, for important information may be derived from an exact knowledge of the acceleration of gravity over its surface. The introduction of the pendulum of short length intended for relative and not for absolute measurement has greatly facilitated this work, and it is hoped that these pendulum observations may be carried out over still more extended regions. India is setting a good example. It has measured two arcs of meridian, and the gravitational work carried out by Captain Burrard, and recently published by the Royal Society, is of primary importance. But otherwise English colonies require encouragement to do more. I am assured that measurements of the gravitational constant in Canada would be of the greatest importance.

The bearing of such work on our knowledge of the earth may perhaps be illustrated by one example. It has often been a matter of wonder how mountain chains such as the Himalayas could rest on the lower strata of the earth without crushing them and forcing them in by the pure power of their weight, and the most plausible theory to account for this was found in the idea first suggested by Pratt, that the mountain chains must not be compared with a large weight resting on an under-structure, but rather with a lighter body partially immersed in a heavier one. Mountains, according to this theory, float in the body of the earth very much like icebergs float in water. The truth of this theory can only be tested by accurate measurement of the gravitational force, from which information may be derived on the distribution of density in the earth's strata near the surface. On the whole, the measurements so far available have confirmed Pratt's hypothesis.

More recently another problem has occupied the attention of the International Geodetic Association, and, owing to its immediate interest, has absorbed the greater portion of its funds. The astronomical world was surprised by the announcement of Prof. Chandler that he was able to demonstrate from existing observations that the earth's pole describes a closed curve taking about fourteen months to complete a revolution. The possibility of a periodic shift of the earth's axis was foreseen by Euler, who calculated the time of revolution to be ten months; but observations did not show a sensible period of that duration. No one apparently before Chandler tried to see whether another period beyond a small annual one existed. The discrepancy between the calculated ten and the observed fourteen months was cleared up by Prof. Newcomb, who pointed out that Euler's calculation was based on the supposition that the earth is an absolutely rigid body. Any yielding would increase the length of the period; in fact, the earth must be more rigid than steel in order that the period should be as short as fourteen months. This shows how indirect information on the physical properties of the earth may be obtained sometimes in an unexpected manner, the periodic revolution of the pole leading to an estimate of the average rigidity of the interior of the earth. The total displacement of the pole of the earth from its average position is small, never amounting to more than 8 metres. The accuracy with which that displacement can be measured is a testimony to the excellence of our astronomical observations. It is a type of work in which cooperation is absolutely necessary. The subject has received additional interest through the suggestion made by Prof. Milne in his recent Bakerian lecture that seismic disturbances may be caused by the changes in the position of the earth's axis. Considering that the distortions in the earth are sufficient to increase the periodic revolution of the pole from ten to fourteen months, this suggestion is well worth investigation, and the 300*l.* per annum spent by this country in support of the work of the Geodetic Association will be well employed if it allows the vagaries of our pole to be more closely studied and all the dimensional quantities of the surface of the earth to become more accurately known.

The contributions received by the Central Bureau of this association from the participating States amount to about 3000*l.*, and there is a balance which at the end of 1904 amounted to more than 5000*l.* The expenditure during 1905 was nearly 5000*l.*, reducing the balance by 2000*l.* The principal items of the expenditure were formed by contributions towards the maintenance of six stations in the northern and two stations in the southern hemisphere for carrying out the observations relating to the changes of the position of the earth's axis. The whole cost of this service is about 4450*l.* The honorarium of the secretary is 250*l.*, which, together with the cost of printing, postage, and a small item for grants toward special scientific work, makes up the expenditure. No charges are made for office expenses, which are defrayed by the Prussian Government.

The geodetic work indirectly gives us valuable, though only partial, information on the interior of the earth, but it confines itself in the main to the surface of the globe; the investigation of our atmosphere carries us beyond.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. J. P. HILL has been appointed to the Jodrell chair of zoology at University College, London.

AT King's College, London, Dr. C. S. Myers has been appointed professor of psychology (including experimental psychology), and Mr. H. S. Allen senior lecturer in physics.

THE Rev. T. C. Fitzpatrick, dean and supernumerary fellow of Christ's College, has been elected president of Queens' College, Cambridge, in succession to the Bishop of Ely.

A COURSE of five free public lectures is to be given, in accordance with the will of Mr. Brown, in the physiological laboratory of the University of London on July 9, 11, 13, 16, and 18, by Prof. T. G. Brodie, F.R.S., on the "Secretion of Urine under Normal and under Pathological Conditions."

THE trustees of the Brooklyn Polytechnic Institute have, we learn from *Science*, subscribed 160,000*l.* toward the 400,000*l.* necessary to endow the proposed extension of the institute, affording facilities for more advanced work. In addition to this handsome provision for higher education, our contemporary announces that Mr. and Mrs. Jacob Turtellout, of Minneapolis, have offered to give 80,000*l.* to build and endow an academy for the town of Thompson, Conn., and that Dr. Henry M. Saunders, of New York, a trustee of Vassar College, has given 15,000*l.* for the erection of a building as a memorial to his wife.

THE current number of *Macmillan's Magazine* contains an article by Mr. A. C. Passmore on technical education, in which some of the weaknesses of systems of instruction of this type are summarised. The need is insisted upon for adequate preliminary training of a suitable kind for students beginning courses of technology. It is urged that instead of being in such a hurry to provide technical schools it would be worth while to consider the qualifications and fitness of the teachers. The examination system is cited as one of the chief causes conspiring to make British technical education unsatisfactory. But the author appears to be unacquainted with the work being done in many of the great municipal technical schools, and to have ceased his educational observations some ten or fifteen years ago. Conditions at present are better than Mr. Passmore paints them.

AMONG the bequests made by Mr. F. W. Webb, who died on June 4, we notice the following:—2000*l.* to Owens College, Manchester, to establish for the benefit of employees and sons of employees of the London and North-Western Railway a "Webb" scholarship tenable at Owens College, Manchester; 2000*l.* to the University College of Liverpool for a similar purpose there as defined for Owens College, Manchester; 1000*l.* to the Institute of Civil Engineers for providing annually a "Webb Medal," and a premium of books to be awarded for the best paper on railway machinery.

THE annual assembly and prize distribution at University College, London, on Tuesday, July 3, was of more than usual interest from the fact that the friends of Prof. Carey Foster had taken the opportunity of then presenting to the college the portrait of Prof. Foster which has been painted by Mr. Augustus John. The presentation was made by Prof. F. T. Trouton, who recalled the fact that Prof. Foster was the first to introduce practical laboratory teaching in physics into England. Many of the methods devised by him in the development of his laboratory courses are to-day recognised as standard ones. For instance, every student has to go through and know his Carey-Foster Bridge as surely and regularly as at school he has to pass the fifth proposition of the first book of Euclid. The example set by Foster was followed in laboratory after laboratory, until to-day there is not a town without its course of experimental physics. Prof. Trouton concluded by hoping that though the portrait represented its subject as an older man than he really is, yet his useful life might be spared until the portrait may become that of a much younger man. The Right Hon. Lord Reay, G.C.S.I., who received the portrait on behalf of the college, referred to the great impetus which the study of physics had received by his work and writings, which are characterised by great clearness and lucidity. More especially he referred to the debt owed to Prof. Foster by the college, of which he became the first principal at a time at which great tact and knowledge were required in connection with the delicate negotiations leading to the incorporation of the college in the University of London. His lordship concluded by presenting a replica of the portrait to Mrs. Carey Foster. Prof. Foster, in acknowledging the presentations, alluded to the interval of fifty-three years since he was first present at a ceremony of the same kind. In one respect the present ceremony was of historical interest, inasmuch as it was the last ceremony to be held by the college before its incorporation. He looked forward to the advantages arising from this incorporation. The prominent defect in the higher teaching in London is the dispersion of the large resources amongst various organisations which are in some respects rivals. Principal Rücker had recently said that "any organisation to be visible must be on a grand scale." It is only by combination that the colleges of London can hope to attract the support which is so urgently needed.

SOCIETIES AND ACADEMIES.

London.

Royal Society, March 8.—"The Microscopic Changes in the Nervous System in a Case of Chronic Dourine or Mal de Coit, and Comparison of the Same with Those found in Sleeping Sickness." By Dr. F. W. **Mott,** F.R.S. (From the Pathological Laboratory of the London County Asylums.)

The author describes the changes in the central nervous system of an Arab stallion, which acquired the disease by infective coitus. After exhibiting 156 characteristic cutaneous plaques, together with marked symptoms of paraplegia, it died $27\frac{1}{2}$ months after infection. The material was forwarded by Dr. Lingard, director of the Imperial Bacteriological Laboratory of India, who has written an interesting monograph on dourine. A full description of the etiology and clinical symptoms of this disease is contained in this monograph, and an account in detail of this particular case.

Dourine is due to a specific form of trypanosome, affects equines, and is transmitted, like syphilis, by coitus. This is of especial interest, since the *Spirochaeta pallida* has been shown to be the infecting agent in syphilis.

A comparative examination of the tissues of the central nervous system in this disease and in sleeping sickness, experimental and human, appears to show that prolonged trypanosome infection results in a chronic lymphadenitis, followed later by a chronic interstitial inflammation of the lymphatic structures of the nervous system. The morbid process in the case of dourine starts in one seat of primary infection, extends to the inguinal glands, and thence (presumably by the pelvic lymphatics) spreads by the lumbosacral nerves to the posterior spinal ganglia, where it may set up an intense inflammatory process with destructive atrophy of the cells. This destruction of the trophic sensory centres which was found in this case of dourine would account for the cutaneous eruption which occurred during life. It would account also for the marked degeneration of the posterior roots and the sclerosis in the posterior columns, especially in the root zones. The lesion in some respects therefore resembled locomotor ataxy, and it is of interest to note that cases of dourine have occurred in which fractures and dislocations have been observed—due probably to neurotrophic changes. Moreover, there were other signs of chronic irritation observed elsewhere in the spinal cord and nervous system, viz. subpial and septal proliferation of the glia tissue. Marek has described the disease as an infective polyneuritis; there were reasons, however, in this case, for supposing that the motor nerves were not affected by a degenerative change in the same way as the posterior roots.

March 22.—"A Note on the Theory of Directive Antennæ or Unsymmetrical Hertzian Oscillators." By Prof. J. A. **Fleming,** F.R.S.

This paper deals with the theory of bent or unsymmetrical Hertzian oscillators. As is well known, a straight linear oscillator radiates equally in all directions around the axis. It has been found, however, by Mr. Marconi that if an antenna for electric-wave telegraphy is bent so that a short part of its length, rising from the earth, is vertical, and the greater part horizontal, and therefore parallel to the earth, such an oscillator radiates less in the direction in which the free end points than in the opposite direction.[1] This is of great practical importance, and the writer accordingly investigated mathematically the behaviour of a simple case of an unsymmetrical oscillator consisting of three simple oscillators of equal electric moment ϕ superimposed so as to make a doubly bent oscillator of the shape $\sqsubset$.

If V denotes the scalar potential at a point in the field at a distance r large compared with the dimensions of the oscillator, and F, G, and H the components of vector potential, then it is shown in the paper that

$$\mathrm{V} = -\frac{\phi}{k}\frac{d\Pi}{dz} + \frac{1}{2}\frac{\phi}{k}\frac{d^2\Pi}{dydz}\delta y - \frac{\phi}{k}\frac{d^2\Pi}{dzdy}dz,$$

$$\mathrm{F} = 0,\ \mathrm{G} = \phi\frac{d^2\Pi}{dzdt}\delta z,\ \mathrm{H} = \phi\frac{d\Pi}{dt} - \frac{1}{2}\phi\frac{d^2\Pi}{dydt}\delta y,$$

where $\Pi = \sin(mr - nt)/r$, and from these expressions the electric (E) and magnetic (H) force at various points in the field can be obtained. The final result is to give expressions for these forces normal to the radius vector drawn in the equatorial plane of symmetry as follows:

$$\mathrm{H} = \frac{1}{r^3}\left[\left(\phi v m^2 r^2\right)^2 + \left(\phi v m r - \frac{\mathrm{M}}{z} m^2 r^2 \cos\theta\right)^2\right]^{\frac{1}{2}},$$

$$\mathrm{E} = \frac{1}{kr^3}\left[\left(\phi(m^2r^2 - 1) + \frac{3}{2}\frac{\mathrm{M}}{v}\frac{\cos\theta}{mr}\right)^2 + \left(\phi mr - \frac{\mathrm{M}}{2v}\left(m^2r^2 + 3\right)\cos\theta\right)^2\right]^{\frac{1}{2}},$$

where $\cos\theta$ is the azimuthal angle the radius vector makes with the axis of the oscillator reckoned from the direction in which the free ends point. These expressions show that as θ increases from 0° to 180° the values of E and H vary, and are greater when $\theta = 180°$ than when $\theta = 0°$.

Hence there is an unsymmetrical radiation by such an oscillator, greatest in the direction opposite to that in which the free ends point.

Such an oscillator may also be regarded as the combination of a completely closed conductive circuit or *magnetic* oscillator with a straight or open *electric* oscillator. The field of the magnetic oscillator was investigated by the late Prof. G. F. Fitzgerald (see his scientific writings, edited by Prof. J. Larmor, Sec.R.S., p. 128) prior to the date of Hertz's discoveries, and in the discussion at the Royal Society on March 22 on Mr. Marconi's paper, *loc. cit.*, it was pointed out by Prof. J. Larmor that a bent oscillator of the kind above discussed was equivalent in electromagnetic action to a magnetic *plus* an electric oscillator.

May 3.—"On a Static Method of Comparing the Densities of Gases." By R. **Threlfall,** F.R.S.

Since it is a simple matter to make a manometer showing differences of gas pressure of a few centimetres of water, accurate to between 1/100 mm. and 1/1000 mm., according to the construction, it is possible to determine the relative densities of gases by a method similar to the one employed by Regnault in determining the temperature-density variation of mercury.

It is shown that, using gas columns 20 metres long, the difference of density of "chemical" and "atmospheric" nitrogen should be capable of observation. The author has employed the method in a comparison of the densities of producer gas and air, using gas columns about 20 metres in height. The two columns of gas and air respectively were contained in composition pipes twisted together and immersed in water in an outer iron pipe through which a stream of water passed.

In two experiments on two different samples of gas differences of pressure of 0·3458 cm. and 0·3550 cm. of water respectively were observed, and producer-gas densities accurate to about 1 5000th part in terms of the density of air were deduced. The commercial micromanometer made by the Cambridge Scientific Instrument Co. to the author's designs was employed in these comparisons, and, since it is possible to construct an instrument say five times as sensitive, and to use columns of gas at least twice as long without inconvenience, the method should yield values of relative density correct to 1 part in 10,000 without difficulty.

[1] See Proc. Roy. Soc., vol. lxxvii. p. 413, 1906. G. Marconi, "On Methods whereby the Radiation of Electric Waves may be mainly confined to certain Directions, and whereby the Receptivity of a Receiver may be restricted to Electric Waves emanating from certain Directions."

June 7.—"Effects of Self-induction in an Iron Cylinder." By Prof. Ernest **Wilson**. Communicated by Sir William H. Preece, K.C.B., F.R.S.

An iron cylinder 10 inches (25.4 cm.) in diameter is traversed in the direction of its axis of figure by an electric current, which is allowed to become steady. Under the action of a sufficiently large potential difference and non-inductive resistance the *total* current is suddenly reversed and maintained constant, and its propagation to the centre of the cylinder is investigated by aid of embedded exploring coils. The results show that a current of about 500 amperes takes two minutes to become steady over the whole section of the cylinder. The delay is caused by the opposing electromotive forces induced in the mass by the change of the magnetic fluxes produced by the currents interior to the successive annuli. When the total current is small, the induced E.M.F.'s at the centre, for example, occur at once, and then die away. With currents of about 300 amperes a second maximum is developed after about eighty seconds. For gradually increased total currents the second maximum occurs at shorter intervals of time after reversal, and becomes the most prominent feature of the phenomenon.

The results obtained can be applied to cylinders of other diameters than the one experimented upon, and an estimate is made of the time taken fully to make use of the whole section of an iron telegraph wire and steel rails as used in alternate-current traction.

Mineralogical Society, June 12.—Prof. H. A. Miers, F.R.S., president, in the chair.—Sartorite from the Binnenthal: Dr. C. O. **Trechmann**. This mineral has hitherto been held to crystallise in the orthorhombic system, and full descriptions have appeared from the pens of vom Rath and Baumhauer. Solly, later, assigns it to the monoclinic system, without, however, publishing details. Two very perfect crystals, originally attached to each other, were examined and compared with other crystals and with the results of the above-named authors. Both crystals exhibit conspicuous monoclinic habit, and one is a distinct twin. The elements of vom Rath are $a:b:c = 0.539:1:0.619$. The elements arrived at now are $a:b:c = 1.27552:1:1.19487$ with β 77° 48′, in which $a:b:c$ correspond with $c:b:a$ of vom Rath. The twin and composition plane is $a = (100)$, and the twinned crystal is a juxtaposition twin on this face. Further evidence of the twinned structure is afforded by many narrow, twin lamellæ on the above law. Baumhauer records fifty-nine observed forms on this mineral, including thirteen pyramids. On the above two crystals eighty-seven forms were observed, including thirty-five pyramids. There is little agreement in the angles and forms with those of the other five crystals, or with previous observations. In the zone of the prisms (brachydomes of vom Rath), however, there is a close agreement, sufficient to make it very probable that all the examined crystals belong to the mineral sartorite. Further research is necessary on the scarce material in order to show whether two or more morphotropically related minerals may not be involved here.—The occurrence of axinite in the area south of Bodmin, in Cornwall: G. **Barrow**.—Cassiterite pseudomorphs from Bolivia: R. **Pearce**. The frequent occurrence of cindery and cellular cassiterite in Bolivia suggested that the pseudomorphs might be after a sulphostannate, but this is not borne out by the crystallographic examination made by Mr. L. J. Spencer.—Notes on skiodroms and isogyres: Dr. J. W. **Evans**. The author referred to Prof. Becke's paper on the subject, and showed that the derivation of the forms and movements of isogyres (the loci in convergent polarised light of vibrations extinguished under crossed nicols) from the skiodroms (the curves expressing the directions of such vibrations) are simplified when a microscope with revolving nicols is employed, instead of one with a revolving stage.—A pseudomorph of quartz after apophyllite: H. **Hartley** and N. Garrod **Thomas**.—A heating stage for the Dick microscope: H. **Hartley**.—Mr. J. P. **De Castro** exhibited a large crystal of tantalite from Western Australia, and Mr. R. **Pearce** specimens of axinite from St. Ives, Cornwall.

Faraday Society, June 12.—Mr. W. Murray Morrison in the chair.—The electrolytic deposition of zinc, using rotating electrodes: Dr. T. Slater **Price** and G. H. B. **Judge**. An improved form of apparatus for the electrolytic deposition of metals, using a rotating kathode, is described. The ordinary beaker is replaced by a tap funnel of about 100 c.c. capacity, so that the electrolyte can be run off at the end of the experiment, thus obviating the use of a siphon.—A simple form of rotating kathode for electrochemical analysis: Dr. F. Mollwo **Perkin**. The kathode consists of a spiral of platinum wire, or, better, iridio-platinum wire. Nickel wire may be substituted for platinum, and the author recommends its employment in place of the more expensive metal. Attention is also directed to the solubility of platinum anodes, with heavy currents 0.0016 grm. being dissolved in a cyanide solution in thirty-five minutes.—The electrolysis of solutions of thiocyanates in pyridine and in acetone: S. **Binning** and Dr. F. Mollwo **Perkin**. On oxidation of thiocyanates with chlorine, persulphates, &c., a yellow colouring matter—canarine—is obtained. By electrolysis of aqueous acidified solutions of thiocyanates an apparently similar product, which was originally described in 1884 by Lurdow, is obtained. The authors consider that this substance is not identical with the canarine obtained by chemical means, because it shows certain reactions not given by the oxidation product.

Geological Society, June 13.—Sir Archibald Geikie, Sec.R.S., president, in the chair.—Recumbent folds produced as a result of flow: Prof. W. J. **Sollas**. Prof. Lugeon has described a series of recumbent folds so greatly exceeding in horizontal extension their vertical thickness that they are spoken of as sheets; they lie flat one on the other, and those higher in the series extend farther to the front than those below, a feature referred to as "*déferlement*." The roots of the lower folds are visible in the high Alps adjacent, but the roots of the higher must be sought in the zone of Mont Blanc and the Briançonnais. Thus some of the uppermost folds may have surmounted the obstacle presented by Mont Blanc on their way to the front in the pre-Alps. The features presented by recumbent folds are more suggestive of flowing than bending. Experiments have been made with pitch-glaciers (*poissiers*) in which an obstruction was placed. Folds were produced, one of which was like the Morcles fold behind the Diablerets, another like the Pilatus, and yet another like the Sentis, and the fourth compared with the overslide of the Bavarian front; all four exhibit *déferlement*. The lower limb of each fold is adjacent to the similar limb of its neighbours; but, in another experiment, in which two obstacles were used, the results were nearer to those seen in the mountains, where the lower limb of a superior fold reposes on the upper limb of the fold immediately beneath it.—The Crag of Iceland—an intercalation in the basalt-formation: Dr. Helgi **Pjetursson**. The existence of fossiliferous deposits on the west coast of Tjörnes, N. Iceland, has been known for 160 years. Mörch enumerates sixty-one species of Mollusca, and concludes that the temperature must have been much milder than at present. From the shells, it has been considered that the deposit could not be younger than Middle Reg Crag. Dr. Thoroddsen thinks that these Crags are younger than the Old Basalts of Tjörnes. The author finds, however, that, about 500 feet above the sea, they are overlain by the Eastern Basalts. Thus there is a fossiliferous intercalation occupying part of the great gap between the Tertiary and the Pleistocene rocks. The basal layer of the Pleistocene series is fossiliferous, and has yielded twenty-two species of Mollusca, twenty of which represent a highly Arctic fauna. Certain of the larger basalt-dykes are cut off at the base of the Crag. The absence of the Crag-deposits from other localities is explained by the erosion of the coast-line.

Paris.

Academy of Sciences, June 18.—M. H. Poincaré in the chair.—Researches on the direct synthesis of nitric acid and nitrates from their elements at the ordinary temperature: M. **Berthelot**. Nitrogen and oxygen were caused to combine at the ordinary temperature under the action of the silent discharge, care being taken that no visible sparks were produced in the apparatus. In some experiments a confined volume of the mixed gases was used; in others a current of gas was slowly circulated through the apparatus for a period of several hours. In all cases nitric acid was the sole product, and this whether the oxygen or nitrogen was in excess. Oxides of nitrogen, nitrous acid, and ammonia were looked for, but were invariably absent, even when the reaction took place in the presence of potash solution.—The application of the telephone and the Claude-Driencourt astrolabe to the determination of the longitude of Brest: E. **Guyou.** Two chronometers, beating half-seconds, were used for the transmission of time, one being regulated to mean time, the other to sidereal time, in order to allow of the application of the method of coincidences. A microphone placed on the glass of each chronometer enabled the beat to be heard in the telephone at the distant station, two observers furnished with receivers working at each station. It was found that the deviations between the comparisons obtained at the same place by two different observations were generally less than 0·01 second, these deviations being indifferently positive and negative, showing the freedom from an appreciable personal error. The results obtained at both ends are of the same accuracy as those obtained at a single station, showing that there is no advantage in working from both ends.—The action of carbon monoxide at a red heat upon steam, and of hydrogen upon carbon dioxide. The application of these reactions to the study of volcanic phenomena: Armand **Gautier.** At a full red heat (1200° C. to 1300° C.) carbon dioxide is reduced by hydrogen, the reaction being limited when the volume of carbon monoxide produced is half that of the hydrogen remaining. The inverse reaction between carbon monoxide and steam was also studied, the composition of the gas mixture being represented by the equation

$$3CO+2H_2O=2CO_2+2H_2+CO.$$

The bearing of this reaction upon volcanic phenomena is discussed.—Some new properties of malt extract: L. **Maquenne** and Eugène **Roux.** The activity of malt extract, prepared rapidly in the cold, increases on standing, and the advantageous influence exercised by acids is due to the fact that they are favourable to the establishment of this new state of equilibrium.—Some Patagonian fossils. Study of a portion of the Antarctic region: Albert **Gaudry.** —The use of metallic oxides as catalysers in oxidation: Paul **Sabatier** and Alphonse **Mailhe.** If a mixture of a paraffin with oxygen is passed over a column of copper oxide heated to a temperature of about 200° C., the oxide glows, and the reaction continues without further heating of the tube being necessary. The greater part of the hydrocarbon is burnt to carbon dioxide and water, but small quantities of aldehydes and acids are found condensed in the water produced in the reaction.—The experimental production of transmissible varieties of the tubercle bacillus and of anti-tuberculous vaccine: S. **Arloing.** A modified human tubercle bacillus has been obtained, the acquired properties being fixed after the eighth generation. It differs from the original bacillus only in that its pathogenic effects are reduced in intensity. This bacillus has been successfully used since 1902 for anti-tuberculous vaccination of calves.—M. Edmund Weiss was elected correspondant in the section of astronomy in the place of M. Struve.—The coal basin of Sarrebrück and its continuation in French Lorraine: Jules **Bergeron** and Paul **Weiss.**—The deformation of certain tetrahedral surfaces: G. **Tzitzeica.**—Differential equations the general integral of which is uniform: M. **Gambier.**—The equation of Laplace with two variables: Georges **Lery.**—The photography of the infra-red spectrum: G. **Millochau.** In addition to the use of screens proposed by Stefanik, the author makes use of the well-known property of the infra-red rays of destroying the photographic action on an exposed plate. As the effect produced during the preliminary exposure to the actinic rays penetrates further into the film than the reversing effect of the red rays, very thin films of emulsion, coloured red or yellow, were found to give the best results.—A new method for the photography of coins: Eug. **Demole.**—The presence of gold and silver in the Trias of Meurthe-et-Moselle: Francis **Laur.** Analyses of rocks from various parts of this region show traces of both gold and silver. In one case, a limestone grit from a depth of 582 metres, the gold amounted to 39 grams, and silver to 245 grams, per ton.—The reduction of antimony selenide: P. **Chrétien.**—Oxidations with air. The problem of the comparison of velocities: André **Job.**—Heterogeneous equilibria. The formation of phosphonium chloride, ammonium carbamate, and sulphhydrate: E. **Briner.**—The osmotic pressure in colloidal ferric chloride: G. **Malfitano.**—Researches on copper steels: Pierre **Breuil.**—Melezitose and turanose: Georges **Tanret.** Turanose gives glucose and levulose in equimolecular proportions on hydrolysis, and not two molecules of glucose, as usually accepted.—The true nature of the leucins and glucoproteins obtained by P. Schutzenberger in the splitting up of proteid materials: MM. **Hugounenq** and A. **Morel.**—The influence of chocolate and coffee on the excretion of uric acid: Pierre **Fauvel.** The methylxanthines of chocolate and coffee increase the urinary purins, but not the uric acid. They prevent the precipitation of the latter by acids.—The law of increase of volume in trees: François **Kövessi.**—The spectroscopic study of the green pigments of ripe seeds: W. **Lubimenko.**—The structure of the different gall nuts in the Euphorbiaceæ: C. **Houard.**—The larval biology and metamorphoses of *Siphona Cristata.* A new case of internal ectoparasitism: E. **Roubaud.**—The influence of phosphoric acid and of mono- and trisodium phosphates on the nutritive exchanges: Mlle. Bl. **Guende.**—The influence of the ovary on nutrition: MM. **Charrin** and **Jardry.**—The characteristics of the stem of *Adelophyton Jutieri*: Paul **Bertrand.** —The rapidity of torrential erosion: E. A. **Martel.**—The polarisation of the sky during eclipses of the sun: N. **Piltschikoff.**

CONTENTS.

PAGE

THURSDAY, JULY 12, 1906.

PHYSICAL CHEMISTRY APPLIED TO CHEMISTRY AND BIOLOGY.

Cours de Chimie physique suivi d'Applications à la Chimie et à la Biologie. By Victor Henri. Cours libre professê à la Faculté des Sciences de Paris. Premier Fascicule. Pp. xii+336 et seq. (Paris: A. Hermann, 1906.) Price 15 francs.

THIS volume forms a portion of the first part of a treatise on physical chemistry and its applications to chemistry and biology, evidently intended for readers commencing the specialised study of physical chemistry, but possessing some considerable knowledge of chemistry and biology.

The subjects described in the thirteen chapters of this first part are as follows:—General conditions of equilibrium in solutions; electrical conductivity of solutions; ionic theory; conductivity in non-aqueous solutions; osmosis and osmotic pressure; diffusion; cryoscopy; vapour pressure and boiling-point of solutions; absorption and solution; solubility and coefficient of distribution in solution; surface tension and viscosity of solutions; optical properties of solutions; electrical phenomena in solutions, study of galvanic and concentration cells (incomplete).

The general scheme of treatment which the author outlines in his preface consists in describing in each case (1) the methods of measurement used in studying the particular phenomenon under consideration, (2) the experimental results obtained, and (3) the hypotheses and general theories which make it possible to connect together the experimental results and also others obtained by different experimental methods. This method of presenting experimental results apart from the theory which may have given birth to the observations, or have formed a connecting link for correlating them with other known facts, may be most philosophical, and occasionally most desirable, in order to impress upon the mind of the student that the observed facts exist apart from any theory, as has been most ably done by the present author, for example, in chapters i., ii., and iii. of his treatise. At the same time it can and does become a most cumbrous and space-robbing form of description, and much beauty is lost by not placing the facts at once in the appropriate setting of the theory which lead the mind to the planning of the experimental work which established the facts.

It is no doubt quite possible that a mathematical treatise might be written without the use of any symbols or any conventions of any type, or that a treatise on chemistry might be written consisting of bare, dry experimental facts without any reference to the atomic theory. Such treatises would be most interesting as monuments of human perseverance and industry, and would be literary curiosities of the highest order; but it is questionable if they would be very intelligible, and certainly they would be very lengthy, and most unstimulating to the student or worker, who could not proceed a step further with their aid alone in the way of advance, but would at once have to proceed to formulate a theory if it were desired to carry out an experiment differing in type from any in such a non-theoretical treatise. Without a theory in advance there can be no such thing as intelligent experimentation; after experimentation, the theory must be adapted where necessary to experimental results, or, if necessary, a new theory formulated which will lead to further experimentation.

It is therefore a relief to find that after the first three chapters the author somewhat alters his plan, accepts the ionic theory, and speaks boldly of ions. Some of the aspects in which the ionic theory, as at present held, fails to account for experimental facts are pointed out in the book, and those many experimental observations which are accounted for, and correlated, by the theory are justly held up for well-deserved admiration.

The author is also to be congratulated upon not having too thoroughly carried out the intention expressed in his preface of making the mathematics of physical chemistry problems easy for the non-mathematical reader.

The authors who invent and perpetuate this style of mathematics made easy surely forget that a reader who has not a rudimentary notion of how to apply the calculus probably has not learnt his more elementary mathematics well enough to follow the solution of their long and involved series and equations, and if he ever did has probably forgotten it long ago, and therefore skips the proof and accepts the conclusion much as he would have done had the proof been given in the shorter way.

As stated above, anything which can be put or proven in mathematical symbols could also be equally put or proven in ordinary words, provided patience and perseverance could be provided on the part of the author to write it, and of the reader laboriously to wade through it; but when there is a better method, surely it is much better for the non-mathematical reader to accept his mathematics ready made for him, or, if he objects to doing this, take up the study of mathematics a little longer and then turn to its applications.

It is accordingly a relief to find that the author does not carry his threat of making mathematics easy too far, and employs the calculus where necessary.

Regarding the subjects treated in the first part so far as they are contained in the present volume, it may be said that on the whole the style of treatment is most interesting, and the information usually full and carried well up to the present date.

Occasionally it would have been well, as the work is obviously intended specially for biological students interested in physical chemistry, if the biological aspects had been treated at greater length, as, for example, in the section on the theory of indicators on p. 110, and that on the study of the fluids of the organism, p. 114; but it is possible that the author may intend to return to these subjects at a later part of the work.

The descriptions of how to carry out experimental work given in the volume are clearly intended to enable the student to carry on experiments, for the precautions to prevent experimental errors are often given in considerable detail, as, for example, in regard to freezing-point determinations and conductivity measurements; yet if this be the intention of these descriptions they are singularly incomplete in other respects. For example, in describing the determination of the freezing point the only thing said about the thermometer to be used is that it may have either a fixed or a variable zero. We venture to think that some description of the Beckmann thermometer and the method of using it would have been of service here.

Benjamin Moore.

THE MAKING OF ROCKS.

Petrogenesis. By Dr. C. Doelter. Pp. xii+262. (Brunswick: Vieweg und Sohn, 1906.) Price 7 marks.

In this work, which would be valued highly for its references to current literature alone, the author brings together what is known as to the origin of various types of rocks. Its outlook is that of the mineralogist and not of the physical geographer; but this enables the author, though far too modestly, to bring his researches on the construction of minerals and rocks to bear upon broad geological problems. As a treatise, the book is elementary and yet satisfying; in the series of which it forms a part, "Sammlung naturwissenschaftlicher und mathematischer Monographien," it exactly fills its place as an exposition of prevalent, if not necessarily established, views. Very often these views are subjected to criticism that shows how far we are from finality and conclusions; but the lucidity of discussion and absence of bias displayed by Dr. Doelter make us grateful to him as a guide. The history of the struggle for the Rhine in no way affects his scientific judgment; and once again we feel that Austria holds the balance in the geological controversies of our time.

When we say that the book is elementary, we mean this in the best of senses. It goes to the root of a question, and compels the reader to understand it. As an example of the large amount of valuable matter that may be compressed into one paragraph, we may take the following (p. 80), from a discussion on differentiation in igneous magmas:—

"Attempts have been made, as we have seen, to connect differentiation fundamentally with the existence of magmas which will not mix with one another. But this is an improbable supposition, since every magma can dissolve any other, as I have shown experimentally. The solubility of one mineral in another depends only on the temperature; and at a temperature varying with each case, the critical temperature of solution, the products of fusion are soluble in one another. Experiment also proves to us that no separation takes place in the fluids so long as they are stirred; it occurs first as cooling goes on; where there is no movement, separation can take place according to specific gravity, even in the fluid state."

The book opens with a discussion of the causes of fluidity of magmas within the earth, and their occasional appearance at the surface is attributed primarily to tectonic movements. When relief from pressure comes, the magma becomes fluid, and corrodes the surrounding rocks. The gases contained in it operate "like a blowpipe-flame." The results of such corrosion are treated later (p. 116, &c.), and Dr. Doelter remarks, following Daly's recent papers, that basic lavas, coming quickly up broad cracks, reach us in a state of greater purity than acid ones, which move more slowly, and have greater opportunities for affecting the walls that bound them. The acid masses "exhibit traces of the country-rocks, but not necessarily near the contact-zone, since, in the case of deep-seated rocks, the absorbed fragments may become distributed in the interior of the mass."

The author's remarks on the potency of mineralising agents during the consolidation of igneous rocks are based upon his own well-known experiments. Mica thus seems always to require the presence of fluorine. While water is the greatest mineraliser, we are reminded that we are not dealing with pure water in the earth, but with water containing chlorides, hydrochloric acid, boric acid, and so forth (p. 24). Certain minerals decompose in their own products of fusion, and give rise to other minerals, or mere glass, on consolidation. In such cases, the crystalline condition remains stable only at a lower temperature than that of fusion, and the function of a mineraliser or "crystalliser" is to reduce the temperature at which the substance crystallises out again. If the right point is reached, the original mineral is recovered in its crystalline form. Thus, in the much-debated case of quartz, the mineral, at ordinary pressure, will not separate from its product of fusion at temperatures above 950°. Below this temperature its crystals are stable. Above it they are unstable, although their melting-point is not reached until 1600° or 1700°. The common minerals that require the help of mineralisers for their formation are albite, orthoclase, quartz, garnet, haüyne, epidote, wollastonite, hornblende, and mica. Hence an acid crystalline rock cannot arise without mineralisers, and the frequent presence of tourmaline, fluorspar, scheelite, and so forth, in granite, indicating boric acid, fluorine, tungstic acid, chlorides, &c., bears out in nature the results of synthetic laboratory work.

On p. 65 it is interestingly pointed out that the different items in the chemical analysis of a rock, as written down, possess very different values, and that too large deductions must not be based on small differences in the quantities of magnesia, soda, or potash stated to be present. Exactitude in these determinations is not obtainable with the same degree of success as in the case of silica and alumina, and the alkalies, unfortunately, usually appear as small numbers, in which the second place of decimals becomes of importance for comparison. The American school, by the by, has made such headway that the word "salisch" slips in naturally on p. 44.

We cannot dwell on all the important considerations here put forward as to the processes that go on during the cooling of igneous rocks. Among these, the description of "Unterkühlung" on p. 137 strikes us as of especial interest. The retention of a mineral in a state of fusion below its ordinary melting-point may allow of the previous crystallisation of another, which cannot sustain such conditions, and thus the normal order of crystallisation may be reversed. This fact is used to explain the crystallisation of augite before the felspar in basic rocks, which, in normal circumstances, so frequently show ophitic structure.

All through the book the influence of personal experiment remains manifest, and we must not complain if the genesis of the sedimentary rocks is treated in a somewhat rapid fashion. Flints thus receive far less than their due (p. 232), considering how much they have been discussed. Guppy's observations on silicified corals in the Fiji Islands raise, for instance, new questions in themselves. But references to recent work, such as Linck's on the separation of calcium carbonate from sea-water, will lead the reader forward; and we turn back contentedly from these scantier pages to the fine account of the problems of contact-metamorphism, and thank the author again and again for his clear and stimulating treatise.

As is natural in so wide a field, we miss mention of some memorable work, such as that of Harker on mixed rocks in the Inner Hebrides; on the other hand, we hail with delight the name of MacGregory (p. 31), who appears to be Prof. J. W. Gregory in the glory of a Scottish title.

GRENVILLE A. J. COLE.

STRUCTURES AND MATERIALS.

Theory of Structures and Strength of Materials. By Prof. Henry T. Bovey. Fourth edition. Pp. xiii+968. (New York: John Wiley and Sons; London: Chapman and Hall, 1905.) Price 1*l.* 11*s.* 6*d.* net.

THIS well-known text-book has been largely rewritten and enlarged for the present fourth edition. In the preface Prof. Bovey states that a number of fresh examples, mostly drawn from actual practice, have been added to the various chapters, and that all tables of strengths, elasticities, and weights of materials have been brought up to date.

In chap. i. a description of Bow's method of notation is given, and the author has now adopted this system throughout the book when dealing with stresses developed in framed structures. The treatment of the three-hinged braced arch for station roofs and for sheds of wide span is a new piece of work in this chapter. In chap. ii. there is a new series of paragraphs dealing with the graphical determination of the maximum bending moment at any point of an arbitrarily loaded girder, and several examples illustrating the author's methods are worked out in full. Chap. iii. of the older editions has wisely been broken up into two chapters, one (chap. iii.) dealing with momentum, energy, and balancing, and the other (chap. iv.) with stress, strain, and elasticity. In the older editions this chapter was a very difficult one for the student to follow, and the author, in rewriting and dividing it, has brought the various steps of the work into their true relation one with the other. The whole of the material in chap. x. of the older editions, which dealt with thick-walled, hollow cylinders, has now been incorporated into chap. v., which treats of the more difficult work on stress and strain, and undoubtedly it follows more naturally in this position after the discussion of the general equations of stress.

In chap. vii., in dealing with the relation of the neutral plane to the stress at any point in a beam, Prof. Bovey has incorporated the results of his own experimental work, which was carried out with the view of determining within the limits of elasticity the changes of fibre length at different depths of a beam when loaded transversely. In this chapter there are also additional paragraphs dealing with the design of reinforced concrete beams, the position of the neutral axis, and the strength of such beams; additional graphical methods are given for determining the slope and deflection in loaded beams, and in connection with the theory of continuous girders fresh matter has been introduced.

In chap. viii., which deals with the theory and the bending of struts, the results of the most recent experiments have been incorporated, and, as the chapter has been rearranged, it is now much more useful to engineers engaged in the difficult problem of strut design. In chap. ix. the stresses in non-circular shafts are discussed, and there is also much new matter in the paragraphs on the efficiency of shafting and the whirling of shafting, and open coil springs are dealt with, as well as the ordinary helical springs. Chap. x., which is devoted to bridges, has been entirely rewritten and greatly improved. Graphical methods are used throughout for the determination of stresses in the piers, and the most recent types of bridges are discussed and explained. Excellent tables are given of the loads upon, and the weights of, bridges, and several examples of fairly large bridges are worked out in complete detail. This chapter is now a most valuable one for those who are concerned with the design of bridges of all classes, and the examples have been made thoroughly practical. We have no hesitation in saying that Prof. Bovey in thus practically rewriting his book has considerably improved its value both to the engineering student and to the civil engineer engaged in the design of all classes of structures in steel and iron.

T. H. B.

RATIONAL DAIRYING.

Dairy Chemistry. By Harry Snyder. Pp. x+190. (London: Macmillan and Co., Ltd.; New York: The Macmillan Co., 1906.) Price 4*s.* 6*d.* net.

PROF. SNYDER'S work as agricultural chemist in the University of Minnesota is well known. This State, with a population less than that of Kent and Essex, possesses a University Agricultural Department in which are 800 students most of whom are attending a three years' course. The majority are students who during the summer months have to work for a living, and at the close of their academic training return to rural employment. Thus Minnesota, in common with other States of the Middle West, is year by year producing an army of workers who have learnt to base their work on scientific principles and to look to the results of scientific research for the future development of their industry.

The success of the American agricultural colleges in turning out trained craftsmen (they are not, perhaps, equally successful in producing highly-trained scientific experts) is to be traced to the intimate association of the practical and the scientific teaching. On the one hand science is taught, but the mind of the student is constantly being directed to its industrial applications; on the other hand the industry is taught, but with constant reference to underlying scientific principles. Prof. Snyder's book is a capital example of the method of industrial teaching. It is a text-book of dairying, but there is no rule-of-thumb; an appeal is made to reason; processes are advocated because found by experiment to be sound; the impression left on the student's mind is, "This is the best to-day; there may be a better to-morrow."

To take from the book two examples of the effect of this method of training on industrial development:—The advantages of the cold curing of Cheddar cheese were established by Babcock and Russell at the Wisconsin Experiment Station. It is a rational process based on recent investigations on the action of the natural enzymes in milk. The results were only published in 1901, but already cold-curing factories have risen throughout Ontario and the cheese-producing States of the Union, showing a readiness to accept the results of scientific investigation, although involving a large capital outlay, to which it is difficult to find a parallel in British agriculture. As the second illustration, take the percentage of fat and total solids in milk, $3\frac{1}{2}$ and 12 respectively, enforced as the legal standard in Minnesota. To obtain such milk, cattle must be bred up to this high standard. The agricultural community is far-sighted enough to see that, although it may involve hardship on individuals, the high standard is an advantage to a State where butter and cheese production is an important industry.

The book should prove almost as useful to dairymen in this country as in America. There are few Americanisms either in spelling or phraseology, and throughout there is an insistence on the importance of proper hygienic conditions in dairying, with several useful suggestions as to how cleanliness can be secured, which should be invaluable, for it is on account of the neglect of such conditions in this country that dairymen's troubles are generally due. The method of calculating dividends in dairying is also worthy of particular attention here. There are, unfortunately, a few misprints and inaccuracies, together with curious repetitions of the same statements, suggesting that the book has been edited from lecture notes compiled in card-catalogue form. As usual in American works, the whole of the nitrogen compounds in foods are considered as proteids. The bibliography containing references to American, German, and British scientific papers is an excellent feature.

T. S. D.

OUR BOOK SHELF.

Gedanken über Vererbung. Dr. Alexander Petrunkewitsch. Pp. 83. (Freiburg, i. B.: Speyer and Kaerner, 1904.) Price 1.80 marks.

THE author thinks that clearness is gained if we regard the organism as a continually changing mechanical system with a life-cycle extending from the arbitrarily chosen moment of oogenesis to the post-mortem death of the last scrap of decaying tissue. An acquired character is the result of a reaction of the system to external influences, and presupposes a definite heritable structure capable of reacting, so that there is no sharp boundary between acquired and inherited characters. What is called a heritable character may be due to a coincidence of successive reactions. The concept of heredity strictly applies only to the germ-cells; it is simply "the process which leads to the formation of germ-cells whose structure is the same as or like the parental germ-cells." Development is the expression of this structure, and the formative causes of development lie in the relation between the system and its environment. An animate system can only exist in definite conditions, which can only oscillate within definite limits. Life is an adjustment between the amplitudes of variation in the animate system and in the environment, and involves a progressive limitation of the organismal variability. Those variations the causes of which lie in the oscillations of the germ-cell structure may be called gametogenous or endogenous as contrasted with exogenous variations (modifications) which are acquired in the course of life. This distinction will hold even if we abandon the theory of the continuity of the germ-plasm, and simply suppose that the germ-cells are those cells which through chemical reactions have attained the same structure as the parental germ-cells. When this sameness is not attained variations result, the amplitude of which may be trivial or fatal, or it may be that a new pattern of system results which we call a mutation. So far as we can see, the author simply re-states familiar facts and ideas in a slightly novel way, and we do not share his confidence that clearness is gained by so doing.

J. A. T.

Giordano Bruno. In Memoriam of the 17th February, 1600. By Alois Riehl. Translated by Agnes Fry. Pp. 112. (Edinburgh and London: T. N. Foulis, 1905.) Price 2s. 6d. net.

THE life of Giordano Bruno is not altogether unfamiliar to readers of reviews in NATURE. A larger volume on this subject was reviewed about two years ago (March 31, 1904, vol. lxix., p. 505). Still earlier, in May, 1900, the original of the present translation was reviewed, and the reviewer expressed the wish that Prof. Alois Riehl's essay could be presented in English. This suggestion has led to the appearance of the present volume.

The first account of Giordano Bruno coming from the pen of Prof. Alois Riehl dates from 1889, the year in which the present monument was erected to Bruno on the site of his martyrdom. The tercentenary of Bruno's death on February 17, 1900, formed the occasion for a second edition, in which the account of Bruno's philosophy was revised. Without entering into minute detail, the present translation bears the impress of being a good one, and when the small size of the book is taken into account the description of Bruno's life will be found to be as full and complete as could be possibly expected.

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.]*

Geological Survey of Canada.

IN the issue of NATURE of June 21 is a letter from Mr. A. P. Low. This communication is liable to be misleading, and I shall be greatly obliged if you will allow me to correct the misstatement which it contain, namely, that "at the same time, Dr. R. Bell simply returned to his former position of assistant-director and chief geologist, to which he had been appointed in 1892."

I was not appointed chief geologist in 1892. This office did not then exist. It was created on March 27 last, and I was appointed to it by a formal Order-in-Council on that date, a large increase being made to my salary at the same time. ROBERT BELL.

Office of the Canadian High Commissioner, London, July 9.

I HAVE taken some trouble to inquire into the extraordinary appointment to the Geological Survey of Canada concerning which you published a paragraph on April 26 (vol. lxxiii., p. 613) and a letter on June 21 (p. 175). I send you my results in case you would care to continue the correspondence.

Report states that the Premier informed Dr. Bell that the Government, for its own reasons, was going to make certain changes in the administration of the department, but that wishing Dr. Bell to be quite contented with these changes, he asked him to state the conditions which would be agreeable to him. I have also learned that the Premier transferred Dr. Bell's letter for action to the Minister of the Interior, who is at the head of the Geological Survey Department. Owing to the great pressure of the business of the session of Parliament, the matter has not yet been considered, and further changes are probable, but for the present Dr. Bell has been promoted to be chief geologist of Canada, and allowed to devote his time entirely to scientific matters. He attains at least equal rank, and receives a substantial addition to his salary, with a promise of further increase in the near future. In connection with the above change, Sir Wilfrid Laurier spoke in Parliament in the highest terms of Dr. Bell's ability and of the great scientific services he had already rendered the Dominion.

If these are facts, then Mr. Low's letter (p. 175) appears to be inaccurate. The office of chief geologist was, it seems, newly created for Dr. Bell last March, and he was not appointed to it, as Mr. Low asserts, in 1892.

Mr. Low, I find, is quite unknown in the geological world, whereas Dr. Robert Bell's name has long been familiar throughout Europe and America. He is now in his fiftieth year of service to the Government of Canada in connection with its Geological Survey, and as practical head of that department for the last five years he has maintained its high reputation and administered all its affairs with credit. He is a Fellow of the Royal Society of London, a Doctor of Science of Cambridge, a Doctor of Medicine of McGill, a Doctor of Laws, &c., and has been honoured by the King with the companionship of the Imperial Service Order.

During his administration of the business affairs of the Canadian Survey, it is generally recognised that he has improved its efficiency in many ways, and has increased the number of its officers, the extent of its operations, the Government grant, the library, the extent of its premises, &c. He has sent to the field an average of more than thirty parties every year, as compared with less than half that number in the time of his various predecessors. Surely this is a good record, for the sooner a country is surveyed the better it is for all economic purposes.

The above matters and many others are clearly described by Dr. Bell in his annual summary reports of the survey for the past five years. He had previously caused to be carried on very extensive topographical surveys in all sections of the vast Dominion, taking the leading part himself in this work. It was for these valuable services to geography that the Royal Geographical Society this year awarded him the patron's gold medal, with the approval of the King.

It is clear, I think, that although the interests of science have not been wholly sacrificed, party politics and not geology have been in question in regard to Mr. Low's appointment. F. R. S.

July 7.

Osmotic Pressure.

THE gravamen of our criticism of Prof. Kahlenberg's paper is directed against his statement that "indirect measurements of osmotic pressures involve the assumption that the gas laws hold for solutions." In vol. lxxvii., Proc. Roy. Soc., we deduce a relation between the osmotic and vapour pressures of a solution which is independent of the gas laws "holding for solutions." Prof. Kahlenberg, in his recent letter, does not attempt to show that this relation is unsound; we may therefore take it that he accepts the theory, but is dissatisfied with the experimental evidence which we adduced to corroborate it. Perhaps the following will help to convince him.

In a paper read before the Royal Society, June 7, we give the results of the direct and indirect measurements of the osmotic pressures of some aqueous solutions of cane sugar.

Concentration	Direct O.P. at 0° C.	Indirect O.P. (from V.P. at 0° C.)
540 grs. per lit. sol.	67·51	69·4
660 ,, ,,	100·78	101·9
750 ,, ,,	133·74	136·0

Since reading this paper we have found that aqueous solutions of dextrose and galactose give similarly concordant results. As regards the last paragraph of Prof. Kahlenberg's letter (p. 222), we would point out that he gives no experimental evidence for the assumption that the sugar that had passed through the rubber membrane was sugar from which, so to speak, the solvent had been filtered off. Until such evidence is forthcoming, it seems to us that the criticism we levelled at his work is legitimate, and suggests a simple explanation of the low results he obtained. BERKELEY.

Foxcombe, near Oxford. E. G. J. HARTLEY.

Family Diseases and Temperaments.

MAY I appeal through your columns to those of your readers who are interested in the tendency of certain diseases and temperaments to run in particular families to aid me in an investigation I am at present making? The schedules now being issued contain space for a great deal of information, but it is rare for any single recorder to be able to supply all of it. What is wanted is a perfectly frank statement of what the recorder knows or can find out without much trouble. The only request made is that if the recorder feels unable to state certain facts not to the family credit, as well as those which indicate a sound, successful stock, no attempt should be made to fill in the schedule. At the same time, *no names are required*, the recorder may select any family he pleases for record, and the name of the recorder is only required in case it is needful to ask for explanation of any entry, and as a general sign of good faith.

I am fully aware of the labour involved in giving a fairly full family record, and my gratitude for aid in the matter is very great. At the same time, it is, I think, not unjustifiable to hope that among the readers of NATURE there will be some ready to help in an inquiry which if completed will be of considerable scientific value. There exists at present no ample data from which we can determine the inter-relationship of disease, temperament, and success in life. We know comparatively little the extent to which these factors are associated together or persist in certain families. After some considerable labour, about 200 records have been obtained, some of them very full and excellent, and the majority of considerable value. But the number must be extended, if possible to 1000, before the work of reduction is begun. May I ask for further aid in the matter? I shall be glad to send two or more schedules to anyone who will help to get a faithful record.

KARL PEARSON.

University College, London, W.C.

Thermodynamics of Diffusion.

IN applying the principles of thermodynamics to diffusion of gases, several pitfalls have to be guarded against.

In the first place, if we adopt the old definition of entropy in terms of integrals of the form $\int dQ/T$, we are almost certain to go wrong when we come to deal with diffusion. If we imagine diffusion to take place between two of the ideal "perfect gases" of our text-books at constant pressure, volume and temperature, and without gain or loss of heat, no quantity of the nature of dQ appears to be associated with the phenomenon, and it is easy to rush to the conclusion that no change of entropy takes place. This danger is avoided if we adopt Mr. Swinburne's plan of defining entropy in terms of "waste" or unavailable energy relative to an assumed auxiliary medium. By "auxiliary medium" is here meant a medium at uniform temperature T_0 which can be used indefinitely as a refrigerator in thermodynamic operations, and any change in the amount of *unavailable* energy under such conditions, when divided by the temperature T_0, gives the corresponding change of entropy.

If this definition is adopted we see that the phenomenon of mixing the gases does not in itself suffice to determine the changes of entropy associated with it. The matter can only be decided by an appeal to experience as to the means whereby the gases can be separated or mixed reversibly. The case of an ideal "perfect gas" forms no exception to this statement.

The proper inference is, not that the diffusion involves no change of entropy, but that the change of entropy, if it exist, cannot be expressed as a sum of differentials of the form dQ/T.

The second pitfall occurs when we take the well-known expression for the entropy of a perfect gas in terms of pressure (or volume) and temperature, and try by this means to connect the entropy of the mixture with the entropies of the components. Where we are likely to get into trouble is by ignoring the integration constants in the expressions for the entropy. There is no evidence from mere thermodynamic reasoning that the constant does not change in the process of diffusion. All we can infer is that the change of entropy associated with the mixing of gases at uniform pressure and temperature is constant, *i.e.* independent of pressure and temperature.

To sum up, then, even when we have defined an ideal perfect gas in the ordinary way, and assumed the property that two such gases can mix in a closed vessel without change of pressure and temperature, thermodynamical considerations still give us no information whatever as to the change of entropy accompanying diffusion, and on this point a further appeal to experience is necessary.

This amounts to saying that our definition of perfect gases is still incomplete. What further property shall we assume in order to complete it? If we regard a "perfect gas" as a mere invention on paper, the most *useful* plan is to take some simple property which is approximately satisfied in the case of actual gases and assume that this property is accurately satisfied by our perfect gases. Now, actual gases may be separated and re-mixed either by diffusion through a membrane or by liquefying, or, if preferred, freezing one of the constituents.

Taking either of these processes, and making suitable assumptions which would render that process perfectly reversible, we are led to the inference that the whole entropy of a mixture of perfect gases should be taken to be equal to the sum of the whole entropies of its components at the same temperature and partial pressure, *i.e.* if each component occupied the same volume as the final mixture.

According to this view, when diffusion takes place at constant temperature and *pressure*, there is a gain of entropy and a loss of available energy equal in amount to that which would be incurred if each of the constituents were to expand by rushing into a vacuum until it occupied the same volume as the final mixture.

There is another way of partially separating the constituents of a gas mixture. If the mixture be introduced into a field of force such as that due to the earth's attraction, or if we imagine it to be whirled in a centrifuge, the denser gases will predominate in the lower parts of the atmosphere or where the potential is greatest, and the lighter gases will predominate in the upper regions or where the potential is least. In this case the partial separation is effected at the expense of work done by the field of force.

This note does not purport to deal in full detail with the thermodynamics of diffusion, but merely to direct attention to certain points which are easily overlooked. One of the most important of these points is that the possibility of producing mechanical work by the diffusion of gases through a membrane at constant temperature is not necessarily inconsistent with the principles of thermodynamics or the ordinary definitions of a perfect gas.

If any physicist should claim to have discovered Maxwell's demons in connection with the diffusion of gases, the first questions we should ask him are:—

(1) Can he, without the performance of external work, separate the gases in a mixture in such a way that the temperature is the same at the end as at the beginning, and the separated constituents each occupy volumes smaller than that of the original mixture?

(2) Can he obtain external work by the mixing of two gases without change of temperature if the initial volume of each gas is not less than the final volume of the mixture?

(3) Are his claims based on new experimental evidence?

G. H. BRYAN.

Early Meteors of the Perseid Shower.

THE moon being new on July 21 this year renders the conditions favourable for observing the earlier members of the great Perseid display. A few of these are usually visible on July 15, and probably just before that night, and it would be interesting if multiple observations of supposed Perseids could be obtained so that their radiants might be definitely assigned without the risk of error.

A single record of a meteor-flight only permits an assumption to be made as to the apparent radiant, and mistakes frequently result. For example, if a streak-leaving meteor, seen at the July–August epoch, happens to be directed from the northern part of Perseus it will certainly be attributed to the Perseid swarm, though it may quite possibly have had its origin in a different shower from Cassiopeia, Andromeda, Aries, Camelopardus or Auriga. To avoid such errors of allocation it is proposed to maintain simultaneous watches this year between July 15 and 28 from 10 to 12 p.m., and the writer would be glad to hear particulars of any observations for comparison with similar results obtained at Bristol.

The mean height of the Perseid meteors has already been satisfactorily deduced, but it seems desirable further to investigate the position and motion of the radiant, especially during the last half of July. Such meteors as appear amongst the stars of Perseus or bordering constellations are the best for indicating the exact place of the radiant, and bright meteors should always be carefully registered, as they are very likely to have been noticed elsewhere. The centre of radiation travels from near ϕ Andromedæ at the middle of July to a few degrees south of the star-cluster at χ Persei at the end, the ephemeris places (*Monthly Notices*, lxii., 160) being as under:—

Date	R.A. °	Dec. °	Date	R.A. °	Dec. °
July 15	15·3	+48·9	July 25	24·9	+52·5
,, 17	17·1	+49·7	,, 27	27·1	+53·2
,, 19	18·9	+50·5	,, 29	29·3	+53·8
,, 21	20·8	+51·1	,, 31	31·6	+54·4
,, 23	22·8	+51·8	Aug. 2	33·9	+55·0

Bishopston, Bristol.

W. F. DENNING.

WESTERN AND CENTRAL ABYSSINIA.[1]

IT is with no desire to depreciate the work under review, or any other of the books published on the subject of Abyssinia since the great work of James Bruce (more than a hundred years ago), if the present reviewer ventures to remark that no modern work on the subject of Abyssinia has yet been written which is at all commensurate with the importance of that marvellously interesting African State. Possibly such a work might have been finally compiled had Baron Carlo von Erlanger lived to write it. In his posthumous "Forschungsreise dürch Süd-Schoa, Galla und die Somali-Länder," he treats of a fragment of Abyssinia in a way which, if it had been applied to the whole of that region, would have illustrated effectively for the first time to the man of science, as well as to the more general reader, the most interesting part of Africa.

A little reflection will convince those who have not thought on the subject that Abyssinia *is* from every point of view the most interesting portion of the Dark Continent. Here the fauna and flora of the Mediterranean region meet those of tropical Africa. Here the lofty, snow-capped mountains retain a wild goat (the most southerly occurrence of the Caprine subfamily in the African continent). Here also is a peculiar and aberrant dog *Canis simensis*. In the western lowlands of Abyssinia there is a true wild boar—*Sus sennaarensis*. Several of the antelopes and two or three species of monkeys are peculiar to Abyssinia in their range, as are numerous birds, a few fish, two or three reptiles, and a great many plants. Some of the fish are closely related to species in North Africa or Syria. The human races are of varied types and widely different origins, speaking a variety of languages, some of which are unclassified. In the extreme south-west of Abyssinia there are Negro types which have been classified as Bantu, and others which resemble either the Congo or the Bushman pygmies. In the south-east and south, and thence almost to the centre of the country, the population is mainly of the handsome Gala-Hamitic type or of the kindred Somali stock. In the west there are Nilotic Negroes, and in the north, centre, and east races that are compounded of Hamite and Semite, with traces here and there of ancient Greek or Egyptian colonies, while there are dark-skinned Jews whose origin would seem to antedate by many centuries the destruction of Jerusalem.

In this country has been developed the strangest and most debased type of Christianity, and there are forms of devil worship or belief in demoniac possession of great interest to the student of religions. Abyssinia has a history, more or less credible, going back to a thousand years before Christ, while its records from the first impact of the Portuguese in the sixteenth century down to the present day have been part of the world's history, linked on to the records of civilised Europe, Asia, and North Africa. Whereas nearly all Africa south of the Sahara, with the exception of the Upper Niger and a narrow fringe along the west and east coasts, only came within the domain of written history a hundred years ago, Abyssinia has as much formed part of the record of Caucasian civilisation as Britain or Morocco.

The author of the book under review gives within the compass of 315 pages an excellent general description of western and central Abyssinia, and the book contains a number of good photographic illustrations. In his preface, and in one or two passages in the body of the book, the author hints with some ominousness at future trouble which is coming on the Sudan from the direction of Abyssinia. It would be out of place in NATURE to discuss international politics, nor do the readers of this Journal tend to take the point of view that what is quite permissible to Great Britain in the way of political pushfulness is almost criminal when forming part of the policy of a sister European or American nation. But apart from the warnings which are given by Mr. Hayes as to the growth of German or American influence in

FIG. 1.—Market day at Zegi. From "The Source of the Blue Nile.

[1] "The Source of the Blue Nile. A Record of a Journey through the Sudan to Lake Tsana in Western Abyssinia, and of the Return to Egypt by the Valley of the Atbara, with a note on the Religion, Customs, &c., of Abyssinia" By Arthur J. Hayes; and an Entomological Appendix by Prof E. B. Poulton, F.R.S. Pp. xi+315. (London: Smith, Elder and Co., 1905.) Price 10s. 6d. net.

Abyssinia, he seems to indicate, and with much more probability, political dangers from the effervescence of the Abyssinians themselves. Before long the adjacent regions of the Egyptian Sudan promise to become exceedingly prosperous with their fertile soil and accessibility through British-made railroads or river navigation. Mr. Hayes seems to anticipate that this coming prosperity may be a source of temptation to the reckless mountaineers of western Abyssinia, who can reach the Sudan so much more easily than the Sudan can vanquish Abyssinia.

In his desire to give an accurate picture of Abyssinia, both at the present day and at previous periods, the author quotes extensively from earlier writers, with acknowledgment, and, where the works are recent, by direct permission. These extracts, coupled with his own shrewd and accurate observations, make up a most readable and, perhaps it may be said, valuable description of Abyssinia. There is a good deal of new information about Abyssinian Christianity, coupled with some admirable photographs of frescoes in the interior of churches. The author's remarks on pp. 56 and 59 on the soil created by the work of the white ant, and the washing of this soil down from the highlands of Abyssinia to the lowlands of Egypt and the Sudan, are distinctly interesting. There are one or two trifling mistakes which should be corrected; for instance, in the text and illustration on p. 184, a fine specimen of a reedbuck antelope is described as a "hartebeest." It is interesting to note that, so far north as the valley of the Atbara, such a typical specimen of the reedbuck should be found.

The author and the authorities whom he quotes somewhat extensively give an interesting description of the Falashas, the so-called black Jews of central Abyssinia, the region round Lake Tsana. The Falashas are undoubtedly Jews in religion, and have been for many centuries; but great caution should be exercised by people who desire to write with scientific accuracy in identifying these people of Semitic origin with the ancient Israelites of Palestine. It is alleged that the traditions of these Falashas would make them the descendants of a branch of the Jewish people which had never known Palestine, but had migrated to Abyssinia direct from Egypt. Such theories as this are hardly worth discussing by the scientific ethnologist. The Children of Israel were undoubtedly an Arab tribe that originated in the region between Syria and Egypt. Their monotheistic religion spread far and wide through the centuries into Arabia, Abyssinia, and North Africa; and, elsewhere, in the form of Christianity. The Jewish people that were expelled from Palestine by the Romans were a very composite race, containing a good deal of Armenian blood. It is possible that the Falashas, like other tribes of "black Jews" elsewhere, adopted the Jewish religion at some period before the spread of Christianity or of Islam, but are not directly descended from any section of the original Jews.

H. H. JOHNSTON.

OPSONINS AND TUBERCULOSIS.[1]

WHEN the scientific researches of Durham, working in Gruber's laboratory, revealed in 1895 the presence of agglutinins in the blood, the discovery was soon put to practical use in clinical medicine by Widal and Grünbaum, who showed what valuable aids these substances were in the diagnosis of typhoid fever; further, and this does not seem to have been so generally recognised, they have been shown to be of service in the prognosis of that disease. A similar and no less important practical use in the diagnosis of tubercular infections was made by Wright and Douglas (Proc. Roy. Soc., vol. lxxiv.), and is here further developed by the former in conjunction with Staff-surgeon Reid. The method employed is the estimation of the opsonic power of the serum; and the technique is that described by Drs. Wright and Douglas in a previous paper (Proc. Roy. Soc., vol. lxxii.). This briefly consists in incubating for fifteen minutes at body temperature a mixture of equal volumes of washed blood corpuscles, bacterial suspension, and the serum under investigation. Blood films of this mixture are prepared and appropriately stained, and the phagocytic count is estimated and compared with the result attained by conducting the same experiment with normal serum, such serum being obtained by pooling the blood of a number of healthy individuals. The phagocytic count of the experiment conducted with normal serum is taken as unity, and the result of the other count as compared with this gives the opsonic index of the serum under investigation.

In the recent paper the authors first give the result of a large number of blood examinations in generalised and localised tubercular infections. Two very important facts are the outcome of this work:—

(*a*) That in localised tubercular infections the opsonic index is uniformly low.

(*b*) That in cases of tuberculosis associated with constitutional disturbances the index is continually varying, the patient living a "life of alternating negative and positive phases," that is to say, the resistance of the blood is reduced as an immediate effect of the bacterial poison and then increased above the normal in response to the infection.

Further, ample evidence has accumulated substantiating the fact already enunciated that normal sera do not vary more than ten per cent. on either side of unity.

Applying these principles to the practical diagnosis of tubercular infections, it will be obvious that much value will accrue from a series of examinations of the blood, and to a less extent from a single examination. Where a series of measurements of the opsonic power of the blood reveals a persistently low opsonic power with respect to the tubercle bacillus, it may be inferred, in the case when there is evidence of a localised bacterial infection which suggests tuberculosis, that the infection in question is tubercular in character. A continually fluctuating index would point to a tuberculous infection associated with constitutional disturbances, whilst an index which never varied on either side of the normal to a greater extent than ten per cent. would be taken as evidence against a tubercular infection.

If only one examination of the blood is possible and the index is found to be low, then according to the evidence in the case under investigation of a local bacterial infection or of constitutional disturbances, it may be inferred with probability that the infection is of a tuberculous nature. A high index would be taken as evidence of a systemic tuberculous infection which is active or has recently been active. But no inference at all, either positive or negative, is warranted if on a single occasion the tuberculo-opsonic index be found to be within normal limits. In this case, however, it is possible by employing a further test to arrive at a diagnosis. This consists in repeating the experiment after having heated the serum for

[1] "On the Diagnosis of Tubercle by the Examination of the Blood, and on Spontaneous Phagocytosis." By Dr. A. E. Wright and Staff-Surgeon Reid, R.N. (Proc. Roy. Soc., B., vol. lxxvii., 1906.)

"On Spontaneous Phagocytosis, and on the Phagocytosis which is obtained with the Heated Serum of Patients who have responded to Tubercular Infection, or, as the case may be, to the Inoculation of a Tubercle Vaccine." (*Ibid.*)

ten minutes at 60° C. This method of testing is based upon the fact that if normal serum is heated it no longer incites phagocytosis, whilst in cases suffering from tuberculous infection "incitor elements" have been elaborated in the organism in response to the infection, and the serum is found, after heating, to retain a considerable measure of its power of inciting phagocytosis. In a series of experiments with normal heated sera the index varied between 0.00 and 0.125; whilst in experiments conducted with the heated sera of patients with tubercular infections the index ranged from 0.09 to 1.7. These figures are obtained by comparison of their phagocytic count with that obtained with unheated pooled blood of healthy men.

In a previous paper (Roy. Soc. Proc., vol. lxxiv., p. 157), Dr. Wright suggested that the fact that the actual focus of infection had a lowered "bacteriotropic pressure" as regards the offending microorganism might be employed in the diagnosis of abscesses or effusions of a doubtful nature, the inference being that the fluid has washed over these bacteria at the site of infection, and has thus been deprived of its antibacterial substances. In this paper an interesting and convincing series of cases is given showing the practical value of this method of diagnosis of tubercle. Further justification for this would seem to be furnished in the proof of the "specificity" of opsonins for given bacteria as demonstrated by Dr. Bulloch in a recent number of the Proceedings of the Royal Society.

The same number of the Proceedings of the Royal Society contains a further paper by the same authors on "Spontaneous Phagocytosis," and on the phagocytosis which is obtained with the heated serum of patients who have responded to tubercular infection. Under the first heading the authors investigate the question of the phagocytosis which occurs in the absence of serum; under the second, the question as to the nature of the "incitor element" referred to above as being present in the heated blood derived from patients who have responded to the tubercular infection, or, as the case may be, to the inoculation of a tubercle vaccine.

As the result of searching experiments, the authors conclude that the "incitor element" is not a "stimulin" which affects the white blood corpuscles, but an opsonin which enters into combination with bacteria. They further conclude in this matter, in agreement with the previous work of Dr. Dean (Proc. Roy. Soc., B., vol. lxxvi.), that the substance in question does not differ with respect to its resistance to heat and sunlight from that which is found in the unheated normal serum.

That the opsonins are eminently heliolabile is also of great practical import, for a blood allowed to lie in the sunlight preparatory to its examination for opsonins is entirely spoilt, as is shown by experiment in the present paper.

As regards spontaneous phagocytosis an important fact was arrived at, namely, that it is in the lowest salt concentrations (0.6 per cent. NaCl) that phagocytic activity is greatest, whilst it is practically abolished by a concentration of more than 1.2 per cent.

Another experiment of practical moment is worthy of mention. When dealing with heated sera, which, as we saw above, may be used as aids to diagnosis, it is very important that the same conditions should exist in every case, for the phagocytosis occurring after the serum had been exposed to various temperatures for varying periods was found to differ considerably. Thus a fixed temperature (60° C.) for a fixed period (10 minutes) should always be employed in the exploitation of this method of diagnosis.

NOTES.

The Mackinnon studentships for the year 1906-1907 have been awarded by the Royal Society to Mr. W. G. Duffield, "for the study of arc spectra of metals under high pressures"; and to Dr. F. H. Scott, "for the continuation of studies on the nature of the process of excitation of nerve cells."

The arrangements for the international celebration of the jubilee of the coal-tar industry to which attention has been directed in these columns are now well advanced, and a very representative gathering of foreign chemists will assemble in London on July 26–27 in honour of Dr. Perkin and his work. As might have been expected in view of the great development of the industry in Germany, that country will send a very strong body of delegates. Among those who have already accepted invitations are Prof. Emil Fischer, representing the German Chemical Society; Drs. Duisberg and Delbrück, representing the "Verein Deutscher Chemiker"; Drs. Böttinger (Elberfeld), H. Caro (Mannheim), Ehrhardt (Badische Co.), Kallé (Biebrich), Klingemann (Cassella and Co.), H. Erdmann (Charlottenburg Technical High School), Kremers, Lepsius (Griesheim), Raschig (Ludwigshafen), Möhlau (Dresden), Gustav Schultz (Münich); and Drs. Bablich, Liebert, de Ridder, Albrecht Schmidt, and Ullrich, representing the Höchst colour works. It is probable that Prof. Liebermann and Drs. v. Martius and Bernthsen will also be present. From France, M. Gautier, president of the Chemical Society of Paris, and Prof. Haller will represent their society. Profs. Étard, Moureu, and Guyot will also attend as representatives of France. Holland will be represented by Profs. Holleman and van Romburgh, Austria by Prof. Friedländer, and Switzerland by Prof. Hans Rupe. America, as already announced, proposes to have an independent celebration in the autumn, but will also participate in the general international movement. The American delegates have not yet been nominated. At the banquet on July 26 all the foreign delegates will be present as guests, and it is hoped that the chemists of this country will attend in large numbers. At the meeting at the Royal Institution on July 26 Dr. Perkin will receive the Hofmann medal of the German Chemical Society and the Lavoisier medal of the Chemical Society of Paris, besides numerous addresses from the learned and technical societies. Among the names of officials and public men who have so far responded to the invitation to attend the banquet are Lords Kelvin, Rayleigh, and Alverstone, the German Ambassador, the Right Hon. R. B. Haldane, Mr. Justice Buckley, Sir Wm. Broadbent and Sir Arthur Rücker. All applications for tickets for the dinner and other functions should be addressed to Dr. J. C. Cain, 28 Pembury Road, Clapton, N.E. As the gathering is expected to be a very large one, it is desirable that those proposing to be present should communicate at once with Dr. Cain so that the necessary arrangements for their accommodation may be made.

There are now on exhibition at the London Hippodrome three microcephalic girls stated to have come from Mexico. Like the famous Maximo and Bartola, who toured the world some fifty years ago and were described to the Ethnological Society by Sir Richard Owen. The present specimens are said to be members of an almost extinct race closely allied to simians; but microcephaly is not associated with any particular race, and the information was probably suggested by the statements made as to the origin of the earlier pair. Although they are often monkey-like, the microcephalics are not technically simian in their characteristics; in some cases they have a small vocabulary, in others they are mute so far as real language is concerned. The skull capacity has been known to fall as low as 270 cm., but the present immature specimens are said to have brains only one-seventh the normal size.

In connection with the third International Colliery Exhibition recently held at the Royal Agricultural Hall, a representative gathering of delegates from mining and allied institutions in different parts of the world was entertained at luncheon by Mr. H. Greville Montgomery, M.P. It was unanimously resolved by the assembly to hold an International Mining Conference in connection with the fourth International Colliery Exhibition in 1908. An organising committee was elected, and among its members are:—Mr. J. C. Cadman, Prof. S. Herbert Cox, Mr. W. Cullen, Prof. Dunstan, F.R.S., Mr. W. B. Esson, Prof. W. Gowland, Mr. E. M. Hann, Mr. T. H. Holland, F.R.S., Mr. J. H. Marr, Mr. T. W. Mitchell, Mr. W. H. Patchell, Mr. H. M. Ridge, Mr. W. Rowley, and Mr. W. Russell, C.B., with Mr. H. Greville Montgomery, M.P., as chairman, and Mr. Allan Greenwell as secretary. All communications should be addressed to the secretary at the offices (provisional) of the conference, 30–31 Furnival Street, Holborn, London, E.C.

The committee of bibliography and of astronomical sciences of the Royal Observatory of Belgium has undertaken to publish a list of the observatories and astronomers of the whole world. A request for information, in the form of a list of questions, with a model reply relating to the astronomical service at the Uccle Observatory, Belgium, has been addressed to directors of observatories. In addition, the list will include such astronomers (university professors, amateurs, &c.) who are not attached to any observatory, but are nevertheless actively engaged in astronomical research. The information already sent will enable the committee to draw up, not only a list of observatories, with their geographical coordinates and the members of the staff, but also a table showing the astronomical activity of the whole world, based upon the information given as to the instruments at the disposal of each institution, the researches undertaken, and the papers published. Directors of observatories who have not received the question-form, or have not yet forwarded a reply, as well as unattached astronomers, are requested to send the information desired, or to repair any omissions, as soon as possible to the chairman of the committee, Prof. P. Stroobant, astronomer at the Royal Observatory of Belgium, Uccle, Belgium.

Through the death of Prof. H. A. Ward, who was struck down by a motor car on July 5 in Buffalo, U.S.A., a figure well known to every museum and mineral dealer in Europe and America has passed away. Prof. Ward was born at Rochester, N.Y., in 1834. For a short period he assisted Prof. Agassiz at Harvard Scientific School; in 1855 he went to Paris for a course of study, and travelled thence widely over Europe; from 1860 to 1865 he was professor of natural science in Rochester University. From that period until his death, most of his time was spent in travelling for the purpose of forming collections of mineralogical and geological specimens, which are well known as "Ward's Cabinets." To geological literature Prof. Ward contributed little of importance, but as a collector he did valuable service. He had built up the most complete private collection of meteorites in existence; in extending it he spared neither time nor money; though more than seventy years of age, he passed through London last year on his way to cross Europe, searching for new specimens with the ardour of a boy.

With the Earl of Grey, G.C.M.G., Governor-General of Canada, as patron, and Sir L. A. Jetté, Lieutenant-Governor of Quebec, as honorary president, the fifteenth International Congress of Americanists will meet at Quebec from Monday, September 10, to Saturday, September 15. The work of the congress will have reference to:—(1) The native races of America, their origin, geographical distribution, history, physical characters, languages, civilisation, mythology, religions, morals and habits. (2) The indigenous monuments and the archæology of America. (3) The history of the discovery and European occupancy of the New World. The committee of organisation is as follows:—President: Dr. Robert Bell, F.R.S., director of the Geological Survey of Canada, Ottawa. Vice-Presidents: Mgr. J. C. K. Laflamme, Dean of the Faculty of Arts, Laval University, Quebec; Hon. R. A. Pyne, Minister of Education of the Province of Ontario, Toronto; Dr. D. Boyle, Department of Education, Toronto. General Secretary: Dr. N. E. Dionne, librarian, Legislative Assembly. Treasurer: Mr. Alp. Gagnon, Department of Public Works, Quebec.

In a long and interesting article in the *Times* of July 9 on the commercial application of wireless telegraphy, the writer deals very fully with the history of wireless telegraphy and with the various systems now being worked on a commercial basis. The claims of the various systems are clearly put forward, and should prove of interest to the non-technical readers who are mostly inclined to the opinion that the words "wireless telegraphy" and "Marconi" are synonymous. Among the many systems which have been developed since Mr. Marconi achieved success, may there not be one or more which is entitled to an equal consideration by the authorities? This is one of the chief points raised by the *Times* correspondent, and it is one which in the interests of the nation should be fully recognised. So long as one company is granted a monopoly, the cost for commercial use is likely to remain high, and any improvements which might be made through fair competition are unlikely to be developed in the same proportion. In Germany a combination of the various systems has been made, and any new improvement brought out is thus welcomed and given the fullest consideration. In this manner the highest efficiency is obtained, and if some similar arrangement could be arrived at in this country it would surely be to the benefit of the country at large. As to whether it would be more to the interests of the nation for the Government to own and work the wireless telegraph stations, when, by a fair trial, the best system or combinations of systems has been established, is a matter which wants the fullest consideration, and before any further licences are granted to any company or companies, this aspect of the situation should be one of the first points to be decided by the authorities in whose charge the welfare of the country is placed.

Prof. Hönnann, professor of mining in the Berlin Technical High School, died on June 30 in his seventy-first year.

The twenty-third annual congress of the Royal Sanitary Institute was opened at Bristol on Monday under the presidency of Sir Edward Fry, F.R.S.

Prof. Walther von Lingelsheim, director of the hygiene station in Beuthen, Upper Silesia, has been appointed director of the newly founded hygiene institute in the same town.

Dr. Wilhelm Bode, departmental director of the Emperor Frederick Museum in Berlin, has been appointed

Director-General of the Berlin Royal Museums, with the rank of Wirklicher Geheimer Oberregierungsrath.

THE Berufsgenossenschaft der chemischen Industrie held its twenty-second ordinary meeting in Detmold on June 28, and sanctioned the spending of half a million marks for the erection of the society's business premises.

DR. THEODOR MEYER, whose work on the commercial preparation of sulphuric acid has given him a high place among technical chemists, has been appointed director of the installations bureau for the German chemical industry, in Berlin, Kurfürstendamm 139, in succession to the late Dr. H. H. Niedenführ.

PROF. HUGO VON GILM died in Vienna on June 21, in his seventy-sixth year. Born in Innsbruck, he studied at the university under Prof. Hlasiwetz, whose assistant and co-worker in several pieces of research in organic chemistry he subsequently became. From 1863 to 1895 he was first lecturer, and ultimately professor of chemistry and chemical technology in the Vienna Landesoberreal- und höheren Gewerbeschule.

PROF. EMIL JACOBSEN celebrated his seventieth birthday on July 3 in Charlottenburg, where he has lived for many years. He was horn in Danzig, and studied as a pharmaceutical student in Breslau and Berlin. In 1862 he opened an analytical laboratory in Berlin, in which he made a number of valuable observations and discoveries. Dr. Jacobson is the originator and editor of several successful periodicals. From 1862 to 1903 he issued an annual publication under the title of the *Chemisch-technisches Repertorium*, and from 1864 to 1894 the weekly paper *Industrie Blätter*, while from 1878 to 1895 he was the director of the *Chemische Industrie*.

AN earthquake shock was felt at Manstrac, Alva, and Blairlogie, in Perthshire, about 3.45 on July 4. The tremor, which passed from west to east, lasted about two seconds, and was accompanied by sounds as of distant explosions.

THE annual exhibition of antiquities connected with the Institute of Archæology, University of Liverpool, will be held in the Lord Derby Museum, Public Museums, Liverpool, from July 11 to July 26 inclusive. The exhibits include prehistoric remains from Hierakonpolis; examples of provincial art from Esna, of Hyksos period and later; scarabs, ornaments, and inscriptions from Abydos, of 2000 to 1200 B.C.; pottery and other remains of primitive man, from Kostamneh in Nubia, recently discovered by Mr. John Garstang and Mr. E. Harold Jones.

FROM the ashes of the monthly magazine of current scientific investigation, *Science Progress*, which came to an end in 1898 through lack of support, has arisen a quarterly review under the same title, edited, with the assistance of a strong advisory committee, by Dr. N. H. Alcock and Mr. W. G. Freeman, and published by Mr. John Murray. The periodical has much the same appearance as its predecessor, and the contributions to it are of the same character. There are twelve articles in which methods and results of work in several departments of science are described by writers actively engaged in scientific investigation. The contributions are thus trustworthy statements of the position and progress of important subjects of scientific study, the biological sciences being given particular attention. In the first number the endeavour of the new periodical is stated to be "to present summaries, as far as possible of a non-technical character, of important recent work in any branch of science, to show the progress achieved, and if possible to indicate something of the line along which further advance is to be made towards the desired end. The chemist, to take an example, will describe for the botanist recent advances in chemistry, the botanist will do the same service for the chemist, often, it is hoped, to the advantage and assistance of both." These intentions are, of course, admirable, and the only difficulty to be anticipated is in their application. Scientific work is so minutely specialised that the vocabulary common to all investigators is somewhat limited; and the greatest trouble the editors will have will be to obtain authoritative articles on subjects of prime importance written in a style that can be read with ease and interest by the world of science in general, while at the same time they appeal to the wants of students of special branches of scientific inquiry. We trust that the new review will be successful in its attempt to provide a common meeting-ground for men of science, where workers in biological and physical sciences can lead one another to appreciate the significance of progress made in their respective departments of natural knowledge.

WE have received a copy of an illustrated prospectus of the new edition of the "Systematisches Conchylien-Cabinet" of Martini and Chemnitz, now in course of issue by Messrs. Bauer and Raspe, of Nürnberg, under the editorship of Dr. W. Kobelt.

FROM the University of Wisconsin we have just received a copy of No. 115 of the Bulletin of that institution bearing the date of September, 1905. It is devoted to a review of the rise and progress of the study of anatomy in the United States, drawn up by Prof. C. R. Bardeen, and delivered as an inaugural address on his assumption of the chair of anatomy in the University. The discourse includes a reference to the early history of anatomy. In the University of Wisconsin a special department has been recently established for the study of human and comparative anatomy, neurology, histology, and embryology.

"NOTES on Malayan Pigs" is the title of an illustrated paper by Mr. G. S. Miller forming No. 1466 of the Proceedings of the U.S. National Museum. As the author has had the advantage of studying large series of specimens in the museums of Washington, London, Berlin, Leyden, and Berne, it may be hoped that this communication will do much towards settling the vexed question as to the number of distinguishable representatives of the genus Sus inhabiting the Malay area, although it is possible that what Mr. Miller regards as "groups" other naturalists may consider "species." Several new forms are named.

No. 1468 of the Proceedings of the U.S. National Museum is devoted to a collection of fishes from Ecuador and Peru, the new forms described by the author, Mr. E. C. Starks, including several cat-fishes (Siluridæ). In No. 1470 of the same serial Messrs. Jordan and Snyder describe two giant bass from Japan, namely, *Stereolypis ischinagi* and *Erilepis zonifer*, both of which have been long known to science, although imperfectly represented in collections. Despite the fact of both being commonly known as "bass," the two species are referable to distinct families. One example of the former was about 6 feet in length, while a specimen of the latter measured 57 inches, and other specimens are stated to weigh as much as 200lb.

BOTANY is the main subject in the June number of the *American Naturalist*, the "notes" being entirely devoted to that subject, while Dr. K. M. Wieland discourses at considerable length on the causes of the pressure and flow of sap in the maple. Osmosis from one living cell to another is, in Dr. Wieland's opinion, the only *vera causa* for the latter phenomenon. "Only by flow through the cell from one reservoir to another, due to the unequal osmotic permeability at the two ends, does it seem possible to obtain pressure by this method. . . . The pith-ray cells seem the only ones in the wood in position to fulfil the above requirements. The most probable explanation at present is that the pith-ray cells, stimulated by the rising temperature, become unequally permeable, thus setting up a current and accompanying pressure from the pith towards the bark." Two shorter articles, one by Mr. R. C. Osburn and the other by Mr. A. S. Pearse, respectively deal with the existence of dragon-fly larvæ in brackish water and with the reactions to chemical and other stimuli of the hydroid polyps of the genus Tubularia.

THE June issue (vol. vii., No. 3) of the Journal of the Marine Biological Association of the United Kingdom opens with an obituary notice of the late Prof. Weldon, who was one of the oldest workers at the laboratories, and one of the most earnest and enthusiastic supporters of that institution. This is followed by an illustrated paper on certain British nudibranchiate molluscs. A report is appended on the work of the council in connection with the International Fishery Investigations. In order to carry out efficiently the work in the North Sea, it was found advisable to establish a laboratory at Lowestoft. The experiments with marked plaice have proved the occurrence of extensive migrations on the part of that species. Very noteworthy are some of the hydrographical results, especially in relation to the fact that the waters of the North Sea and the English Channel have, respectively, different origins, according to the season of the year. It would appear, for instance, that during the summer and early autumn of 1903, the Channel waters were largely derived from the Irish Sea, while during the remainder of the year they were chiefly drawn from the Bay of Biscay, as indicated by their excessive saltness. The issue closes with the report of the working of the laboratory, &c., during 1904-5.

AN important communication on the morphology of fishes appears in the June issue of the *Quarterly Journal of Microscopical Science*, in which Mr. E. S. Goodrich discusses the development, structure, and origin of the median and paired fins. It is shown that the mode of development of the dorsal fins is essentially the same as that of the paired fins, both arising as longitudinal folds, into which grow buds from the myotomes, these being subsequently affected by concentration and fusion. The careful and detailed observations of the author practically give the death-blow to the theory that the paired fins of fishes (and consequently the limbs of vertebrates generally) are derived from modified gill-arches, for, as is mentioned in the text, that theory gives no explanation of this remarkable structural resemblance of the paired to the median fins. On such a theory the resemblance is in truth absolutely inexplicable, whereas on the lateral (and median) fold-theory such a resemblance is not only easy of explanation, but is precisely what we should expect to occur. Mr. Goodrich has done good service in brushing aside collateral issues and putting the *crux* of the problem plainly before his readers, and it may be hoped that his efforts will result in the general acceptance of the lateral fold-theory. The contents of the above-named issue of the *Quarterly Journal of Microscopical Science* also include a continuation of Dr. Woodcock's review of the hæmoflagellates, and a preliminary account, by Miss R. M. Harrison, of a newly-discovered organ (consisting of a glandular body between the fifth and sixth abdominal ganglia) in the cockroach.

NOT for the first time American botanists are extending their sphere of operations to British colonies in undertaking an investigation of plants in the Bahama Islands. The collections gathered hitherto by various American botanists have been of a somewhat meagre character, so that Drs. N. L. Britton and C. F. Millspaugh, with the consent of the British botanists concerned, have planned a botanical survey of the group. Under the title "Prænunciæ Bahamenses," Dr. Millspaugh, in vol. ii., No. 3, of the botanical series of the Publications of the Field Columbian Museum, Chicago, treats the orders Amarantaceæ, Euphorbiaceæ, Rubiaceæ, and Verbenaceæ. Under the Verbenaceæ two new genera, Nashia, allied to Lantana, and Pseudocarpidium, allied to Vitex, are founded.

THE systematic articles in the recent part of the Kew Bulletin, No. 4, include a decade of new orchids described by Mr. R. A. Rolfe, and a series of "Diagnoses Africanæ" contributed by Mr. N. E. Brown, among which are several plants collected by the Hon. Mrs. E. Cecil in Rhodesia and Portuguese East Africa. The nature and uses of Chinese wood oil, generally known as t'ung oil, are discussed by Mr. J. M. Hillier, and the tree yielding it is referred by Mr. Botting Hemsley to *Aleurites Fordii*. A number of new species of Indian fungi are recorded by Mr. Massee, who also writes a note wherein he advances arguments proving that potato-disease and potato leaf-curl are more often perpetuated by hibernating mycelium than by diffusion of spores.

THE exhibit organised by the Meteorological Office for the International Exhibition, Christchurch, N.Z., 1906–7, was, by permission of Dr. Shaw, viewed on July 6 by many persons interested in meteorology. The exhibits were intended to illustrate the methods adopted by the Office and by the institutions associated with it, and the results obtained on land and sea. For this purpose instruments, published works, and specially prepared diagrams were arranged according to the branches into which the operations of the Office are divided. Perhaps the most imposing display was in connection with maritime meteorology; many beautiful specimen sheets of monthly charts for the various oceans testified to the care and skill bestowed on this important part of the work of the Office. Among the many objects of interest was a meteorological log contributed by the Prince of Wales when in command of H.M.S. *Thrush*. The details connected with the preparation of weather forecasts and the issue of storm warnings were well represented. Among the most attractive charts may be mentioned one showing the portions of the globe for which daily weather reports are published, with isobaric lines drawn for December 21, 1905, from the charts received; maps showing passages of cyclonic depressions across the British Isles and the prevalence of gales on our coasts. In the section dealing with climatological statistics maps were exhibited showing the stations under the control of the English and Scottish Meteorological Societies and the British Rainfall Organisation. Dr. Shaw contributed some carefully drawn diagrams showing the apparent relation between the yield of wheat and rainfall; meteorological sequences—dry autumn followed by wet spring and *vice versâ*—and the meteorological relations of widely distant regions. Although somewhat of a tentative character, the results were very striking, and led to the conviction that a great step in the right direction had been made in grappling with the multitudinous details at the disposal of the Office. The department dealing with automatic recording apparatus took also a prominent position in the exhibit; some excellent drawings were shown illustrating the mounting and working of the instruments at the first order observatories. Among the instruments exhibited by some of the principal opticians was a Beckley's anemometer with Whipple's improvements, by which the direction of the vane could be read at any time by pressing the electric button of an indicator placed in any convenient room in the observer's apartments. Another interesting feature was some carefully drawn diagrams illustrating the wind circulation at the South Pole (results of the *Discovery* observations) for each month, both at the surface and in the higher regions of the atmosphere. Mr. Dines exhibited a model of a kite and a meteorograph used for the investigation of the upper air.

THE *Physikalische Zeitschrift* for June 15 contains a description by Prof. Simon, illustrated by plans and photographs, of the new buildings and equipment of the institute for applied electricity in the University of Göttingen. A historical sketch is given of the steady development of the teaching of electrotechnics at Göttingen during the past twelve years, with particulars of the funds available during this period and of the circumstances which have led to the creation of the new "institute."

AN attempt to ascertain the cause of the explosion which sometimes occurs of sealed glass tubes containing radium bromide is described by Mr. Paul L. Mercanton in No. 11 of the *Physikalische Zeitschrift*. Such an explosion might possibly be due to the pressure set up within the tube by some gas being gradually produced by the radium. A glass tube containing 15 mg. of radium bromide, which had been kept sealed during more than three years, was accordingly opened under such conditions as would permit of the measurement of any increase of pressure, and of the examination of any gas liberated from the tube. It was found, however, that no increase of pressure could be observed, nor could the presence of helium be detected.

THE fourth edition of Prof. J. E. V. Boas's "Lehrbuch der Zoologie für Studierende," which has just been published by Mr. Gustav Fischer, Jena, contains much new matter, both in the text and illustrations. There were 378 figures in the first German edition of this work, reviewed in NATURE of January 22, 1891 (vol. xliii., p. 268), and this number has now been increased to 577; while both the general and special parts of the text have been thoroughly revised by the author, with the assistance of Prof. J. W. Spengel, professor of zoology at Giessen.

A SECOND edition, revised and enlarged, of Prof. C. Moureu's "Notions fondamentales de Chimie organique" has been published by Messrs. Gauthier-Villars, Paris. The book is a synopsis of the facts and theories of organic chemistry, and is intended to be an introduction to the study of this science.

OUR ASTRONOMICAL COLUMN.

FINLAY'S COMET.—Writing to the editor of the *Astronomische Nachrichten* (No. 4102), Herr L. Schulhof states that the Jupiter perturbations of Finlay's comet bring the time of perihelion passage forward by about twelve hours, thereby making it September 7·5 instead of September 8·0 as given originally. The uncertainty of the elements is probably not greater than a quarter of a day, so that the perihelion time may now be taken as lying between September 7·25 and September 7·75. On June this comet was twice as bright as when discovered in 1886, and its apparent brightness will steadily increase until the end of August; the observation of the comet is, therefore, very probable.

THE RADIANTS OF THE PERSEID SHOWER.—From a number of observations made at Dorpat during 1901 and 1902, M. Wwedenski, under the direction of Prof. Pokrowski, has determined the following radiants of the Perseid meteors:—

Date of observation.	No. of meteors observed.	Chief radiant point. α	δ
		°	°
1901 Aug. 10	23	40	+57
,, ,, 11	37	47	+58
,, ,, 12	17	47	+56
1902 Aug. 10	17	43	+60
,, ,, 11	27	35	+55

Another set of observations made on August 10 and 11, 1901, gave $40° + 57°$ (24 meteors) and $44° + 57°$ (43 meteors) respectively (*Astronomische Nachrichten*, No. 4098).

MAGNITUDE OBSERVATIONS OF NOVA AQUILÆ NO. 2.—The magnitude of Nova Aquilæ No. 2 was observed at the Bothkamp Observatory on seventy-seven occasions between September 5 and December 10, 1905, and the results are given and discussed in No. 4098 of the *Astronomische Nachrichten*. On analysing these results, Dr. Guthnick found that the curve showing the diminution of magnitude was not a straight line, but a parabola of the following form:—

$$m = 10{\cdot}96 + 0{\cdot}0272t - 0{\cdot}000095t^2,$$

where m = the Nova's magnitude at the time of observation, 10·96 its magnitude on September 5, 1905, and t the number of days which elapsed between September 5 and the time of observation. The departure of the observed values from those computed, for the same epoch, from the curve are given in the table accompanying the results.

AN OBJECTIVE-PRISM COMPARISON SPECTROGRAPH.—In No. 5, vol. xxiii., of the *Astrophysical Journal*, Mr. de Lisle Stewart, of the Cincinnati Observatory, proposes a new form of objective-prism spectrograph which might be employed for the determination of stellar radial velocities. Instead of making two exposures with the one instrument, as has been proposed in previous suggestions to this end, Mr. Stewart proposes to employ two similar spectrographs mounted rigidly on one equatorial mounting and having the prism bases adjacent. This would bring the two spectra of each star near together on the plate, and would, presumably, eliminate, at least to some extent, the differential effects of flexure and temperature changes. Various details as to the inclination of the two tubes to each other, the inclination of the plate, the positions of auxiliary telescopes, &c., are given in the paper. Prof. Frost estimates that the probable error of radial velocities so determined would not be less than 20 km., but Mr. Stewart suggests that practical experience would remove the outstanding obstacles to more trustworthy determinations.

RUSSIAN ASTRONOMICAL OBSERVATIONS.—We have recently received five Bulletins of the St. Petersburg Imperial Academy of Sciences, each of which contains one or more papers of astronomical interest. Thus No. 5, vol. xvii. (1902), includes a paper, in French, by Prof. Brédikhine on the *rôle* of Jupiter in the formation of simple radiants, and in vol. xviii. (1903) MM. Donitch and Jaegermann have articles on the solar envelopes during the last minimum and on the production of comets' tails respectively. Vol. xix. (1903) contains several astronomical papers, including one on the observations of the chromosphere outside eclipses (M. Donitch), and another on comet forms (M. Jaegermann). Vol. xx. (1904) is largely astronomical, and includes articles on the Pulkowa spectrograph, the repulsive force of the sun, the solar activity, and the International Catalogue; whilst vol. xxi. (1904) contains papers by Prof. Belopolsky dealing with radial-velocity problems.

A NEW OBSERVATORY FOR HAMBURG.—From *Himmel und Erde* (No. 8, 1906) we learn that a new observatory is to be erected near Hamburg. The senate and council of that town have voted one million marks towards its erection and equipment. Among the other instruments which it is proposed to instal in the new building, the following are the chief:—A meridian circle of 18 cm. (7 inches) aperture, a 60 cm. (23 inches) refractor, a double telescope for photographic purposes, and a reflector having a mirror of 1 metre diameter.

STAR TRANSITS BY PHOTOGRAPHY.[1]

THE annoyance that arises from the effects of a "magnitude equation" in transit observations has led to various suggestions for its detection or removal. Screens in front of the object-glass so as to reduce the light of bright stars have been employed with advantage, and various photographic devices arranged with the view of eliminating personal peculiarities have been adopted. But while ingenuity has been active in proposing practical applications and methods, the numerical results have been few. Recently, Prof. S. Hirayama, of the astronomical observatory at Tokyo, has put in practice a contrivance similar to that employed by the Rev. Father Hagen in photographing a star in the focus of the transit telescope. In this method the exposure and occultation of a star is alternately effected by means of a bar, moved in obedience to a clock, so as to give rise to a series of dots along the star trail.

The Tokyo transit was for this purpose provided with a triple object-glass, reducing the secondary spectrum, and specially corrected for photographic rays. The aperture was 13·5 cm., and the focal length 211 cm. The range of magnitude to which the telescope was applicable depended, of course, upon the time of exposure permitted by the occulting bar. As a matter of fact, with a full second's exposure, equatorial stars of the fifth magnitude gave a measurable image. For stars of greater declination than 73° the exposure of one second was too short to divide distinctly the successive impressions from each other. The limitations of the method are thus clearly indicated. For fainter stars it seems necessary to consider the possibility of moving the photographic plate at the same rate as the star, and imprinting on the plate the image of a fixed reticule at known times. The simpler method adopted by Prof. Hirayama recommended itself to him, since the apparatus could be constructed in the workshops belonging to the observatory.

This apparatus consisted of a camera containing the reticule, occulting bar, and the dark slide, which could be inserted in the place ordinarily occupied by the wires and eye-piece. The reticule consists of seven fine lines ruled upon a microscope cover-glass, firmly cemented to a rectangular frame which carries the dark slide. These lines are interrupted for a short distance in the middle of the field so that they shall not interfere with the star images. The centre of the field is marked by two horizontal wires in the ordinary manner. The occulting bar (Fig. 1) is a

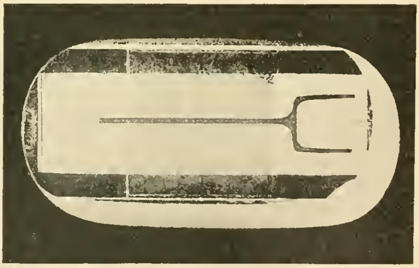


FIG. 1.—Showing the bar at rest, in the centre of the field.

thin metal slip about 8 cm. long with a square opening at one end, so as to allow the observer to see the star enter the field, and to permit him to adjust the instrument so that the transit shall take place behind the bar when in its stationary position. The end of this bar is soldered to the armature of an electromagnetic coil. Whenever the electric circuit is established the bar is lifted up and the star exposed. This circuit is made and broken automatically by contact springs in the standard sidereal clock. The bar consequently operates as an exposing shutter, permitting the cone of light from the star to fall for a longer or shorter period upon the sensitised plate, the period being decided by the contact springs.

The sensitive plate when inserted in the dark slide comes within 0·2 mm. of the lines of the reticule, so that these lines and the image of the star are practically in the same focus. Evidently this distance must be made as small as possible to reduce any error arising from photographic parallax, but the plate can be shifted in its own plane, so that five separate exposures can be made upon the same plate. The advantage thus secured of taking

FIG. 2.—The bar removed, showing the transit of a star; slightly enlarged.

five stars on the same plate is somewhat discounted by the fact that no proper adjustment can be made for developing the plates according to the different actinic intensity of the stars.

The method of observation will be easily apprehended from the description of the apparatus and the character of the results obtained (Fig. 2). The measurement of the plates is not so simple. It is distinctly admitted that to measure a negative is more laborious than to read the fractions of a second from a chronographic sheet. Theoretically, the beginning of each "break" made by the clock is the exact point to which the reading should refer; but owing to the difficulty of measuring the edges of the dots, due to the want of sharp definition, this plan could not be adopted. The middle of the "break" to the middle of the "make" has been taken as the full second. This arrangement, or conventional rule, has probably got over the difficulty arising from the photographic spread, for it seems not impossible but that the want of definition at the edges of the dot, or the distance between two dots, is dependent upon the brightness of the star. But if this source of error is eliminated the author has to regret that the length of the dot depends upon the battery, the spring, the friction, and the moving parts of the apparatus as affected by the variable component of the force of gravity. "The weakening of the battery has been constantly provided for, but at present I see no way of escape from all the other disadvantages."

This admission seems to deprive this peculiar method of observation of much practical benefit. The question that has to be solved is not so much one of relative accuracy as it is of the possibility of eliminating systematic errors, inherent in older and more familiar methods. Looked at as a simple matter of determining the position of a star on a plate at any required moment, the results leave nothing to be desired. In an example worked out in detail it is shown that the error in a single pair of measures is $\pm 0{\cdot}017$s., and the mean error of thirty-two pairs, or what may be regarded as equivalent to a complete transit, $\pm 0{\cdot}002$s. The results of the measures of 140 stars, made when the plate was moved with, and against, the direction of diurnal motion, gave for the average value of personal equation $+0{\cdot}027$s., the positive sign implying that the time of transit was longer when the plates were measured along the diurnal motion than when measured against it.

But such measures leave the question of a possible error dependent upon magnitude untouched. Unfortunately, the limited range of magnitude and the small number of observations do not permit any very definite conclusion to be drawn. The author presents a table of forty-six stars in which the photographic magnitude varies from 1·2 mag. to 5·5 mag., and gives residuals for each night and the mean residual. The latter is less than 0·05s. in all but two cases out of the forty-six. Further, when these mean residuals are arranged for each star in the order of photographic magnitude, no relation between the two is notice-

[1] "Preliminary Experiments on the Photographic Transit." By S. Hirayama. Annales de l'Observatoire astronomique de Tokyo. Tome iii., 4e fascicule. (Tokyo, 1905.)

able. Of the two errors greater than 0·05s., one is +0·072s. and the other −0·060s., and the magnitudes of the two stars are the same, and practically in the middle of the series.

But if there is no indication of a "magnitude equation" there is another circumstance which is not a little suspicious, and interesting as suggestive of the introduction of fresh sources of error. The author has referred to the fact that the mean error of observation can become comparatively large when the photographic image is poor, owing to the small altitude of the star. When the residuals are collected according to the zenith distance of the star, there is some indication of a connection between the two. "There is," says Prof. Hirayama, "a common tendency for the residual error to be least at the zenith, and to increase with the zenith distance." No stars below the pole have been observed, so that there is no means of comparing the results given by stars at small altitudes on opposite sides of the zenith. But many important questions are raised in this paper, and we notice with pleasure that Prof. Hirayama proposes to continue the inquiry. We can assure him that his investigations will be watched with interest in this country.

THE MUSEUMS ASSOCIATION.

THE seventeenth annual meeting of the Museums Association was held in Bristol on July 2–5 under the presidency of Dr. W. E. Hoyle, director of the Manchester Museum. The attendance of curators and representatives from various British museums was greater than in any previous year, foreign museums and museum workers being also represented by Geheimrat Dr. A. B. Meyer, of Dresden, Prof. Conwentz, of the Provincial Museum, Dantzig, Prof. Lehmann, of the City Museum, Altona, Mr. H. L. Brakstad, Norwegian Vice-Consul, and others.

The public conference commenced on the morning of July 3 in the Council House, a warm welcome being given to the association on behalf of the city by the Lord Mayor, High Sheriff, and museum committee, after which Dr. Hoyle gave the presidential address, taking as his subject the education of a museum curator. Briefly reviewing the varied training, or lack of training, which many curators have received, Dr. Hoyle divided museums into two great classes:—(a) museums of art, or institutions in which objects are regarded simply as material for æsthetic contemplation, where they are arranged so that each may be seen to the best advantage and minister to the cultivated enjoyment of the onlooker; and (b) museums of science, in which the object is to exhibit the state of human knowledge on one or more subjects, and to supply means of increasing that knowledge.

Confining his observations to the character of training required for curators of science museums, the president urged the necessity of a fair preliminary training in manual industry and the knowledge and use of tools, and afterwards a technical and scientific training in those subjects underlying the future work of the embryo curator. As subjects necessary to be studied because of their close relation to museum collections were enumerated the natural sciences, mineralogy, geology, biology, including in the latter term botany, zoology, anthropology, and ethnology. As sciences more nearly concerned with the acquisition, registration, preservation and exposition of museum collections were instanced the rudiments of mechanical engineering, physics, and chemistry. As a kind of post-graduate course, the necessity of visiting and studying the nature and methods of work of various museums was strongly insisted upon.

Alderman W. R. Barker, chairman of the Museum and Art Gallery committee, laid before the association a paper he had prepared tracing the rise and progress of the Bristol Museum from its inception in 1808 to the present union of museum and City Art Gallery.

Mr. H. Bolton, curator of the Bristol Museum, followed with a paper describing the general character of the collections, and the steps which had been taken to bring the mode of exhibition and usefulness of the museum contents up to modern requirements, mentioning that it was the intention of the committee to introduce a type-series of mounted specimens, an osteological series, and one in which the main structural features of the animal kingdom would be shown by prepared dissections. Work on similar lines was proceeding in other departments of the museum, and ultimately it was hoped to be able to place at the disposal of any student or visitor all that is necessary in the way of types for the full degree course of any university. Papers were also read by Mr. R. Quick, on the hanging of pictures; by Mr. F. R. Rowley, on a method of displaying coins, and on models of Protozoa; and by Mr. W. W. Watts, on the City plate and insignia.

Wednesday, July 4, was occupied with the discussion of a series of papers on museum cases and fittings, the subject being opened by Dr. A. B. Meyer, of Dresden, who outlined the result of his experiments and researches during the last thirty years upon museum cases. He strongly advocated metal and preferably iron cases, which could be made dust-proof, elegant in appearance, and not more costly than wooden cases. Dr. Meyer's remarks were followed by a paper from Mr. F. A. Lucas, of Brooklyn Museum, and one by Dr. Lehmann on a simple practical dust-proof case in the Altona Museum. Mr. Bantry White, of the Dublin Museum of Science and Art, exhibited an iron museum case built in that museum's own workshops, which was very efficient, dust-proof, and not costly.

A remarkable cabinet case, with changing trays each of which could be brought into view in turn by mechanical means, was exhibited and explained by the Rev. S. J. Ford. Mr. A. M. Rodger exhibited case fittings from the Perth Museum, and Mr. Woolnough, of Ipswich, complete models of cases it was proposed to introduce into the museum at that town. The lighting of museum cases was dealt with by Mr. Thos. White, of London. Dr. F. A. Bather explained the character of some cases in the British Museum, and illustrated his remarks, as did other speakers, by photographs and drawings. Mr. J. Osborne Smith also dealt with the same subject, and exhibited the original drawings and plans of many of the more recently made cases. Owing to the interest and importance of the subject the session was continued in the afternoon until four o'clock.

Thursday was occupied by a paper on the American Museum of Natural History, by Dr. H. C. Bumpus; by a paper on wall diagrams to illustrate prehistoric archæology, from Prof. Conwentz; a paper on the Altona room in the Arts and Crafts Exhibition, Dresden, designed to show how the form of animals is the concrete expression of adaptation to their suroundings; and one on the construction and management of museums of art, by Mr. B. Ives Gilman.

The afternoons and evenings of July 3 and 5 and the whole of Friday, July 6, were occupied by visits to the zoological gardens at Clifton, a conversazione at the Museum and Art Gallery, visits to the stone circles at Stanton Drew, the ancient British lake village near Glastonbury, the Glastonbury Museum, and the Cheddar Gorge and Caves. The meetings were well attended throughout, and a highly successful conference was brought to a close on Saturday last.

THE METEOROLOGY OF THE FREE ATMOSPHERE.

AT the request of the council of the Royal Society of Edinburgh, M. L. Teisserenc de Bort gave an address on the meteorology of the free atmosphere at the meeting of the society on May 21. Subjoined is a summary of his lecture.

The methods for sounding the atmosphere employed at the present day have been in our possession but a few years. The kite, carrying self-registering apparatus, was introduced by the Americans about fifteen years ago; the sounding balloon dates but twelve years back. The use of balloons, furnished with registering apparatus, was proposed by Lemonnier, a French physicist, at the end of the eighteenth century; but they were actually employed for the first time by the Brothers Renard, and especially by MM. Hermite and Besançon, whose first observations go back to 1893.

Observations of great interest had already been made on mountains. To these are now added observations made in air altogether free.

The distribution of the barometric pressure at a distance of several thousand metres above the ground was first examined, and maps were shown giving the isobars at 4000 metres as calculated from the pressure and temperature on the surface of the earth.

M. Teisserenc de Bort has carefully verified that the pressure in free air diminishes in accordance with the barometric formula. For that purpose he determined the heights of a large number of balloons by observing them with two theodolites. On the average the heights thus observed agree with those deduced from the barometers carried by the balloons to within 2 or 3 millimetres of barometric pressure for a height of 4000 metres. The maps of the isobars at 4000 metres show that most of the areas of high and of low pressure observed near the ground become effaced as we rise in the air, and give place to a pressure distribution of a much simpler kind, viz. a maximum of pressure all round the earth in the tropical regions, and low pressures at the poles. The average direction of cirrus clouds is in harmony with these conditions.

As regards the distribution of temperature, the following conclusions were established :—

(1) Even at a height of several thousand metres above the ground there is, contrary to what had been thought, a very sensible variation of temperature from winter to summer, the divergence of temperature between the coldest and the hottest month being 9° C. at 10 kilometres height.

(2) After it had been noticed that the rate of fall of temperature increases with the height above the ground, it was naturally supposed that temperatures at great heights in the air were extremely low. But sounding balloons dispatched from the Trappes Observatory have proved that, after a certain height, varying from 9 to 14 kilometres, the fall of temperature ceases altogether—another fact that was wholly unexpected.

(3) The zone where the temperature ceases to fall, called the "isothermal zone," is situated nearer the ground (8 to 9 kilometres in certain places) with low pressures, and further from the ground (about 12 or 13 kilometres) above high-pressure areas.

(4) As a general rule, it is colder in the upper part of an anticyclone than it is at a corresponding height above low pressures, but the contrary holds at medium heights of about 5 kilometres. The absolutely lowest temperatures are observed near high pressures. A temperature of −73° has been observed several times at Trappes, and recently as low as −80° in Austria.

(5) Balloon flights made daily for a week or more at a time, in different years and at different seasons, have shown that at intervals of a few days the atmosphere experiences variations of temperature which are much more important high up than on the ground. At a height of 11 kilometres variations of 15° to 20° are often observed at a time when variations of only 2° to 3° are found near the ground.

It is believed that the arrest of the decrease of temperature is connected with the cessation at a certain height of movements of the air having a vertical component, the air then having movements which follow the isobaric surfaces. There is no longer any temperature variation due to expansion or compression of the air.

It has been demonstrated, alike by calculation of the isobars and by the flight of balloons, that most of the depressions which appear near the ground as complete atmospheric vortices suffer deformation as the height increases, and in their northern part lose themselves in the great polar vortex; so that, at a certain height (4 to 7 kilometres), east and north-east winds are no longer found to the north of a depression, and the isobars at this height form a handle attached to the low-pressure areas of northern latitudes. On the front of a depression its characters remain distinct to the top; a sheaf of ascending air reaches the height of cirrus cloud, and then spreads over the barometric maxima to east and south-east.

M. Teisserenc de Bort exhibited his very light, compact self-registering apparatus for measuring the temperature, pressure, and humidity in the upper regions of the atmosphere. Dr. W. N. Shaw, F.R.S., expressed the indebtedness of meteorologists to M. Teisserenc de Bort, whom he had come all the way from London to hear. After referring to the main points of the address, Dr. Shaw directed attention to another important line of research for which M. Teisserenc de Bort has fitted up a fish carrier, acquired at Hull, with the aid of which he is investigating at the equator the problem of the upper trade winds.

INTERNATIONAL SCIENCE.[1]

IN an address delivered to the British Association at its Belfast meeting in 1902 I expressed the opinion that meteorology might be advanced more rapidly if all routine observations were stopped for a period of five years, the energy of observers being concentrated on the discussion of the results already obtained. I am glad to say that meteorologists have taken this remark as being meant seriously, and its echoes still reach me from distant parts of the earth. They disagree with me, but their disagreement is of the apologetic kind. I do not wish to retract or to weaken my previous statement, but merely to qualify it now to the extent that it is only to be applied to two-dimensional meteorology. There is a three-dimensional meteorology as far removed from the one that confines itself to the surface of the earth as three-dimensional space is from a flat area. Three-dimensional meteorology is a new science, which at present requires the establishment of new facts before their discussion can properly begin. The extension of our range of observations by kites and balloons is of comparatively recent origin. Mr. Archibald in this country was one of the pioneers of meteorological investigation by means of instruments attached to kites. In the United States Mr. Rotch, having established a separate observatory, succeeded in convincing scientific men of the great value of the results which could be obtained. M. L. Teisserenc de Bort, who established and maintained an observatory for dynamic meteorology at Trappes, near Paris, rendered similar services with regard to "pilot" or unmanned balloons carrying autographical instruments. The aëronautical department of the Royal Prussian Meteorological Institute, with Dr. Assmann at its head, under the direction of Prof. von Bezold, also made a number of important contributions in the early stages of the work. Prof. Hergesell, of Strassburg, similarly made numerous experiments, and chiefly through the efforts of those whose names have been mentioned, and more especially Prof. Hergesell, an international agreement has been secured by means of which kite and balloon ascents are made in several countries on the first Thursday in each month, and on three consecutive days during two months of the year. A large station for aëronautical work was recently established at Lindenberg, near Berlin, where kites or balloons are sent up daily for the purpose of securing meteorological records. The greatest height yet reached was during the ascent of November 25, 1905, when by means of several kites sent one after another on the same wire, the upper one rose to an altitude of 6430 metres, almost exactly four miles. Owing to want of funds this country could until recently only participate in this work through the individual efforts of Mr. Dines, who received, however, some assistance from the British Association and the Royal Meteorological Society. The reconstruction of the Meteorological Office has made it possible now for Mr. Dines's work to be continued as part of the regular work of the office, and further stations are being established. Mr. Cave carries out regular ascents at his own expense at Ditcham Park, and through the cooperation of the Royal Meteorological Society and the University of Manchester, assisted by a contribution for apparatus from the Royal Society Government Grant Fund, a regular kite station is being established on the Derbyshire moors.

The International Committee which collates the observations is a commission appointed by a union voluntarily formed between the directors of meteorological observatories and institutes of countries in which regular observations are taken. The meeting of directors discusses schemes of observations and encourages uniformity.

If I mention a few of the difficulties which stand in the way of a homogeneous system extending over Europe, I

[1] Discourse delivered at the Royal Institution on Friday, May 18, by Prof. Arthur Schuster, F.R.S. (Continued from p. 237.)

do it in the hope that it may perhaps ultimately assist in removing some of them. It is obviously desirable that the charts, which are intended to show the distribution of pressure and temperature, should be derived from observations made at the same hour. Germany observes at eight o'clock of central European time, and France observes simultaneously (or nearly so) by choosing seven o'clock Paris time for its readings. We observe at eight o'clock Greenwich time, which is an hour later. It is the great desire of Continental meteorologists that our standard hour should be seven o'clock; and what prevents it from being so? Chiefly and absolutely the additional cost which the Post Office must claim for the transmission of telegrams; because messages transmitted before eight o'clock are subject to an additional charge of one shilling, which may be claimed by the postmaster, the claim being possibly increased to two shillings when the postmaster and telegraphist are different persons. This is prohibitive, but it does not exhaust the inconvenience of the additional charge. For the purpose of weather forecasting it is clearly necessary that telegrams should be received as early as possible by the Meteorological Office. But the eight o'clock rule delays telegrams from some Irish stations, because eight o'clock by Dublin time is 8.25 by Greenwich time, and therefore Irish telegrams may have to wait until nearly half-past eight if they are to be transmitted without extra charge.

While the international organisation of meteorology is well on its way, though difficulties such as those I have mentioned may temporarily retard it, another question not altogether disconnected with it has been raised by Sir John Eliot. This is the establishment of an institution devoted to the collective study of meteorological problems affecting all parts of the British Dominions. It is true, not only in this, but also in other matters, that in order to take our proper position in international work it is necessary that we should set our own house in order, and we must give Sir John Eliot's proposals our hearty support. If I do not enter further into this question it is because I am to-day dealing more especially with problems which go beyond the limits of the Empire. I assume the existence of a national organisation, but lay stress on the insufficiency of this limitation.

The importance of the subject, however, may be my justification if I direct your attention for a moment to the meteorological question as it presents itself in India. We all know and realise the vital importance of the rainy season, and the benefit which the native population would derive if it were possible to predict, even if only imperfectly, the setting in of the monsoon. It appears that Dr. Walker, the present director of observatories in India, recently obtained very encouraging results in this respect. According to his investigations, a forecast of the monsoon may be derived from a knowledge of the weather during preceding months in different parts of the world. Thus a heavy rainfall in Zanzibar in May is followed by a weak monsoon, while a pressure deficiency in Siberia during the month of March indicates a probable deficiency of rain in India during the following August. I need not insist on the importance of these results, which at present are purely empirical, and require further confirmation; but it is quite clear that for the successful prosecution of these inquiries political boundaries must be disregarded, and a system of intercommunication organised between the countries chiefly concerned. Dr. Walker informs me that he has successfully arranged for telegraphic reports to be sent to him at the beginning of June from six different stations in Siberia. It is hoped that this cooperation, which was unavoidably discontinued during the late war, may now be re-established.

The course of international organisations does not always run smoothly. The efforts made toward cooperation in earthquake records have unfortunately led to differences of opinion, which have hitherto prevented a truly international system being formed; and if I give a short historical account of the circumstances which have led up to these differences it is only in the hope that this may help to remove them. The scientific investigation of earthquakes may be said to have begun when British professors of physics, engineering, and geology were appointed at the Imperial College of Engineering in Tokio. Some of them, on returning home, succeeded in interesting the British Association in the subject. Ever since 1880 that association has been an active supporter of seismic investigations. The much disturbed region of the Japanese island was naturally the first to be studied; but in 1895 Prof. Milne, as one of the secretaries of the committee, issued a circular directing attention to the desirability of observing waves which have travelled great distances, and some months later, Dr. E. v. Rebeur-Paschwitz, of Strassburg, drew up suggestions for the establishment of an international system of earthquake stations. To this scheme Prof. Milne and other members of the British Association committee gave their approval. The cooperation which thus seemed so happily inaugurated was broken by the unfortunate death of its originator. Circumstances then arose which compelled the British Association committee to go its own way. Under its direction a system was established which now includes about forty stations distributed all over the world. But the needs of different countries are not, and were not meant to be, completely satisfied by this organisation.

There is always a certain number of earthquakes having purely local importance and requiring discussion from a purely local point of view. For the purpose of such discussion relating to the disturbances which chiefly affect Central Europe, the Union (so-called Kartell) of the Academies of Vienna, Munich, Leipzig, and Göttingen formed a committee and did excellent work. In the meantime Prof. Gerland, who had succeeded Dr. Rebeur-Paschwitz at Strassburg, had personally invited a number of friends interested in the subject to a conference at Strassburg with the object of forming an international association. This was followed in 1903 by a formal conference called by the German Government, at which Great Britain was represented by Sir George Darwin and Prof. Milne. This conference drew up a scheme for an international association, and a large number of countries, including Russia and Japan, joined. Strassburg was selected as the seat of the Central Bureau. The matter came up for discussion at the meeting of the International Association of Academies, which was held in London in the year 1904, and a committee was appointed for the purpose of suggesting such modifications in the constitution of the seismic organisation as might bring it into harmony with the views of the associated academies. This committee, over which I had the honour to preside, met at Frankfort, and recommended a number of important changes, which were unanimously accepted by the second seismic conference held last summer in Berlin. In consequence of this acceptance it appears that Italy and the United States joined the seismic association, while England declared its willingness to join under certain conditions, of which the simultaneous adhesion of France was one. The following summary of the States which have joined, and their population, is copied from the official report of the last meeting at Berlin:—

Country	Population	Contribution
		£
German Empire	60,000,000	160
Belgium	7,000,000	40
Bulgaria	3,700,000	20
Chili	3,000,000	20
Congo State	19,000,000	80
Spain	19,000,000	80
United States of America	76,000,000	160
Greece	2,500,000	20
Hungary	19,250,000	80
Japan	48,000,000	160
Italy	33,000,000	160
Mexico	13,600,000	80
Norway	2,300,000	20
The Colonies of the Netherlands	5,500,000	40
Portugal	5,400,000	40
Roumania	6,300,000	40
Russia	129,000,000	160
Switzerland	3,300,000	20

It was decided at the Berlin meeting that Prof. Kövesligethy, of Budapest, should be secretary, and Prof. Palazzo, of Rome, the vice-president, of the International Seismic Association. Prof. Gerland had already previously been designated as director of the Central Bureau. The office of president of the association was left vacant until the final decision of Great Britain as to its adhesion had been settled. There the matter stands for the present.

The disastrous results of recent earthquakes and volcanic eruptions have directed increased attention to the subject. Its thorough investigation is indeed likely to yield important information on the interior constitution of the earth. A hearty cooperation to obtain and circulate the material for a detailed discussion cannot fail to bear fruit, and, even though there may be legitimate grounds for dissatisfaction at the manner in which a particular scheme has been organised, I must express my own opinion that at the present moment the permanent interests of this country would be best secured by our joining the association and helping to direct its work in a manner which would assist rather than hamper the present organisation of the British Association.

Although time is running short, I am perhaps in private duty bound not altogether to pass over in silence an organisation which has its central bureau in my own laboratory at the University of Manchester. This is a union for the observation of solar phenomena. Called into being chiefly by the energy of Prof. Hale, this association is perhaps unique in two respects. It aims more directly at conducting research work than is the case with other unions, and in so far may run the danger of hampering private efforts. This danger has, I believe, been well guarded against by the constitution adopted at the first meeting of the conference held last September at Oxford. The second peculiarity referred to is that it works a central bureau, a computing bureau (under the direction of Prof. Turner), and is going to publish Transactions without any funds beyond those doled out to it by charity. Its vitality will, I hope, help it to overcome its initial troubles. Its ambitious programme includes a definite agreement on the standard of wave-length and investigations on the permanence or variability of solar radiation.

This latter question is of considerable interest to meteorologists, and comes, therefore, within the purview of the directors of meteorological observatories, who have also, under the presidency of Sir Norman Lockyer, established a commission charged with its discussion. An arrangement has been made securing cooperation between the two bodies, the Solar Union leaving out of its programme the difficult question of the relationship between sun-spot variability and meteorological phenomena.

Although an unnecessary overlapping of two separate enterprises has in this instance been avoided, such overlapping constitutes a certain danger for the future, as the problems of geo-physics—for the investigation of which international associations are specially marked out—are so intimately connected with each other that a homogeneous treatment would seem to require a central body supervising to some extent the separate associations. Such a central body may be found in the International Association of Academies, which promises to play so important a part in scientific history that a short account of its early history may be of interest. The Kartell of some of the German academies and that of Vienna has already been referred to. In discussing the utility of its deliberations, Prof. Felix Klein, of Göttingen, first mentioned to me the idea that an association of a similar nature would be likely to prove of still greater value, if formed between the scientific and literary academies all over the world. In consequence of this conversation I tried to interest the Royal Society in the subject; and in order to obtain further information Prof. Armstrong and myself attended privately, though with the knowledge and consent of the council of the Royal Society, the meeting of the Kartell which was held at Leipzig in the year 1897. In the following year the two secretaries of the Royal Society, Sir Michael Foster and Sir Arthur Rücker, together with Prof. Armstrong and myself, attended the Kartell which then met at Göttingen. The secretaries were impressed by the great possibilities of the scheme, and the council then took the initiative and approached the academies of Paris and St. Petersburg, which both returned favourable answers.

In consequence of the correspondence between these learned societies, the Royal Academy of Berlin, in conjunction with the Royal Society of London, issued invitations for a general conference to be held at Wiesbaden on October 9 and 10, in the year 1899.

The following were represented at this meeting, at which the statutes of the new association were agreed upon:—

The Royal Prussian Academy of Sciences of Berlin.
The Royal Academy of Sciences of Göttingen.
The Royal Saxon Academy of Sciences of Leipzig.
The Royal Society of London.
The Royal Bavarian Academy of Science of Munich.
The Academy of Sciences of Paris.
The Imperial Academy of Science of St. Petersburg.
The National Academy of Science of Washington.
The Imperial Academy of Sciences of Vienna.

The unanimity of the meeting may be judged from the fact that a working constitution, which subsequent experience proved to be eminently effective, was finally arrived at on the second day. Many distinguished men took part in the discussions; amongst them Prof. Simon Newcomb and the late Prof. Virchow may be specially mentioned.

Although the Berlin Academy had never joined the German Kartell, the first idea of a wider association seems to be due to a distinguished member of that body, the historian Mommsen, who, though of advanced age, was able to be present at the first regular meeting of the association, which was held at Paris on April 16–20, 1901. In addition to the societies which took part in its foundation, the following form part of the association, and were represented at Paris:—

The Royal Academy of Sciences of Amsterdam.
The Royal Belgian Academy of Sciences, Arts and Letters.
The Hungarian Academy of Sciences.
The Academy of Sciences of Christiania.
The Academy of Sciences of Copenhagen.
The Academy "des Inscriptions et Belles Lettres" of the Institut de France.
The Academy of "Sciences, Morales et Politiques" of the Institut de France.
The Royal Society "dei Lincei" of Rome.
The Royal Swedish Academy of Sciences.

This meeting is not likely to pass out of the memory of those who took part in it. Its importance was enhanced by the social functions which were held in connection with it, and which included a luncheon given by President Loubet at the Elysée, a banquet given by the Conseil Municipal, and a special performance at the Théâtre Français. The subsequent triennial meeting of the academy, which was held in London in 1904, passed off not less brilliantly. The representatives of the learned societies were received by their Majesties at Windsor, and the Lord Mayor invited them to dinner at the Mansion House. Social entertainments, though welcome as marking the importance of the occasion, are not allowed to interfere with the very substantial work which is being done at these meetings. The list of subjects which were included in the discussion of the London assembly may give an idea of the range of activity of the association. A permanent committee is charged with the investigation of the functions of the brain, others deal with questions of atmospheric electricity, and of the measurement of magnetic elements at sea. An important proposal to carry out an exact magnetic survey along a complete circle of latitude is under discussion. The section of letters dealt with the mutual arrangements between libraries regarding the interchange of manuscripts, approved the intended edition of the Mahabharata, and considered a proposal to construct a new Thesaurus of Ancient Greek. The association also took cognisance of and received reports on independent international undertakings, such as the Catalogue of Scientific Literature, the Geodetic Association, and the Geological Congress.

The association meets every three years. To these meetings each constituent academy may send as many delegates as may be found convenient. For the discussion of special questions the assembly divides itself into a scientific section and a literary section.

In each of these sections, as well as in the plenary meetings comprising both sections, each academy has only one vote. At each triennial assembly the next meeting place is chosen. In the intervals between the meetings the affairs of the association are placed in the hands of a council on which each academy is represented by two members or one, according as it comprises both a literary and scientific section or only one of them. The resolutions passed by the association are not binding on the constituent academies, who maintain their liberty of adopting or rejecting them.

The Association of Academies suffers unavoidably from a certain want of homogeneity, owing to differences in the constitution of its component bodies. Most Continental academies contain both literary and scientific sections, and at the organising meeting held at Wiesbaden, marked attention was directed to the fact that there was no body in England that could be considered as representative of literary studies. If matters had been left as they stood then, this country would have been altogether unrepresented as regards half the activity of the association. Efforts were made in consequence to take a more liberal view of the branches of knowledge coming within the range of the Royal Society, and to include literary subjects. Very unfortunately, in my opinion, these efforts failed, and a charter was granted to the British Academy, which has now been included as a separate body among the list of academies forming part of the association. While in this respect we have been at a certain disadvantage, the constitution of the Royal Society has the great advantage of being truly representative of the Empire. In France, on the other hand, no one can belong to the Academy of Sciences who is not domiciled in Paris. Similarly, although Germany possesses four Royal academies (Berlin, Göttingen, Leipzig, Munich), each of them is confined, as regards ordinary members, to its own locality, so that a professor of the Universities of Bonn or Heidelberg, however eminent he may be, could not become a member of any of these academies. Neither in France nor in Germany can the academy therefore be called truly representative. The disadvantages which may arise from this defect have been minimised by adopting a rule that the International Association of Academies may appoint committees for the discussion of special questions, and that members of these committees need not be members of any of the constituent academies. This to a large degree obviates what would otherwise be a considerable difficulty. Nevertheless, I believe that the circumstances to which I have directed attention form the only impediment in the way of handing over to the Association of Academies the ultimate control of every new international undertaking, and even the charge of some of those already established. It is highly desirable that we should work towards this end. An energetic enthusiast may easily start a new enterprise, and Governments are appealed to from different sides for help and support. There ought to be some authoritative body to whom the Governments could apply for advice. Overlapping and waste would thus be avoided.

It is not my desire to disguise the difficulties which have sometimes been encountered in providing for joint undertakings on a large scale. Whether national or international, combined work between men of different temperaments always requires some suppression of personality. Even stronger feelings may be involved when a central office or bureau has to be selected which specially distinguishes one locality. The advantage gained by the locality is often one of appearance rather than of reality, for these central offices should be the servants rather than the masters of the undertaking. In order to prevent national feeling being aroused by any preference given to one nation, it has been customary in some cases to have a president who belongs to a different country from that of the director of the Central Bureau; there are also a vice-president and a secretary, all belonging to different nations. It is thought that such a distribution of office may assist in preserving harmony. I believe that this is the case, but sometimes at the risk of impaired efficiency. It cannot be denied, however, that the seat of the central office of an important undertaking confers a certain dignity, and it is quite natural that a country should feel some pride in the distinction.

England on the whole has not done so badly. We should not forget that in a great portion of the world all clocks strike the same minutes and seconds. Before long all civilised countries (except Ireland) will have adopted the Greenwich meridian for their standard of time, and we may rightly, therefore, call Greenwich the central bureau of universal time.

The offices of the International Catalogue and both the central and computing bureaux of the Solar Union are situated in this country, and if we have not secured an even larger share of the onerous but honourable duties incumbent on such offices the fault is our own. The questions which at the present moment more especially require combined treatment are those of geo-physics, a subject for which very inadequate provision has been made in England. Our earthquake observations almost entirely depend on the self-devotion of one man, and the Meteorological Office, which might reasonably be expected to take charge of certain portions of the work, such as atmospheric electricity, is kept in a state of chronic poverty, and has to restrict itself to work of the most pressing necessity.

Germany, having a large number of well-equipped stations for geodetic, magnetic, and aëronautic work, naturally reaps the reward when the offices of an international undertaking have to be chosen which shall be attached to flourishing institutions in charge of men possessing the leisure and qualifications for the work.

No serious advance will be made in our own country in this respect until our universities pay more attention to the subject of terrestrial physics. This would involve the establishment by the universities of separate laboratories or institutions, to which their present funds could not be applied. The matter wants consideration in detail, and should be carried out according to a homogeneous scheme which would prevent wasteful repetition in different places. But I feel certain that until we have trained up a number of students who possess an adequate knowledge of questions of meteorology, geodetics, terrestrial magnetism, and seismology, the position which this country will take in international organisation cannot be a leading one, though it may be, and, indeed, owing to private efforts, is at the present moment, one of which we need not be ashamed.

Finally, I must lay stress on one aspect of the question which I hope may induce us to attach still greater importance to international undertakings. The cooperation of different nations in the joint investigation of the constitution of the terrestrial globe, of the phenomena which take place at its surface, and of the celestial bodies which shine equally upon all, directs attention to our common interests and exposes the artificial nature of political boundaries. The meetings in common discussion of earnest workers in the fields of knowledge tend to obliterate the superficial distinctions of manner and outward bearing which so often get exaggerated until they are mistaken for deep-seated national characteristics.

I am afraid I have only given a very inadequate account of the serious interests which are already involved in international scientific investigations. But if I may point once more to Indian meteorology, and remind you of the vital importance of an effective study of the conditions which rule the monsoon, you will, I think, realise how impossible it is to separate scientific and national interests. The solution of this particular problem requires an intimate cooperation with Central Asia and Siberia—a cooperation which has been easily secured. I do not wish to exaggerate the civilising value of scientific investigation, but the great problems of creation link all humanity together, and it may yet come to pass that when diplomacy fails—and it often comes perilously near failure—it will fall to the men of science and learning to preserve the peace of the world.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

The Technical High School of Prague will celebrate its hundredth anniversary in November next. Prof. Wilhelm Gintl has been appointed rector for the year 1906-7.

On July 4, the honorary degree of Sc.D. of Dublin University was conferred upon Colonel David Bruce, C.B., Mr. E. T. Whittaker, F.R.S., Astronomer Royal of Ireland, and Sir A. E. Wright, F.R.S.

Prof. C. Graebe has tendered his resignation of the professorship of inorganic, organic, and technical chemistry in Geneva University, to take effect from October 1, after which date Prof. Graebe will be an honorary professor of the University.

The cost of the new metallurgical institute now being erected in connection with the Technical High School at Aachen will be met chiefly by the voluntary contributions of the Rhine and Westphalian metallurgical industries; the sum set apart for the actual buildings is 500,000 marks. At the recent laying of the foundation stone, General-director Springomm, as president of the Verein deutscher Eisenhüttenleute, expressed the sympathy and best wishes of the society with the undertaking.

Mr. F. C. Forth, principal of the Municipal Technical Institute, Belfast, has sent us a copy of an interesting article on the compilation of technical students' records reprinted from the Journal of the Department of Agriculture and Technical Instruction for Ireland (vol. vi., No. 3). The system advocated of chronicling for ready reference data relative to students' attendances, marks, and successes has been devised to meet the requirements of a large technical institute, and as it has now stood the test of two years' working, the description of it should prove a valuable guide to other technical institutions.

Scarcely a week passes without an announcement in the American papers of some handsome contribution to higher education from public-spirited citizens. In the last issue of *Science* received we notice that at the commencement of Brown University it was announced that 32,400*l.* had been subscribed for the John Hay Memorial Library, thus securing the additional gift of 30,000*l.* by Mr. Andrew Carnegie. Mr. D. W. Goodspeed, secretary of the board of trustees of the University of Chicago, has announced a gift of 52,000*l.* from Mr. John D. Rockefeller for current expenses for the year beginning July 1. At the recent commencement of Olivet College gifts aggregating 53,000*l.* were announced. Of this amount 43,000*l.* applies toward the Carnegie endowment, leaving only 7000*l.* to be raised to ensure receiving Mr. Carnegie's gift of 50,000*l.* By the will of the late Prof. George A. Wentworth, of Phillips Exeter Academy, 2000*l.* is bequeathed to the academy.

The new Code of regulations for public elementary schools marks a great advance on similar publications of a few years ago. The detailed schedules of former years, with their minute instructions as to the work of separate standards, are discontinued. Great prominence is given to a few broad educational principles, on which all successful school practice must be based. The new code, in fact, supplemented by the recently published excellent suggestions for teachers, provides just that necessary official guidance which should suffice to enable properly trained teachers to adapt their procedure and curriculum to local conditions and requirements. The tendency exhibited by the central authority to give efficient teachers a freer hand is satisfactory, and we welcome it. A new scheme of arithmetic is included in the Code, and it reflects the movement started by the British Association to eliminate from school arithmetic all fanciful problems of little everyday use, and to introduce practical measurements at an early stage. The scheme in the new Code puts such measurements in the Fifth Standard work, but omits to state definitely in the same section that such practical work with a scale of inches and tenths, or centimetres and millimetres, is the most satisfactory and natural introduction to decimals. Decimals are, of course, included in the scheme, but the apparent omission referred to makes it appear that the study of decimals is to be postponed until vulgar fractions and mensuration have been mastered. Though the formal study of decimals may be deferred until the Sixth Standard is reached, the use of a decimally-divided scale for measurements should certainly form part of the work in the Fifth Standard at least, if not at an earlier stage. Mensuration without decimals is an anachronism; and the Board of Education ought to state, through its inspectors or otherwise, that use should be made of scales divided into tenths, in the measurements of rectangles and rectangular solids, and of triangles, included in the course prescribed.

SOCIETIES AND ACADEMIES.

London.

Royal Society, December 14, 1905.—"An Investigation into the Structure of the Lumbo-sacral-coccygeal Cord of the Macaque Monkey (*Macacus sinicus*)." By Mabel Purefoy **FitzGerald.** Communicated by Prof. Francis Gotch, F.R.S.

From the examination of the cross-sections of the lumbo-sacral-coccygeal cord of the Macaque monkey (*Macacus sinicus*), it is seen that:—

(1) The maximum section area of the cord, of the white substance as a whole, as well as of the dorsal and the ventro-lateral columns, is found in the fourth lumbar region.

(2) The maximum section area of the grey substance as a whole, and of the dorsal and the ventral horns, is found in the fifth lumbar region.

(3) Reckoning the cross-sectional area of the cord as 100, the maximum percentage of the white substance as a whole, and of the dorsal and the ventro-lateral columns, is found in the first lumbar region.

(4) The maximum percentage of the grey substance is reached in the first coccygeal region.

(5) Reckoning the total area of the grey substance in each cross-section of the cord as 100, the maximum percentage of the dorsal horns is found in the third coccygeal region, and that of the ventral horns in the fifth lumbar region.

January 18.—"Observations on the Life-history of Leucocytes." By C. E. **Walker.** Communicated by Prof. C. S. Sherrington, F.R.S.

January 25.—"On the Origin of the Sertoli, or Foot-cells of the Testis." By C. E. **Walker** and Miss Alice L. **Embleton**. Communicated by Prof. C. S. Sherrington, F.R.S.

In animals, those cells set aside to produce definite sexual elements go through two divisions, the first and second maiotic (heterotype and homotype) divisions, and are then, without any further division, converted directly into spermatozoa. The same thing happens in the maturation of the ovum. No post-maiotic (post-homotype) divisions have hitherto been recorded.

In plants, on the other hand, after the second maiotic division has occurred, an apparently unlimited number of generations may be produced of cells that have gone through the maiotic phase, and consequently possess only half the somatic number of chromosomes. In the first of the above papers, the occurrence of maiotic phenomena is recorded among the leucocytes and the cells which are their immediate ancestors. According to these observations, after the first and second maiotic divisions have occurred, they are followed by an indefinite number of generations of cells possessing only half the somatic complement of chromosomes. The first maiotic division is preceded by amitosis and mitosis of the somatic character, just as happens in the testes of many animals, if not in all. It must be remembered that in certain plants only a few of the cells which have gone through the maiotic phase ever become sex cells. The others may form tissues having somatic characters and functions. This parallel between certain vegetable cells and leucocytes is carried further by the observations recorded in the second of the above papers.

Here it is stated that at an early stage in the development of the testis, before the tubules or pockets are formed, it is impossible to discriminate between the cells destined to become foot-cells and the leucocytes or their immediate ancestors in the same animal.

Among these cells, also, divisions are seen where the chromosome number is half what is found in the somatic cells. The conclusion drawn from this is that the undifferentiated cells which surround the male ova, and which eventually form both the foot-cells and the walls of the pockets or tubules of the testis, are derived from leucocytes or have immediately common ancestors. If these observations be correct, we have, therefore, animal cells which, though reduced, form tissues possessing somatic characters and functions known to happen in plants.

The bearing of these observations upon the cancer problem is obvious when the fusion between leucocytes and tissue cells recorded elsewhere is borne in mind.

May 17.—"Some Physical Constants of Ammonia: a Study of the Effect of Change of Temperature and Pressure on an Easily Condensible Gas." By Dr. E. P. **Perman** and J. H. **Davies.** Communicated by Principal E. H. Griffiths, F.R.S.

(1) The vapour density of ammonia at 0° has been found to be 0·77085 (mass of 1 litre in grams at latitude 45°), previous results being 0·7708 by Guye and 0·7719 by Le Duc.

(2) When the ammonia and the glass vessel were thoroughly dried no appreciable adsorption of ammonia by glass, or condensation of ammonia on the surface of glass, was found to take place.

(3) From density determinations at different temperatures, the coefficient of expansion of ammonia has been deduced as 0·003914 between 0° and −20°, and 0·003847 between 0° and 100°.

(4) From Rayleigh's determination of the compressibility of ammonia and our own value for the density, the molecular weight of ammonia has been calculated as 17·030, and the atomic weight of nitrogen as 14·007.

(5) Incidentally, the density of air free from water vapour *and carbon dioxide* has been determined as 1·2920 (lat. 45°).

(6) The deviation from Dalton's law for a mixture of approximately equal volumes of air and ammonia has been found to be about 1 part in 1000.

(7) The pressure-coefficient of ammonia has been determined, the pressure being atmospheric at 15°. Between 0° and −20° the coefficient was 0·004003, and between 0° and 98° it was 0·003802.

The determination of the vapour-pressure of liquid ammonia was repeated at some of the lower temperatures, using *pure* ammonia, in order to obtain an accurate value for its boiling point. From the results, the boiling point of liquid ammonia at 760 mm. pressure was found to be −33°·5 C.

June 7.—"On the Osmotic Pressures of some Concentrated Aqueous Solutions." By the Earl of **Berkeley** and E. G. J. **Hartley.** Communicated by W. C. D. Whetham, F.R.S.

This communication gives an account of measurements of osmotic pressures of aqueous solutions of cane sugar, dextrose, galactose, and mannite. The method adopted is that briefly outlined by us in vol. lxxiii., Roy. Soc. Proc. A gradually increasing pressure is placed upon the solution (which is separated from the solvent by a semipermeable membrane) until the solvent, which at first flows into the solution, reverses its direction, and is squeezed out. The pressure, when there is no movement of the solvent, is considered to be the osmotic pressure. Owing to the difficulty of determining the exact point at which no movement takes place, and for other reasons, the experiments are carried out so as to enable an observation to be made of the rate of movement of the solvent, both when the pressure on the solution is just below and when just above the turning-point pressure. The osmotic pressure is deduced from these rates. The range of pressures covered by the experiments is from 12 to 135 atmospheres.

A description is also given of the methods adopted for making the copper ferrocyanide membranes, and it is pointed out that with the best membranes, in most cases, a small quantity of solution comes through during the experiment. It is shown that even a small leak causes a considerable lowering of the observed pressure, hence the final results accepted are those where the leak was least.

Attention is directed to the fact that the osmotic pressures of cane-sugar solutions, when measured directly and when calculated from their vapour pressures, agree to within 3 per cent.

Zoological Society, June 19.—Sir Edmund G. Loder, Bart., vice-president, in the chair.—The nudibranchs of southern India and Ceylon, with special reference to the collections and drawings preserved in the Hancock Museum at Newcastle-on-Tyne: Sir Charles **Eliot.** This paper was an attempt to settle the synonymy of various Nudibranchiata of the Indo-Pacific with the help of Kelaart's drawings and the collections made by him and Walter Elliot, and now preserved at Newcastle. It also contained some new information as to the anatomy of several species (particularly *Platydoris formosa*, *P. papillata*, *Doriopsilla miniata*, *Kalinga ornata*, and several Pleurophyllidiidæ).—An account of the Entomostraca taken during a bathymetrical survey of the New Zealand lakes, and a comparison of this fauna with that of the English lakes: Dr. G. S. **Brady.**—A paper dealing with the higher Crustacea obtained during the above-mentioned survey: Prof. C. **Chilton.**—A classification of the Selachian fishes: C. T. **Regan.** The author stated that the Selachii were regarded as entitled to rank, at least, as a well-marked subclass, and he divided them into two principal groups, viz. Trematopnea and Chasmatopnea, the latter including the single order Holocephali.—An account of the polyclad Turbellaria from the Cape Verde Islands collected by Mr. C. Crossland: F. F. **Laidlaw.** The collection shows that, on the whole, the fauna of this region of the Atlantic agrees closely with that of the Mediterranean so far as the polyclads are concerned. The most interesting of the sixteen or seventeen species represented in the collection are, perhaps, a species of Anonymus (of which several specimens were taken) and *Traunfelsia elongata*, gen. et sp. nov. The latter is an elongated form remarkable for the possession of marginal tentacles, which are not usually associated with a long, narrow body in this class. A unique feature in this genus is the presence of a pair of alveolar glands, each with a long duct opening on either side of antrum masculinum. The genus is referred to the Diposthiidæ of Woodworth.—A large unknown marine animal observed off the coast of Brazil during a cruise in the Earl of Crawford's yacht the *Valhalla*: E. G. B. **Meade-Waldo** and M. J. **Nicoll** (see p. 202).

Royal Microscopical Society, June 20.—Dr. Dukinfield H. Scott, F.R.S., president, in the chair.—The structure of some Carboniferous ferns: Dr. D. H. **Scott.** The author pointed out the change which had taken place during the last three years in our conception of the Carboniferous ferns. So many examples of fern-like plants were now known to have borne seeds, or were suspected of having been seed bearers, that comparatively few undoubted ferns were left, and it was questioned whether, at least in the Lower Carboniferous, true ferns existed. One family, the Botryopterideæ, was admitted to be well represented in Lower as well as Upper Carboniferous times, and Mr. Newell Arbor had proposed to establish a group of Primofilices to include this and other primitive ferns of the Palæozoic age. The object of the communication was to give a few illustrations of this ancient race of ferns. The Botryopterideæ were first described, beginning with the type-genus Botryopteris. The genus Zygopteris was next considered. A new genus from the Lower Coal-measures of Lancashire, for which the name of Botrychioxylon was proposed, was then described. Two or three other examples of the family having been noticed, Dr. Scott described certain annulate fern sporangia. The germination of spores within a sporangium was demonstrated, and this sporangium had quite recently been identified as belonging to *Stauropteris Oldhamia*.

Chemical Society, June 21.—Prof. R. Meldola, F.R.S., president, in the chair.—The Cleve memorial lecture: Prof. T. E. **Thorpe**.—The constituents of the essential oil from the fruit of *Pittosporum undulatum*: F. B. **Power** and F. **Tutin**. The results show that the oil contains *d*-pinene, *d*-limonene, esters of valeric, formic and other acids, a sesquiterpene, palmitic acid, and a phenol.—Mobility of substituents in derivatives of β-naphthol: J. T. **Hewitt** and H. V. **Mitchell**.—The decomposition of nitrocellulose: O. **Silberrad** and R. C. **Farmer**. The decomposition products are ethyl nitrate, ethyl nitrite, ethyl alcohol, nitric and nitrous acids, ammonia, formic, acetic, butyric, dihydroxybutyric, oxalic, tartaric, *iso*saccharinic, and hydroxypyruvic acids. Carbohydrates were also present.—Note on gunpowder and bullets made about 1641, recently discovered in Durham Castle: O. **Silberrad** and W. S. **Simpson**. The gunpowder was found to approximate closely in composition to the black powder now used in this country. The ingredients had been merely ground and mixed together. It seems probable that this powder was of Prussian origin.—The constitution of acetone: Miss M. **Taylor**. The results prove that acetone does not behave either towards sodium or Grignard's reagent as *iso*-propenylalcohol, $CH_3.C(OH):CH_2$.—Diazo-derivatives of the mixed aliphatic aromatic ω-benzene-sulphonylaminobenzyl amines: G. T. **Morgan** and Miss F. M. G. **Micklethwait**.—Influence of substitution on the formation of diazoamines and aminoazo-compounds, part v.—*s*-Dimethyl-4:6-diamino-*m*-xylene: G. T. **Morgan** and A. **Clayton**.—Improved apparatus for the determination of molecular weights: P. **Blackman**.

Linnean Society, June 21.—Dr. A. Smith Woodward, F.R.S., vice-president, in the chair.—A contribution to the botany of southern Rhodesia: Miss L. S. **Gibbs**. The collections on which the report was based were obtained in August to October, 1905, at the end of the dry season. The air is dry and the sun's rays very strong, temperature from 80° to 90°, so that the country presented a burnt-up aspect, and the trees were bare, except a few evergreens. The veld is systematically burnt, to promote young growth for cattle-food, to the detriment or destruction of trees and shrubs. Distribution of species is wide, and the present paper tends to a confirmation, with many new records. Twenty-three new species are described, amongst the more interesting being the grass *Erianthus teretifolius*, Stapf, and a characteristic Elephantorhiza.—The authentic portraits of Linnæus: W. **Carruthers**. The author recalled the fact that in 1889 he made the subject the chief topic of his address at the anniversary meeting on May 24 of that year; he subsequently visited Sweden, Germany, and the Netherlands to inspect the originals, and read a paper detailing his results at the general meeting held on November 19, 1891; a transcript of his remarks had been prepared, but did not satisfy him, and nothing was published. The approaching bicentenary celebration of the birthday of Linnæus, for which the Swedes have been making extensive preparations, had induced him to revise his old transcript, and add some recently ascertained facts, which he now submitted to the society.—Plantæ novæ Daweanæ in Uganda lectæ: Dr. Otto **Stapf**. Mr. M. T. Dawe, officer in charge of the Forestry and Scientific Department of the Uganda Protectorate, made an expedition from Entebbe, through Buddu and the western and Nile provinces of that territory. His collections were transmitted from time to time to Kew, and his report was issued as a Blue-book (1906, Cd. 2904) last April; it gave an account of his journey, with some rough illustrations of specially noteworthy plants. Much new light is thrown on distribution, and new species are described, amongst them the new genus of Rutaceæ, Balsamocitrus, Stapf, and a new species of Warburgia (Canellaceæ). As an appendix, Mr. Dawe gives a summary of his report on the vegetation of the country traversed.—The genitalia of Diptera: J. **Hopkinson**. The structure of bamboo leaves: Sir Dietrich **Brandis**.

Physical Society, June 22.—Prof. J. Perry, F.R.S., president, in the chair.—The effect of radium in facilitating the visible electric discharge *in vacuo*: A. A. C. **Swinton**. It has been shown by Edison, Fleming, and others that the passage of the electric discharge *in vacuo* is much facilitated by heating the kathode. More recently it has been shown that the passage of the discharge is still further facilitated by coating the heated kathode with oxides of the alkaline metals. It is generally held that the efficacy of the hot oxides in this direction is due to their giving off negatively-charged ions or corpuscles. The author therefore decided to ascertain whether similar effects could be obtained by painting the kathode with radium, and as radium gives off corpuscles when cold, it was anticipated that it might not be necessary to heat the kathode. Using a continuous current up to 400 volts pressure, this was found not to be the case, the radium having no appreciable effect in producing a visible discharge. When the radium-coated kathode was heated to redness, the radium was found to have a very marked action in facilitating the production of a luminous discharge. Experiments were made which proved that the mere presence of radium in the tube was insufficient to produce the effect, and, furthermore, it was found that the tube would only allow visible discharges to pass in the direction that made the radium-treated electrode the kathode, the tube acting as a unidirectional valve in the same way as do tubes with kathodes coated with oxides.—The effect of the electric spark on the actinity of metals: T. A. **Vaughton**. It has been pointed out by several observers that some metals, such as aluminium, cadmium, zinc, magnesium, &c., although not radio-active in the ordinary sense of the word, yet have the power of affecting a photographic plate. The electric spark has a remarkable influence on this "actinity," in some cases causing an increase, and in others apparently diminishing it. The alteration is not merely momentary, but remains for months. It is, however, quite superficial, and may be removed by slightly rubbing the surface of the metal with emery-paper. In the case of aluminium sparked with gold, the direction of the current does not make much difference in the actinity of the sparked plate, but in the case of other couples the difference is very marked. For example, if a cadmium strip is sparked with antimony, the cadmium being connected with the positive terminal, the cadmium becomes very active photographically, not only on the spot sparked, but all over its surface. If, however, the cadmium is connected with the negative terminal and sparked with a positive terminal of antimony, the cadmium remains very slightly more active than if not sparked at all.—The dielectric strength of thin liquid films: Dr. P. E. **Shaw**. The range of voltage used in the experiments is from 25 to 400, and the corresponding spark-lengths vary from about 0·15 μ to 6·0 μ (μ = 0·001 mm.) for the insulating liquids used. The apparatus employed for measuring length is the micrometer designed by the author for measuring gauges (Proc. Roy. Soc., April). The substances used were olive oil, castor oil, linseed oil, rape oil, turpentine, fusel oil, oil of resin, cod-liver oil, neat's-foot oil, paraffin, transformer oil, the homologous series C_5H_{12}, C_6H_{14}, C_7H_{16}, C_8H_{18}, and armacell, ohmaline, and Sterling varnishes. The best insulators are paraffin and transformer oil, though for these, as for all commercial oils, great care was taken to remove water and acid by prolonged heating to 110° C., and treating with potassium carbonate. No simple connection can be traced between specific inductive capacity and dielectric strength.—The effect of electrical oscillations on iron in a magnetic field: Dr. W. H. **Eccles**. In attempting to make precise measurements of the effect of high-frequency oscillations on iron held magnetised by a magnetic field, two main difficulties are met. The one is that arising from the fact that the oscillatory currents induced on the surface of the iron investigated shield the inner layers, and thus make the mass of iron affected a variable quantity. The other difficulty arises in the matter of producing oscillations of determinate and invariable character. The author has endeavoured to meet the first difficulty by using oscillations so feeble that they affected only the outermost layers of the iron wires employed, and these even only slightly. The second difficulty has been met by using the oscillations produced in an open insulated solenoid by a single small measurable spark passed to one end of the solenoid.

EDINBURGH.

Royal Society, June 18.—Dr. Munro, vice-president, in the chair.—A study of the dietaries of students' residences in Edinburgh: Dr. Isabella **Cameron.** The objects of the investigation were to compare the dietary of the middle classes with that of the working classes, which had already been carefully studied, to ascertain how far this diet conformed to the various standard diets, and to investigate the question of the reduction of cost through combination. The dietaries of four men's residences and one women's residency were studied for one week, which was equivalent to 1129 men for one day. The average amount consumed per man per diem was: proteids, 143 grams; fats, 138 grams; carbohydrates, 511 grams; fuel value, 3973 calories. The expenditure came to fully 1*s.* 2*d.* per day per man, nearly double the cost of the average labouring man's diet. When compared with similar institutions in America, the Edinburgh residences were found to consume more proteid and carbohydrate, but less fat. There was also less waste.—The theory of epidemics: Dr. John **Brownlee.** The growth and decay of an epidemic seemed to depend on the acquisition of a high degree of infectivity at the start, this infectivity being then lost at a rate expressible mathematically as an exponential. This truth was realised by Dr. Farr, but the subject did not seem to have been pursued with any definite scientific aim. Dr. Brownlee had subjected various epidemic statistics to mathematical analysis, and had found that the curves representing their growth and decay could be well represented by Prof. Karl Pearson's curve of type iv. The correspondence was very close, except in the neighbourhood of the vertex. The general conclusion was that the condition of the germ had much more to do with the causation of an epidemic than the constitutional peculiarity of the persons affected at the moment. There was no evidence in favour of the idea that the epidemic ended because of the lack of susceptible persons.—The plant remains in the Scottish peat mosses, part ii.: Francis J. **Lewis.** This part had to do with the Scottish Highlands, the preceding part having discussed the peats of the Lowland Uplands. These Highland peat mosses began later than the Lowland mosses, and did not show the intercalated Arctic condition after the retreat of the ice-sheet. The bottom layers in the mosses in Caithness and Inverness had Arctic plants, but these were lacking in the Skye mosses, which accordingly were shown to have begun still later. The succession of layers was broadly similar to the succession already made out in the Lowland mosses, but in the Highland peats of recent age there were two distinct dry woodland mosses full of trunks of *Pinus sylvestris*, separated by a layer of sphagnum moss. The peat deposits over Scotland thus showed a definite succession of changes which could be correlated with the later stages of the Glacial epoch.

PARIS.

Academy of Sciences, June 25.—M. H. Poincaré in the chair.—The formation of endothermic compounds at high temperatures: M. **Berthelot.** According to the current thermodynamical theories, endothermic compounds can be formed and are stable at high temperatures. The author criticises the experimental observations adduced in support of this view, and concludes that no exact observation has been brought forward establishing, either in principle or in fact, that very high temperatures can cause a reversal of chemical affinity by directly forming endothermic compounds by simple heating.—The generalised problem of Dirichlet and Fredholm's equation: Émile **Picard.**—The radio-activity of gases evolved from the water of thermal springs: P. **Curie** and A. **Laborde.** The data given in a previous paper are corrected, and some additional determinations given for some new springs.—The action of steam upon sulphides at a red heat. The production of native metals: Armand **Gautier.** The sulphides of iron give rise to magnetic iron oxide, sulphuretted hydrogen and hydrogen. In the case of lead sulphide, taken as a type of the sulphide of a metal which does not decompose water, the primary products would appear to be lead, sulphuretted hydrogen and sulphur dioxide, the two latter substances reacting to give free sulphur. Copper sulphide gave copper, sulphur dioxide, and hydrogen. These experimental facts are applied to the consideration of volcanic phenomena. The condensation of $\beta\beta$-dimethylglycidic ester with sodio-malonic ester. Syntheses of terebic and pyroterebic acids: A. **Haller** and G. **Blanc.** Dimethyl-glycidic ester, heated on the water bath with sodio-malonic ester, gives 4-methyl-2:3-dicarboxyl-pentanolide-4, and this, boiled with hydrochloric acid, gives terebic acid, the latter being characterised by its conversion into isocaprolactone and pyroterebic acid. The external work created by the statical and dynamical actions of the internal work of the motor muscle: A. **Chauveau.** The treatment of pulmonary tuberculosis by serotherapy: MM. **Lannelongue, Achard,** and **Gaillard.** The identification of pathogenic Trypanosomes: attempts at diagnosis: A. **Laveran** and F. **Mesnil.** The serum of an animal which has acquired immunity against a particular trypanosome frequently possesses to a high degree specific properties which can be utilised for the identification of trypanosomes. The authors give a detailed account of experiments made in this connection, and show that the application of this method is not without difficulties. The indication for the anti-tuberculous vaccination of young ruminants by the alimentary canal: S. **Arloing.** Details of experiments on young goats are given from which the author concludes that complete immunisation can be effected by the aid of human or bovine tubercle bacilli, suitably modified, introduced into the alimentary canal.—M. Gernez was elected a member in the section of physics in the place of the late M. Pierre Curie.—The deformation of certain tetrahedral surfaces: G. **Tzitzéica.** A theorem of algebraic surfaces of the *n*th order: G. B. **Guccia.**—Differential equations of the second order and first degree the general integral of which is uniform: M. **Gambier.**—Diminution of velocity and change of trim of ships by the reflex action of water on the bottom: E. **Fournier.**—A simplified study of the effects of capacity of alternating current cables: A. **Blondel.**—Interferential photography: the variation of the incidence: polarised light: M. **Ponsot.**—An arrangement permitting of placing simultaneously several prisms in the position of minimum deviation: P. **Lambert.**—A simple method for the study of the movements of metallic vapours in the oscillating spark: G. A. **Hemsalech.** The sparks are blown on one side by a current of air of known velocity, resulting in curved lines in the spectrum, from measurements of which the tangential velocities of the metallic vapours can be determined.—The methods of photographing the absorption lines of the colouring matters of the blood: Louis **Lewin,** A. **Miethe,** and E. **Stenger.** Details of the apparatus used are given. The present note contains no results.—The heat of formation of carbonyl-hydroferrocyanic acid: J. A. **Muller.** The heat of combustion, determined in the calorimetric bomb, was 3444 calories per gram, from which the heat of formation was calculated as −122 cal.—The kathodic phosphorescence of europium diluted with lime. Study of the ternary system lime-gadolina-europia: G. **Urbain.**—The refractive index of substances dissolved in other solvents than water: C. **Chéneveau.** Results are given for solutions of lithium chloride in water, methyl and ethyl alcohols, and in glycerol.—The variations in state undergone by amorphous carbon under the influence of a sudden variation of temperature: O. **Manville.** The variation in state was measured by the alteration in the temperature at which the carbon commenced to give carbon dioxide in a current of oxygen.—The double sulphate of iridium and potassium, $Ir_2(SO_4)_3 \cdot 3K_2SO_4$: Marcel **Delépine.**—The properties of the substances formed by the action of hydrochloric acid upon certain metallic silicides: M. **Boudouard.** These substances contain hydrogen, and may be regarded as mixtures in variable proportions of silicoformic anhydride and silico-oxalic hydrate.—The crystallography of iron: F. **Osmond** and G. **Cartaud.**—The action of oxygen on rubidium-ammonia: E. **Rengade.** The three metals potassium, cæsium, and rubidium, dissolved in liquid ammonia, give in presence of oxygen a white dioxide and a yellow tetroxide. Potassium and cæsium give in addition a dark trioxide, but there is no evidence of the formation of an analogous oxide of rubidium.—Researches on the pyrazolones: new methods of synthesis: Ch. **Moureu** and J. **Lazennec.** The reaction between the arylpropiolic esters and hydrazine, forming pyrazolones has been extended to the alkylpropiolic esters. The pyrazolones can also be obtained when the ester is replaced by the amide or by the β-oxyalkylacrylic esters obtained from the acetylene compounds by a method described in a previous paper. The theory of the reactions is discussed.—Phenyl migrations in the halohydrins and in the α-glycols: M. **Tiffeneau**. Cinnamenyl-paraconic acid: J. **Bougault**.—Researches on the relations of functional groups in distant positions: cyclic amines: E. E. **Blaise** and M. **Houillon**. Octamethylene diamine chlorhydrate gives by the action of heat an unsaturated hydrocarbon and a secondary cyclic base. This has been proved to be identical with a synthetically prepared specimen of butylpyrrolidene.—The basicity of the xanthyl oxygen: R. **Fosse** and L. **Lesage**. A description of a series of double salts, of which xanthyl-lead bromide, $CH(C_6H_4)_2O.Br+2PbBr_2$, may be given as a type.—The production of Ascidia by traumatisms: L. **Blaringhem**.—The origin of the materials utilised by the ovary: Jean **Friedel**. The assimilating power possessed by the green carpels of many plants is well known. From experiments on *Ranunculus acris* the author concludes that the ovary utilises both its own products of assimilation and the reserves of the peduncle. If the conditions in which it is placed suppress one of these two modes of nutrition, the ovary can arrive at complete development from the other.—The longevity of seeds: Paul **Becquerel**. Experiments were carried out on 550 species belonging to fifty families, the age of which varied from twenty-five to 135 years. The only seeds preserving their vitality for more than eighty years were those protected by a thick skin and possessing slightly oxidisable reserves.—A disease of the plane tree due to *Gnomonia veneta*: J. **Beauverie**.—Some new Madagascan Asclepiadaceæ producing caoutchouc; J. **Costantin** and I. **Gallaud**.—The biology of the Virgularia: Ch. **Gravier**.—A new form of operculated Cirripede, *Pyrgopsis Annandalei*: A. **Gruvel**.—Prehistoric remains in the neighbourhood of Kayes, Soudan: Fr. **de Zeltner**. The deposits of stone instruments are large, and formed out of rocks still existing in the district. The instruments cannot be classified with any of the usual European types, are highly polished, and show considerable skill in their manufacture. It is impossible at present to fix their age.—A method of isolating the hæmatablasts of the blood in a state of purity: L. Le **Sourd** and Ph. **Pagniez**.—Researches on animal electricity: MM. **Girard** and Victor **Henri**. The *rôle* of the cellular elements in the transformation of certain carbohydrates by the intestinal juice: H. **Bierry** and A. **Frouin**.—The problem of statical work: Ernest **Solvay**. A criticism on a paper of M. Chauveau on the same subject.—The sensibility of the retina for luminous radiations: Milan **Štefánik**. Using a spectroscope with glass prisms and a suitable coloured screen the red end of the spectrum is visible with sufficient clearness for measuring the lines down to λ 3830. The photographic results obtained by M. Millochau with the same apparatus give the same limit. It follows that the retina is sensible for all the radiations which pass the spectroscope.—The use of sodium chloride in the histological impregnation of tissues by silver: Ch. **Achard** and M. **Aynaud**. An experimental proof of the view recently put forward by M. Quinton that the results are due to the presence of sodium chloride in the intercellular spaces, the chloride of silver thus formed darkening in the light.—A method of detecting iron in living tissues: A. **Mouneyrat**.—Study of the transmissibility of tuberculosis by alimentary casein: Marcel **Guédras**. Food products for infants containing dried casein as a base may transmit tuberculosis. Casein dried at a low temperature may still contain the tubercle bacillus.—The extension of the marine invasion of the upper Sparnacian in the neighbourhood of Paris: Paul **Combes**, jun.—The existence of the Cretacean in the Oran schists: MM. **Ficheur** and **Doumergue**.—The Yprés clays of the department of Aisne and the climatic conditions at the Lutetian epoch: Paul **Fritel**.—The trajectory of electric corpuscles in space under the influence of terrestrial magnetism, with applications to the aurora borealis and to magnetic disturbances: Carl **Störmer**.—Two relief maps of Paringu and Soarbele (Southern Carpathians) executed from unpublished topographical sketches: E. **de Martonne**.

Calcutta.

Asiatic Society of Bengal, June 6.—Indian meteorites recently acquired by the Geological Survey: L. L. **Fermor**. The crusts of some of them show interesting flow-structures.—(1) Notes on a rare Indo-Pacific barnacle. Remarks on *Conchoderma hunteri*, Owen, which the author, agreeing with Hoek, regards as a variety of *C. virgatum* (Spengler). (2) Contributions to Oriental herpetology. No. 4. Notes on the Indian tortoises. Remarks on some obscure species, with a list of the Indian Chelonia. (3) Notes on the common Hydra of Bengal: Dr. N. **Annandale**. The systematic position of *Hydra orientalis* is discussed, with a description of its anatomy. As the result of two years' investigation, the author concludes that the species is diœcious, but that sexual reproduction plays an unimportant part in the life cycle.—Rawāts and Merāts of Rajputana: R. C. **Bramley**.—An old reference to the Bhotias: H. **Beveridge**.—Parasites from the Gharial (*Gavialis gangeticus*, Géoffr.): Dr. **von Linstow**. Two new nematodes, each representing a new genus, and a new linguatulid are described. The former were found in the stomach and on the mesentery; the latter in the lungs and trachea.

New South Wales.

Royal Society, May 2.—Mr. H. A. Lenehan, president, in the chair.—Annual general meeting. An address was delivered by the president.—A specimen of diamond in the matrix: E. F. **Pittman**. The specimen was found by Messrs. Pike and O'Donnell in their claim at Oakey Creek, near Inverell. The diamond is a small one, weighing about one-third carat, and the material in which it is embedded is an igneous rock known as dolerite. The dolerite occurs at Oakey Creek as a pipe or dyke, and the specimen is of special interest as throwing some light upon the question of the origin of the diamond.

CONTENTS. PAGE

THURSDAY, JULY 19, 1906.

SOME RECENT MATHEMATICAL WORKS.

Correspondance d'Hermite et de Stieltjes. Edited by B. Baillaud and H. Bourget. Vol. ii. Pp. viii+404. (Paris: Gauthier-Villars, 1905.) Price 16 francs.

G. Lejeune Dirichlet's Vorlesungen über die Lehre von den einfachen und mehrfachen bestimmten Integralen. By G. Arendt. Pp. xxiv+476. (Brunswick: Friedrich Vieweg and Son, 1904.) Price 12 marks.

Le Calcul des Résidus et ses Applications à la Théorie des Fonctions. By Ernst Lindelöf. Pp. viii+144. (Paris: Gauthier-Villars, 1905.) Price 3.50 francs.

Les Principes des Mathématiques. By Louis Couturat. Pp. viii+342. (Paris: Félix Alcan, 1905.)

Méthodes de Calcul graphique. By Frederico Oom. Pp. 26; with 4 plates. (Lisbon: Imprimerie nationale, 1905.)

Volume and Surface Integrals used in Physics. By J. G. Leathem. Pp. 48. (Cambridge: University Press, 1905.) Price 2s. 6d. net.

Recherche sur les Champs de Force hydrodynamiques. By V. Bjerknes. Reprinted from *Acta Mathematica*, vol. xxx. Pp. 146.

Sur la Recherche des Solutions particulières des Systèmes différentiels et sur les Mouvements stationnaires. By T. Levi Civita. Pp. 40. (Warsaw: J. Sikorskiego, 1906.)

ONE of the most noticeable features of recent times has been the increasing interest taken in the history of mathematics. That two international congresses—the historical and the mathematical—have devoted separate sections to this study is, let us hope, a stepping-stone towards the realisation of the resolutions passed at both congresses in favour of the establishment of chairs of mathematical history in the leading universities of the Continent and America, and possibly even Great Britain.

Reference has previously been made to the first volume of the interesting correspondence between Hermite and Stieltjes. The second volume, covering the period 1889–1894, is no less delightful reading than the first. Every letter fills up some gap in the reader's mathematical knowledge, either by introducing him to some little-known proposition or by presenting some well-known result in a new aspect. An appendix contains four letters addressed by Stieltjes to Prof. Mittag-Leffler in 1885–1887 dealing with Riemann's Zeta function. These letters afford a striking insight into the difficulties experienced by Stieltjes in his efforts to master Riemann's works and his ingenuity in devising alternative methods. The present volume contains a portrait of Hermite and the facsimile of a manuscript by Stieltjes.

The historic spirit has further shown itself in Prof. Arendt's issue of the nearest possible approach to a verbatim report of the lectures on definite integrals as given by Dirichlet at Berlin in 1854. It is true, as the author points out, that the lectures which Dirichlet gave on the same subject at Göttingen four years later formed the basis of the well-known treatise by Gustav Ferdinand Meyer, but it appears that the notes on which Meyer's account was based were far from complete, and it was necessary to spend considerable time in filling up the gaps in the reasoning, and, moreover, the object was to give a complete treatment of the subject rather than an exact account of the lectures. Prof. Arendt, on the other hand, has compiled the present work from a set of notes mostly transcribed on the actual dates of the lectures. The course covers a branch of mathematics well known to the average student, namely, the definition of an integral and its connection with summation, the theorems on change of limits and differentiation of integrals, the evaluation of the ordinary well-known definite integrals, the Beta and Gamma functions, transformation of multiple integrals, the attractions of ellipsoids, and applications to harmonic and hypergeometric series. The notes at the end afford evidence of the care with which the original manuscript has been followed; where any divergence has been necessary the changes are carefully pointed out; the only important innovation, however, is the introduction of the modern notation $|a|$, which greatly simplifies certain formulæ. At the present time these lectures of Dirichlet make an excellent text-book, and an interesting historical comparison may be made between the present course and Kronecker's lectures delivered at the same university about thirty years later.

Another prominent place among the "classics" must be assigned to Prof. Ernst Lindelöf's charming exposition of Cauchy's calculus of "residues." This is the eighth of a series of monographs on the theory of functions appearing under the editorship of Prof. Émile Borel. In Prof. Lindelöf, Cauchy's ideas have found an able exponent, and from a detailed study of a number of papers, including some of Cauchy's little-known writings lent for the purpose by Prof. Mittag-Leffler, the author has produced a treatise in which the simplicity and perfection of this important method of analysis are well shown. Of the applications, those in the second chapter are mainly due to Cauchy. The third shows how certain formulæ of summation can be immediately deduced from the same principle, while in the fourth it is shown how this method of treatment greatly simplifies the study of the Gamma function and of Riemann's function. Of the importance of the latter application the difficulties of Stieltjes already referred to give sufficient proof, and on the other hand the name of Stieltjes figures conspicuously in the discussion of Stirling's series, in connection with which Prof. Lindelöf contributes several new results and proofs. Finally we have a general account of certain modern results relating to functions defined by Taylor's series, thus bringing into one small volume a general survey of the recent as well as the original developments of Cauchy's method. The book includes new matter for which the author is himself responsible as regards methods of treatment no less than as regards results.

A second line of modern mathematical development consists in the attempt to probe ever deeper and deeper into the foundations of mathematics. In France, where everything mathematical is as popular as it is unpopular in England, the philosophy of mathematics has taken such hold of public thought that the multiplication of books on the subject has in a small way resembled the multiplication of school geometries with us. But a philosophical treatise stands on a very different level from a mere examination text-book, and if we have been somewhat severe in the past in our criticisms of the work of isolated writers in France, it was felt that what was wanted was something more than a number of isolated writings, each, from the nature of the case, presenting the views of one individual without much reference to the subject and its literature considered as a whole. The opening words of M. Couturat's preface, "The present book has no pretension to originality, and this is precisely what ought to recommend it to the reader," show that the author has been at great pains to fill the want. His book is to a large extent based on Mr. Bertrand Russell's English treatise with the same title, and is intended to provide a *résumé* of our present knowledge on the philosophy of mathematics. It is somewhat remarkable that up to the middle of last century logic and mathematics were regarded as essentially distinct, and it was largely the result of the labours of Boole, Peano, Cantor, and others that led to the gap being filled and to the opening out of what has proved to be one of the most fertile regions of modern thought. The complete rapprochement owes its existence very largely to the symbolical logic or "logistic" of Peano, and leads to the conclusion that mathematics is entirely and exclusively founded on the principles of logic. This view is, as M. Couturat shows, diametrically opposed to the philosophy of Kant of which a summary has been given in the appendix. It need hardly be said that Russell's treatment is in many places closely followed, and it is the author's hope that the book will induce French writers to contribute to our knowledge of mathematical philosophy in a way that has not been done hitherto.

A perusal of Mr. Oom's pamphlet will convince any reader that however much has been done elsewhere in facilitating calculations by the introduction of graphical methods, the observatory of Lisbon under the directorship of Vice-Admiral Campos Rodrigues has made a number of very distinct advances. For the correction of level and deviation error diagrams are used, as also for the corrections due to precession, and a still happier thought is the construction of slide rules for the performance of addition operations other than the addition of logarithms performed by the ordinary slide rule. Thus, for example, a slide rule graduated in reciprocals is used to work out relations between the conjugate foci of a lens; another, graduated in squares, is applicable to quantities connected by the relation between the sides of a right-angled triangle, and is particularly useful for calculations of probable error, and so on. Possibly some reader of NATURE will write and say that these slide rules have been in existence previously. In any case they are worthy of note, and M. Rodrigues appears to have devised them "off his own bat."

The issue of a series of "Cambridge Tracts in Mathematics and Mathematical Physics" under the able editorship of Messrs. Leathem and Whittaker affords evidence of the activity of the younger generation of Cambridge mathematicians. The idea is a good one. Many people have ideas about the best methods of treating some particular piece of work, which do not cover a sufficiently wide range to form a book, and are unsuitable for publishing and possibly burying in a volume of transactions. So much is this the case that we should not be surprised if Mr. Leathem finds himself besieged by tracts submitted for publication. His own contribution deals with an important point. Many physicists in the solution of problems have had to transform volume and surface integrals in a way that they either have known or ought to have known was not perfectly rigorous, but with the knowledge that the results would be all right; this particularly applies to integrals extending to infinity, and we have here in a convenient form a study of these transformations in their mathematical aspect. In discussing the application of infinitesimal analysis to potential properties of bodies of discontinuous structure, Mr. Leathem introduces the notion of *physical smallness*. The term is, perhaps, not altogether a happy one, as physics concerns itself not only with bodies of finite size, but with molecules which are of a higher order of smallness than the elements contemplated. The important point is that the applications of differential equations are based on the consideration of elements which for purposes of analysis may be regarded as infinitesimal, but which may be regarded, on the other hand, as infinitely great compared with the dimensions of molecular structure. It would be better to call such elements "differential elements" since they represent the $dx\ dy\ dz$ of the formulæ. The careful discussion of the legitimacy of the assumptions involved, as given by Mr. Leathem, is important, as we often find unscientific writers announcing as a great discovery the view that there is no such thing as temperature, quite forgetting that the notion of "temperature at a point" stands on much the same footing as that of "density at a point" or, indeed, many other similar concepts without which the study of mathematical physics would not have made the progress that it has made.

The series of papers and books by C. A. Bjerknes the father and V. Bjerknes the son well illustrate the proper spirit of scientific inquiry as opposed to the spirit of the unscientific faddist whose rejected addresses give so much trouble to reviewers. The discussion of the fields produced by bodies moving in fluids, if it has not given us a new theory of matter has certainly greatly helped us to understand the lines on which such theories should be laid down. The elder Bjerknes confined his attention to solid spheres moving in liquid; in the present instance, "bodies" are represented by portions of fluid differing from the remainder by the fact that in the latter the equations take a simple form. But is not this merely the vortex atom theory? It is true that on pp. 134–7 Prof. Bjerknes compares his results with those of von Helmholtz and Lord Kelvin, and points out the differences in his method of treatment, but all these investigations are only different developments of the same fundamental ideas.

In recent years, Prof. Levi Civita has published a number of papers in the *Atti dei Lincei* dealing with particular solutions of the equations of dynamics, and in especial with stationary motions. At the invitation of Prof. Dickstein he has now prepared a simplified account of these researches for the transactions of the "Prac matematyczno fizyczynych," published at Warsaw. The original starting point of the investigation was the method of ignoration of coordinates, but the conclusions have now been shown to be results of a general principle applicable to any system of ordinary differential equations. They form a development of the work of Routh, and the stationary motions investigated by the author of "Rigid Dynamics" are shown to belong to a particular class to which Prof. Levi Civita gives the name of "mouvements à la Routh." G. H. B.

A TREATISE ON CHEMISTRY.

A *Treatise on Chemistry*. By Sir H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S. Vol. i. The Non-Metallic Elements. New edition, completely revised by Sir H. E. Roscoe. Pp. xii+931. (London: Macmillan and Co., Ltd., 1905.) Price 21s. net.

SIR HENRY ROSCOE is to be heartily congratulated by all chemists on the appearance of a new edition of the first volume of Roscoe and Schorlemmer's "Treatise on Chemistry." This volume deals chiefly with the non-metallic elements, and is now in its third edition.

Many chemists remember the interest which the first appearance of this volume excited in 1877. Printed in large, clear type, with excellent illustrations, it was recognised both here and on the Continent as a clear and readable account of the facts relating to the chemistry of the non-metallic elements. If the student failed to find in it any new light on the obscurities of chemical theory, he at any rate was put in possession, not merely of the facts, but of the facts stated with a due regard for the history of their discovery which was then and is still foreign to the ordinary "handbook." There were, moreover, many experimental details of service to workers in the laboratory recorded in the volume which were at that time not easily accessible to the ordinary student. During the nearly thirty years which have elapsed since the first edition appeared, many treatises have been published in other languages, notably in German, but the treatise of Roscoe and Schorlemmer still retains a certain individuality for which it will be valued.

In preparing this edition Sir Henry Roscoe has had the valuable assistance of several collaborators with special knowledge, and their handiwork is to some extent evident in the different literary treatment which may be discerned in various sections of the book.

The first section of the volume relates to the general principles of the science, including a description of the properties of gases and liquids, and a very intelligible account of the development of the atomic theory. A clear sketch is given of the theory of electrolytic dissociation. This portion of the volume would have been improved by some concrete illustrations of the methods of determining atomic weights. As it is, the reader must be very much at sea in understanding what this constant actually means, apart from the implications of the atomic theory.

The remainder of the book is occupied with an account of the properties and modes of preparation of each of the non-metallic elements and their chief compounds. The history of each element is succinctly and well described, and important industrial applications are also alluded to. There is an excellent account of the modern manufacture of illuminating gas and of acetylene, as well as of the commercial processes adopted for the production of a number of the elements and their compounds which find industrial uses.

There is also a very complete account of the preparation and properties of the new gases of the atmosphere, argon, &c., which, while interesting, does not throw any new light on the obscure chemical relationships of these elements. In this connection the absence of an account of the periodic classification under the general principles of the science is specially felt. It would have been better to have included in the first part of this volume a complete consideration of the general principles of chemistry, including the determination atomic weights, instead of reserving the discussion of the periodic classification and other matters of principle for the subsequent volume relating to the metals.

When the first edition of this volume appeared, many of the lecture experiments described were new, and were of interest and value to the teacher. A number of these are now generally familiar, whilst some of those still described have since been improved upon. This feature is indeed no longer a striking one in the book. Very few new lecture or laboratory experiments are included. The teaching of chemistry is, however, no longer conducted on the old lines, and perhaps the teacher would not now look to a treatise of this kind for this information. The fact that in some sections of the work pains are taken to describe fully striking lecture experiments whilst in other and newer sections this aspect is entirely neglected is a defect in the general plan of the book which might be remedied in future editions.

This raises the question as to the characters which such a work as this should possess to be of real utility at the present day. Handbooks and text-books of chemistry for the teacher abound, many of them excellent as practical guides to the work of the lecture room and laboratory. Then there are more ambitious works purporting to be of the nature of treatises. These, however, are too often ill-assorted and ill-considered collections of the facts and theories of chemistry utterly lacking in those literary qualities without which no work of the kind can expect to appeal to the general reader or to take any permanent place in the literature of the science. There is still room for a treatise in the broad sense of the word, in which the facts and doctrines of modern chemistry are expounded in a lucid manner free from the details and technicalities which are essential in a handbook or text-book. Such a work should appeal to the teacher and to the student as a work of reference, and also to the outsider, it may be a worker in another department of science, who wishes to understand what the science of chemistry now is without being confronted with all the bewildering and conflicting details of the subject, such as the advanced student may find in Watts's Dictionary or in many German works on chemistry.

Such a treatise, perfect as a broad and general description and discussion of the science of chemistry, has not yet been written in English. Roscoe and Schorlemmer's treatise, however, still remains the nearest approach to the ideal.

POPULAR EVOLUTIONARY THEORY.

Darwinism and the Problems of Life; a Study of Familiar Animal Life. By Prof. Conrad Guenther. Translated by Joseph McCabe. Pp. 436. (London: A. Owen and Co., 1906.) Price 12s. 6d. net.

THIS is a disappointing book. The idea of using the common sights and sounds of nature which are open to general observation as material for building up a detailed comprehension of evolutionary theory is a good one; there is much to be said for the inductive system of instruction as a supplement to the deductive methods more often employed. But in this particular instance the errors in matters of fact are so prominent and so numerous as to overshadow such merit as the plan of the work possesses. Some of these mistakes must be laid to the charge of the translator, who obviously is but imperfectly acquainted with the subject-matter of his original, and whose want of due care appears in the occurrence of such phrases as "the grouping of their elements is different from in dead albumen," "Pentastomum has little of the characteristics of a spider, to which it really belongs," and of such unwonted forms as "terrestial," "adaption," "caracoid," "strepsitera"—the last two being found more than once. "Sexually," on p. 301, is clearly intended for "non-sexually." "An example of a genius under the generic title" is capable of easy emendation, but "weel" (p. 220) almost baffles conjecture. Can it be meant for "valve"?

The "processionary butterfly" is, of course, a moth; the "tentacles" of the stag-beetle (p. 91) are apparently its mandibles; we hear for the first time of the "bones" of articulates, and that our muscles are "secretory products." It is implied on p. 143 that the adder is not poisonous. This is surprising until we find from other passages that the author's "adder" is not an adder at all, but the harmless ringed snake. A sentence on p. 226 is absolutely unintelligible, unless we may conjecture that the word "falls" is an attempt to render the German "Fälle," here obviously used in the sense of "cases."

It is charitable to the author to suppose that not he but his translator is responsible for the statement that "in the case of moths and grasshoppers there is not a very great difference in habits between the larva and the imago." But when we find it stated that "in the grasshoppers the front extremities have become a powerful leaping apparatus"; that an insect is covered with "dust" by the "stigma" of a flower; that "if we take two beetles that seem absolutely like each other and only differ in size" they are of different species; that "the frogs have only one chamber to the heart"; and that "iron is always found combined with sulphur," it is difficult to avoid the conclusion that the author has to answer for mistakes of his own.

There are advantages in using the popular names of natural objects in a book intended mainly for the unlearned. But a protest must be entered against the slovenly habit, too common with translators, of contenting themselves with a literal rendering of such names into another language. How, for example, is the English reader to identify the "small nocturnal peacock's eye"? If the scientific name be disallowed, at least the recognised English popular title should be given.

Many of the author's conclusions on the main subject are sound enough. It is the more to be regretted that his statements of fact are so often open to adverse criticism, and that he has been, on the whole, so badly served by his translator. F. A. D.

OUR BOOK SHELF.

Aufnahme und Analyse von Wechselstromkurven. By Dr. Ernst Orlich. Pp. viii+117. (Brunswick: F. Vieweg and Son, 1906.) Price 3.50 marks.

IN the usual handbooks on alternating currents the methods of study of the wave-form of the alternations and the analysis of the curves of E.M.F. and current obtained are usually treated very scantily. Recently, however, the subject has attracted considerable attention, and its importance to a station engineer, who wishes to make alternators not identical in design run well in parallel, is now recognised.

Prof. Orlich, of the Reichsanstalt, has endeavoured in this little book to present a clear account of what is known on the subject. It begins by definitions and a short mathematical introduction to the use of Fourier series, &c. Then follow descriptions of various methods of taking curves by the point-to-point process, and of the apparatus of Rosa, of Callendar, and of Hospitalier's "Ondographe."

The Braun tube is described and illustrated, but no mention is made of the fact that owing to the kathode-ray bundle not being composed of rays of the same magnetic deflectability, and the consequent lack of sharpness of the moving image, its use for the study of alternating currents is limited rather to qualitative than to quantitative work. The next chapter deals with oscillographs in their various forms. Their theory is discussed, and the advantages of the different patterns of moving needle and bifilar instruments pointed out.

The recent experiments on telephony of Mr. Duddell, and the wonderful curves shown by him at his recent lecture at the Royal Institution on the analysis and transmission of sounds, show that substantial advances have recently been made in the construction of very sensitive oscillographs of his pattern, the curves of currents furnished by an ordinary microphone being readily shown to a large audience.

After a chapter on the phenomena of resonance, the concluding portion of the book deals with the analysis of curves, with descriptions of the best-known forms of harmonic analysers, including those of Henrici, and the machine devised by Michelson and Stratton for their analysis of visibility curves of interference fringes.

The information given in the book seems, on the whole, fairly complete and accurate. The word "periode" seems used in a loose sense, sometimes as "time of a single oscillation" and sometimes as "frequency." J. A. HARKER.

Cultures du Midi de l'Algérie et de la Tunisie. By C. Rivière and H. Lecq. Pp. xii+511. (Paris: J. B. Baillière et Fils, 1906.) Price 5 francs.

IN view of the fact that inside the British Empire agriculture is being practised under all sorts of tropical and semi-tropical conditions, there is a singular paucity of books in the English language dealing with the cultivation of exotic plants. The book before us, one of the "Encyclopédie agricole" series, reviews briefly the whole range of plants which are cultivated economically in the Mediterranean region belonging to France, *i.e.* in Provence, Algeria, and Tunis. This is a very special district possessing a characteristic flora adapted to its well-marked climatic conditions of insufficient rainfall which falls mainly in the winter, great heat and dryness in the summer, excessive radiation resulting in extreme variations of temperature, with sharp frosts in the winter, incessant wind, and an all-pervading sun. Under these conditions many forms of agriculture are only possible where irrigation water is obtainable, and much of the country is little better than bare rock or sand; there are, however, many important cultures, special to the district, which have been brought to a high state of perfection by the inhabitants of the Côte d'Azur.

The most distinctive example is perhaps the growth of plants for scent and essences which has its centre at Grasse, but which has been extended into both Algeria and Tunis; the rose, the orange-flower, the tuber rose, the violet, and the jasmine being the most important of the flowers thus cultivated. The olive, that most distinctive feature of all Mediterranean landscapes, is losing ground, we learn, being displaced by the competition of oils like cotton-seed and sesame; in Provence, also, the land is wanted for more intensive forms of cultivation, such as the production of early vegetables and cut flowers.

The book of MM. Rivière and Lecq suffers somewhat from the very extensive ground it has to cover; the accounts of each plant in cultivation have to be so curtailed that the details are insufficient for the needs of the practical man, who will, however, find an excellent series of references to more special books and articles on each subject. The book may be of considerable service to many of our colonists living in semi-arid countries and looking round for suitable and remunerative crops to grow; from it they can obtain both ideas as to possible introductions and such economic information as to the labour required and the probable value of the returns as may enable them to embark on the experiment with some prospect of success.

Tabulae Botanicae. (Part i., containing plates i. and ii.) Edited by E. Baur and E. Jahn. (Berlin: Gebrüder Borntraeger, n.d.) Price per plate: paper, 7 marks; cloth, 10 marks. Series of five, 25 marks.

UNDER this title the publishers announce a series of coloured illustrations of plants intended for lecture purposes, and arranged in sets for each subject, order, or class. The two diagrams received illustrate the Myxobacteriaceæ, the one representing successive stages in the life-history of *Polyangium fuscum*, selected as a general type, the other depicting the fructification, spores, &c., of Myxococcus and Chondromyces as special details. So far as one can judge from these specimens, the drawing entrusted to Ehrlich, of Berlin, promises to combine correct representation and artistic treatment, and the publisher's name is sufficient guarantee for good reproduction; the paper selected is not strong enough to withstand wear and tear, but at a somewhat higher price the plates may be obtained backed with linen and attached to rollers. The size of the diagrams, about 5 feet by 3 feet, is sufficiently large for most practical purposes. The short prospectus prefixed to the accompanying text provides little information, except to say that the plates will be designed two, three, or more to each subject, that the series will cover the whole field of the anatomy and the life-histories of plants, and that the lower plants will receive especially full treatment.

Reports of the Expedition to the Congo, 1903–5. Liverpool School of Tropical Medicine, Memoir xviii. Pp. 74. (London: Williams and Norgate.) Price 7*s.* 6*d.* net.

IN this report, the late Mr. Dutton and Dr. Todd contribute an important paper on gland-palpation in human trypanosomiasis, in which they show that most early cases of trypanosomiasis have enlarged glands, and can therefore be detected by gland-palpation. A second paper by the same authors discusses the distribution and spread of sleeping sickness in the Congo Free State. This is illustrated by four maps, which demonstrate very clearly the enormous extent of territory in which this terrible disease is now met with compared with twenty years ago. This is in great measure accounted for by the increase in travel following the opening up of the country. Two new Dermanyssid Acarids from monkeys' lungs are described by Mr. Newstead and Dr. Todd, and Dr. Stephens and Mr. Newstead contribute a paper on the anatomy of the proboscis of biting flies. It will thus be seen that the report contains matter of considerable interest, and the general "get up" leaves nothing to be desired.

Ten Years' Record of the Treatment of Cancer without Operation. By Dr. Robert Bell. Pp. 107. (London: Dean and Son, Ltd., 1906.) Price 2*s.* 6*d.* net.

IT is difficult to understand the *raison d'être* of this book, which consists mainly of a diatribe against the modern surgical treatment of cancer, and a veiled recommendation of the author's method of treatment by medicinal and hygienic measures. As regards any "record" of ten years' treatment by the author's methods we find little evidence—"several cases" eventually got quite well (p. 42), a case "recovered completely" (p. 43), a case in which "the tumour quite disappeared" (p. 63), three cases in which "recovery was complete" (p. 71). This constitutes the "record"; can the author be surprised if his views and methods be received with scepticism?

R. T. H.

The Opal Sea. By John C. Van Dyke. Pp. xvi+262. (London: T: Werner Laurie, 1906.) Price 6*s.* net.

PROF. VAN DYKE provides in these pages a readable account of many branches of modern oceanography expressed in a literary form too seldom found in works dealing with scientific subjects. As one would expect, the romance and poetry of science are given great prominence, and the attractive word-pictures reveal the fascinating nature of the work of the man of science. Many readers of these essays will be encouraged to undertake a more precise study of the physical geography of the sea from formal treatises.

LETTERS TO THE EDITOR.

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

The Stability of Submarines.

SIR WILLIAM WHITE, in his paper in the Roy. Soc. Proceedings (vol. lxxvii. A., p. 528), discusses the hydrostatic forces tending to stability or instability of a submarine at the surface of the water. When the vessel is in motion, hydrodynamical forces come into play from the stream-line action of the water, and these also will affect the stability of the vessel. Sir W. White insists that these forces can only be examined experimentally, and has no data to give as to their magnitude. Although it is obviously impossible to obtain an exact calculation of the magnitude of these hydrodynamical forces, yet it may be worth noticing that a very simple calculation will give an approximation to their value, which at least is of importance in that it suggests that the question is one of extreme gravity.

The principle involved is, of course, the well-known principle by which an ellipsoid moving through still water tends to turn so that its smallest axis is in the direction of motion.

We may obtain a first approximation to the stream-line action by treating the submarine as a cigar-shaped spheroid, and assuming it to be completely immersed in an infinite ocean. Let a, b denote the semi-axes of the spheroid, and let it be moving with velocity V, its major axis making a small angle θ with the horizontal. The couple tending to decrease θ is known to be

$$\tfrac{1}{2}V^2 \sin 2\theta \left(\frac{\alpha}{2-\alpha} - \frac{\beta}{2-\beta}\right)D,$$

where

$$\alpha = -2ab^2\left\{\frac{1}{(a^2-b^2)^{\frac{3}{2}}}\log\frac{a-\sqrt{a^2-b^2}}{b} + \frac{1}{a(a^2-b^2)}\right\},$$

$$\beta = ab^2\left\{\frac{1}{(a^2-b^2)^{\frac{3}{2}}}\log\frac{a-\sqrt{a^2-b^2}}{b} + \frac{a}{b^2(a^2-b^2)}\right\},$$

and D is the displacement of the vessel.

The figures given by Sir William White for an actual submarine are—length 150 feet, breadth 12·2 feet. If we take $a/b = 12{\cdot}3$ in our spheroid, we obtain

$$\frac{\alpha}{2-\alpha} - \frac{\beta}{2-\beta} = -0{\cdot}95.$$

Thus, for a displacement through a small angle θ from the horizontal, the stream-line couple produced by a velocity V through the water is

$$0{\cdot}95\, V^2 D\theta,$$

tending to turn the vessel further from the horizontal.

If h is the metacentric height for longitudinal displacement, the hydrostatic righting couple is

$$ghD\theta.$$

Thus the effective righting couple is

$$gD\theta\left\{h - \frac{0{\cdot}95V^2}{g}\right\},$$

so that the metacentric height is diminished by the motion of the submarine by an amount $0{\cdot}95\, V^2/g$. This factor does not appear to depend much on the shape of the submarine; clearly, if its shape had been that of a thin long stick, we should merely have to replace 0·95 by 1·00, whereas if the ratio a/b had had only half of its present value, the numerical factor would still be about 0·9.

Sir William White gives as the metacentric height of an actual submarine 37 feet when awash on an even keel, and only 45 per cent. of this, say $16\frac{1}{2}$ feet, when trimmed to an angle of 4 degrees. The value of V^2/g when V = 10 knots, is about $9\frac{1}{2}$ feet, so that the effective metacentric height would be reduced to about 28 feet on an even keel, and to $7\frac{1}{2}$ feet when trimmed 4 degrees by the stern. So far as can be judged from a diagram given by Sir William White (Fig. 7 in his paper), the metacentric height would vanish altogether for a trim of about 7 degrees.

Thus a submarine moving ahead at 10 knots, even under perfect conditions, might apparently be expected to founder if its inclination at any time reached as much as 7 degrees.

Sir William White mentions that in the case of the submarine A8, the hydrostatic metacentric height had been reduced, at the time the accident occurred, to $8\frac{1}{2}$ feet. The further diminution in this height produced by a headway of 8 knots is about 6 feet—by a headway of 9 knots is about $7\frac{1}{2}$ feet, leaving only about 1 foot of effective metacentric height as the margin of safety.

Obviously these rough calculations ignore a great number of factors which ought to be taken into account before accurate knowledge can be obtained. The most important of these factors is probably the proximity of the surface and the consequent formation of surface-waves. A calculation which omits a factor of this kind cannot lay claim to any value as advancing exact knowledge, but may serve the humbler purpose of suggesting possible, and even probable, dangers, and of emphasising the need for experimental knowledge, before this is forced on us by a catastrophe. J. H. JEANS.

Trinity College, Cambridge.

THE mathematical investigation which Mr. Jeans puts forward is of great interest, but avowedly rests on the assumption of the complete immersion of a submarine in an infinite ocean. The concluding paragraph of his letter indicates that a great number of factors, which ought to be taken into account, are not represented in the mathematical investigation, the most important being near proximity to the surface and the consequent formation of surface-waves. It will suffice, therefore, for me to say that my insistence on the necessity for direct experiment, rather than mathematical investigation, had relation to the case where the submarine was moving at the surface with a small reserve of buoyancy. The slides which I exhibited at the Royal Society reproduced photographs taken in these circumstances, and showed the singular and irregular character of the surface-waves produced by the headway of submarines under these conditions. These slides furnished conclusive evidence of the impossibility of representing the conditions of practice by purely mathematical investigation, and the absolute necessity for experiments on models and full-sized submarines.

Mr. Jeans's investigation for the completely submerged vessel has, however, a great practical value, because it furnishes fresh and important reasons (in addition to those urged by myself) against the tendency to increase the under-water speeds of submarines. When submerged, the measure of stability of the vessel for all directions of inclination is found in the height of the centre of buoyancy above the centre of gravity. We are informed authoritatively that in the diving condition this height is less than 1 foot in existing types of submarines. It will be seen, therefore, that a very small value of V—less than 6 knots—might render such a vessel unstable; if the speed were increased to 10 knots no possible use of water-ballast could give such a hydrostatic stability to the vessel when at rest as would secure the maintenance of stability when she moved at full speed. The existence of superstructures on the upper portions of submarines, of course, involves a departure from the cigar-shaped spheroidal form, but cannot be accompanied by any such decrease in the moment of the couple resulting from the stream-line forces as would secure, or even add sensibly to, the safety of the submarine moving at high speed under water. W. H. WHITE.

The Action of "α" Radiation on Diamonds.

The action of the "α rays" on diamonds is of considerable interest, for while the fluorescence caused by the β and γ radiation from radium is probably similar to that caused by the X-rays, the appearance of a diamond made luminous by the impact of a stream of "α" particles suggests some considerations as to the possible action of "α" radiation on fluorescent crystals in general. The fluorescence of a fairly large stone (cut and polished) when viewed with a suitable lens shows practically nothing of the spinthariscopic action, although the stone may be brightly luminous. Instead of the familiar scintillations, the whole crystal, or at least the whole surface exposed to the rays, appears to give out a steady bluish-white light.

The thought at once occurs to one that this seemingly continuous flow may be the collective effect of the very numerous scintillations produced by a too intense stream of "α" rays; such an action is well shown on a zinc sulphide screen when there is an excessive quantity of radium used. That this action is really the collective fluorescence of scintillations is at once evident by removing the fragment of radium to a greater distance, reducing the quantity used, or increasing the magnifying power employed to view the screen. In the case of a diamond, however, this does not appear to be so. The use of a higher power to view the fluorescence still shows a seemingly steady glow, and the increase of the distance between the radium and the stone merely causes the light to become gradually fainter, while still preserving its steady character. Yet it is certain that the diamond responds readily to the "α" particles, and also that, as the quantity of radium is so very small, the action of the β and γ radiation is quite negligible. It is, of course, well known that when an "α" particle strikes a fluorescent screen, the point of impact becomes the centre of a luminous area, which is simply enormous in extent when compared with the size of the atomic projectile which causes it.

The following may perhaps be suggested as a possible explanation of this action:—When an "α" particle strikes a homogeneous fluorescent crystal (say a diamond), the energy which excites the fluorescence finds equal conduction in all directions. The fluorescence caused thus tends to fill the whole volume of the crystal. If there are many such atomic projectiles incident on the same crystal, they are all tending to do the same thing, and consequently their spheres of influence mingle with one another. As such spheres of fluorescence find equal conduction of all sides, they extend indefinitely within the limits of the crystal in question. As fluorescence is apparently a molecular property, and probably electrical in its nature, it is not difficult to imagine that such may be the case. A still pond, into which a handful of gravel is scattered, may present an approximate analogy. The ring-waves (neglecting the time they take to travel) would mingle with one another, and yet each one might be said separately to occupy the whole area of the pond. In the case of a zinc sulphide screen, or one coated with minute fragments of diamond crystals, the energy received by one crystal or fragment of a crystal is confined exclusively to the volume of that fragment. Moreover, it is impossible for an "α" particle to strike more than one crystalline fragment at a time, for it is a body of atomic dimensions compared with which the most minute fragment of the fluorescent compound would be enormous.

The whole of the available energy is thus confined to the limits of the fragment struck, and is not, apparently, extended to the neighbouring crystals, which are only in loose and indifferent contact with it. When such a crystalline fragment is of a size which is comfortably visible with the aid of a lens magnifying about 20 diameters to 30 diameters, the resulting fluorescence will be visible as a scintillation. To diminish the size of the crystals beyond a certain point in order to increase the brightness of the scintillations is apparently not advantageous, as it requires the higher powers of a compound microscope to render the areas properly visible, and there would be a corresponding loss of light.

On the analogy of the pond given above, the spinthariscopic effect may be compared to throwing a handful of gravel into a collection of small puddles. The disturbance caused in each would be strictly confined to its own area, and would be correspondingly intense within that area. With a given stream of "α" radiation, a small stone appears to give a very slight scintillating effect which is not seen in a larger stone, except at the edges and angles of the facets, where the area of fluorescence is abruptly terminated, and even here it is very faint. The above remarks would, of course, only apply to perfect crystals. If a crystal is full of flaws and imperfections, the areas or spheres of fluorescence would not find easy conduction across the faults, and would therefore become localised in their action. It may be noted that a lump of willemite (natural), which is of a semi-crystalline character, does show scintillations, though very imperfectly, while the powdered mineral answers much better. This may be explained on the assumption that the areas of conduction are restricted to the size of the particles. C. W. R.

June 20.

The Day of Week for any Date.

The following method for finding the day of the week for any given date (new or Gregorian style) may interest your readers. We assign a number for each month in accordance with the *old* style, beginning with March, so that the last four months are numbered according to their Latin names, as follows:—

January, 0; February or March, 1; April, 2; May, 3; June, 4; July, 5; August, 6; September, 7; October, 8; November, 9; December, 10; next January, 11; next February, 12.

For a Leap Year, January and February must count as 11 and 12 respectively in the *preceding* year.

It is only in dealing with the month-number that anything not straightforward and obvious is involved.

The rule then runs as follows:—

A. For the *century*: divide by 4, and calculate 5 *times the remainder*.

B. For the *year*: add *to the number the quotient obtained from divisor* 4.

C. For the *month*: multiply by 4, and *negate the units digit* (*i.e.* subtract instead of adding it).

D. For the *day*: retain the number unchanged.

Then add together the results A, B, C, D (casting out *sevens*, of course, as you proceed), and the result gives the required day of the week.

The rule holds without modification, not excepting such years as 1600, 2000, &c., as well as 1700, 1800, 1900, &c.

Examples—1906, September 19.

A. For *century*: $3 \times 5 = 15$ ... ... $\equiv 1$
B. For *year*: $06 + 1 = 7$ ... ... $\equiv 0$
C. For *month*: 4×7 gives $20 - 8 = 12$ ... ... $\equiv 5$
D. For *day*: 19 ... .. $\equiv 5$

$A + B + C + D = 11 \equiv 4$, *i.e. Wednesday.*

1815, June 18 (Battle of Waterloo).

A. For *century*: $2 \times 5 = 10$ ... ... $\equiv 3$
B. For *year*: $15 + 3 = 18$ ... ... $\equiv 4$
C. For *month*: 4×4 gives $10 - 6 = 4$ ... .. $\equiv 4$
D. For *day*: 18 .. ... $\equiv 4$

$A + B + C + D = 15 \equiv 1$, *i.e. Sunday.*

1784,* January 12 (Pitt's appearance as Prime Minister).

A. For *century*: $1 \times 5 = 5$ 5
B. For *year*: $83^* + 20 = 103$ ... ... $\equiv 5$
C. For *month*: $11^* \times 4$ gives $40 - 4 = 36$ ... . $\equiv 1$
D. For *day*: 12 ... 5

* Leap year.

$A + B + C + D = 16 \equiv 2$, *i.e. Monday.*

W. E. Johnson.

King's College, Cambridge, July 11.

SOME SCIENTIFIC CENTRES.

VIII.—THE MACDONALD PHYSICS BUILDING, McGILL UNIVERSITY, MONTREAL.

WISE liberality has rarely reaped a richer and more immediate harvest than the gift by Sir William Macdonald of the Physics Building to McGill University at Montreal. This benefaction is but one instance—though a very important instance—of the fact that education, particularly scientific and technical education, is of enormous practical advantage, and that the most wealthy men in Canada and the United States recognise that it has the first claim on their generosity. In England money is given with no less lavish hand, but vast sums are devoted to objects less deserving than education, inasmuch as they afford palliatives, and not preventives, of failure, suffering, or distress.

The Physics Building, with its accompanying endowments and equipment both for instruction and research, forms but a small fraction of the total gifts of Sir William Macdonald to McGill University—gifts which exceed in value three and a half million dollars. A brief history of its growth, more particularly as a centre of research work, may be of service to those desirous of emulating a noble example.

In 1891 a chair of physics was endowed by Sir William Macdonald, to which John Cox, formerly Fellow of Trinity College, Cambridge, was appointed as the first professor. He was at once instructed to visit the best laboratories in America, and thus add to his experience of similar institutions in Europe. He received the most cordial assistance in the United States, and learnt both what to acquire and what to avoid. On his return, in conjunction with the architect, Mr. Andrew T. Taylor, he planned a building, beautiful in appearance, and so complete in every detail, that it is scarcely possible, with an intimate knowledge of the internal arrangements, to suggest any material improvements. The general scheme was to provide a building which would meet the requirements of the ensuing fifty years. The cost of the fabric was 29,000*l*., being at the rate of about elevenpence a cubic foot.

The donor further instructed Prof. Cox to prepare estimates for equipment and apparatus, and in response for a request of 5000*l*., the sum of 6000*l*. was placed at his disposal. At this point Sir William Macdonald decided to endow another chair for research in physics, and the institution was fortunate in obtaining H. L. Callendar, from Trinity College, Cambridge, as its first occupant. The equipment of the laboratory continued from 1892 to 1897, when the founder was assured that sufficient apparatus had been obtained; but the first grant had been greatly exceeded, and the total donation for this purpose was 22,000*l*. This sum has been discreetly spent, and adequate provision has been made for lecture tables, laboratories, and for all branches of physical research. Sir William Macdonald made a further gift of 30,000*l*. in order to secure an annual income of 1500*l*. to provide for the salaries of demonstrators and to defray the cost of heat, light, upkeep of apparatus, and repairs to the fabric. As educational property is not subject to taxation in Canada, the only rate payable is the water tax. In addition to the preceding gifts, the donor of the Physics Building has made special grants from time to time for the purchase of radium, for a liquid-air plant, for two large induction coils, and in particular 1000*l*. for the purchase of books for the library in the building, and 400*l*. for a special research fund. It is fortunate that such splendid munificence has been judiciously expended by Prof. Cox, and that the results obtained have been such as to win for the laboratory a place in the foremost rank.

A detailed account of the rooms in the building is unnecessary, but an important item in the establishment is the workshop, with tools and lathes driven by electric motors, sufficient to make a large proportion of the more simple apparatus required for instruction or research. A complete plant of this nature, under a competent mechanic and assistant, effects a great saving of time and money in a city where skilled labour is often scarce and always costly. It is not within the scope of this article to give an account of the purely educational uses of this building, but it is sufficient to state that the lecture theatres and laboratories are ample in size and equipment, so that all students in the faculties of arts and of science receive courses in physics suited to the requirements of their future professions. An interesting question arises as to the extent to which professors of research should devote their time to the instruction of ordinary students. On the one hand, it may be regarded as a waste of valuable time, but from the student's point of view it is a great gain to come into contact, both in laboratory and lecture room, with the best intellects in his university. A research professor must necessarily devote some of his time to the instruction of advanced students, and particularly to the assistance of research students. It is therefore undesirable that any large

FIG. 1.—Macdonald Physics Building, McGill University, Montreal.

fraction of his time should be absorbed by giving lectures to elementary students. This difficult question of the division of time appears to have been satisfactorily solved in the Physics Building.

The first research professor, H. L. Callendar, was an active and able investigator. He invented and improved his platinum thermometer with an ingenious compensation method, and applied it to various uses. In conjunction with Prof. J. S. Nicholson, of the engineering building, he solved many temperature problems connected with the steam engine. He investigated some important meteorological questions, determining the temperature at various depths in the earth—a matter of special interest during the severe winters in Canada. He also constructed a self-recording instrument which measured the difference of temperatures between the top of Mount Royal and the base near the observatory. Further results have been obtained by Prof. C. H. McLeod and Dr. H. T. Barnes, using the same instrument. The latter was also associated with Prof. Callendar in effecting some improvements in the Clark cell as a standard of electromotive force. But Prof. Callendar's most important work at McGill was the development, in conjunction with Dr. Barnes, of the continuous flow method of calorimetry. This has proved a great advance, both for simplicity and accuracy, on the older methods of calorimetry. Very exact determinations have thus been made by Dr. Barnes of the mechanical equivalent of heat, and of the specific heat of water at various temperatures. Dr. Barnes, with Dr. Coker, determined the effect of temperature on stream lines and the critical velocity. He has also made a close study of the properties and peculiarities of ice formation in Canadian rivers. Freezing does not occur merely at the surface, as in most English rivers, but, after passing rapids, water may congeal at the bottom and form "anchor ice." Still more remarkable is the formation of "frazil," consisting of minute crystals pervading the whole mass of water. The presence of ice in this state occasions serious trouble in the turbines of the power stations, and special precautions are necessary to mitigate the evil.

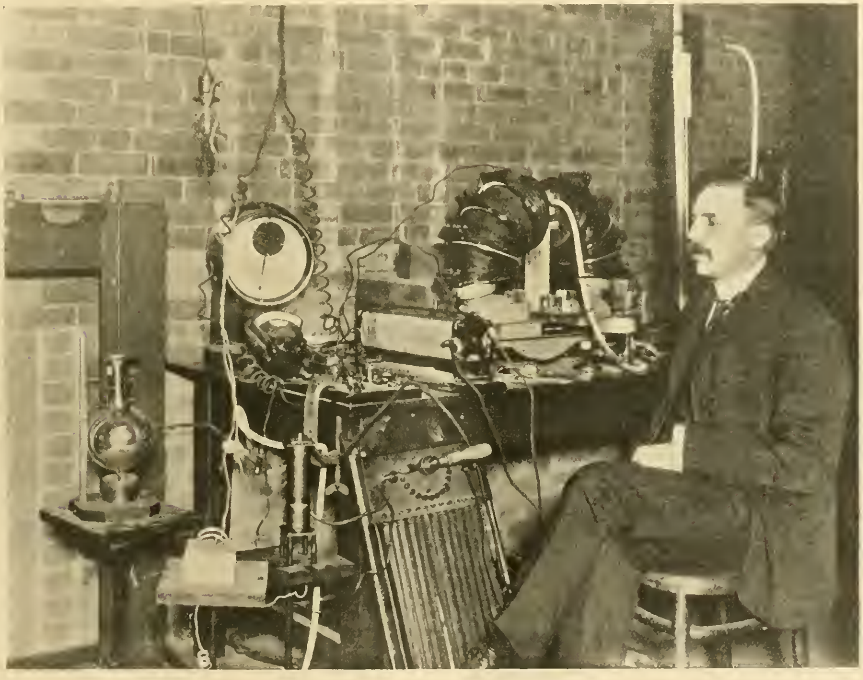


FIG. 2.—Prof. E. Rutherford, F.R.S., in his laboratory.

On the appointment of Prof. Callendar to the chair of physics at University College, London, Prof. Cox again visited the Cavendish Laboratory, and, on the advice of Prof. J. J. Thomson, he selected to fill the vacancy E. Rutherford, a young man who had already distinguished himself for originality, insight, and great capacity for work. Soon after M. Becquerel's discovery of the radiations from uranium, Rutherford had published a paper on that subject, and removed some misapprehensions as to the properties of the radiations. Moreover, he had served a most useful apprenticeship on the investigation of the properties of ions, whether produced by Röntgen rays, ultra-violet light, or by uranium. This thorough mastery of the indispensable elements served him in good stead when he continued at Montreal his researches on radio-activity. At this time Prof. H. B. Owens, of the engineering building, had noted the peculiar inconstancy of the radiations from thorium, and traced it to air currents. Prof. Rutherford then made an exhaustive examination of the phenomena, and he found that thorium emitted a gaseous substance, to which he gave the name "emanation." He also proved that the emanation had the remarkable property of making other substances active by a material surface deposit due to the emanation. Assisted by Miss Brooks, he proceeded to measure the rate of diffusion of the emanation from radium, for he then saw, and saw correctly, that the emanation was a gas and a distinct form of matter.

At this point Mr. Soddy came from Oxford to McGill University and worked with Prof. Rutherford. Together they tried the effect of varying the physical conditions, such as temperature, upon the emanating power of radio-active substances, and in the course of this work it was found that the emanation came from thorium X, a substance which could be separated from thorium. When they realised and clearly proved that the emanation was produced from thorium X, that thorium X constantly appeared from thorium, and as constantly decayed, that the curves of decay and of recovery were strictly complementary, and followed with exactitude simple exponential laws, that the rate of change was proportional to the amount of material still unchanged, then for the first time a most clear conception of the sequence of production of matter in fresh forms, with distinct chemical properties, was attained. The substances thus discovered were in quantities too minute to be detected by the balance or spectroscope. The new theory of radio-activity was published in two papers by Rutherford and Soddy in the *Philosophical Magazine* of September and November, 1902. In these papers the experimental evidence was first reviewed, and then the theory was stated that radioactivity is an atomic phenomenon accompanied by chemical changes in which new types of matter are produced, that the changes must occur within the atom, and that the radio-active substances must be undergoing transformation. This theory on its first appearance was regarded by many as a mere flight of the imagination, and efforts were made to detect a cause exterior to the atom. The theory was stoutly championed by Rutherford in the face of doubt and criticism, and it is now so thoroughly accepted by all who have investigated the subject that the initial opposition is almost forgotten. It is remarkable that a new subject should have reached the position of an exact science with such great rapidity.

Experimental research continued at McGill with speed which was almost feverish. Having established the fact that the highest temperatures obtainable had no effect on the rate of transformation of the emanation of radium, it was desired to try the effect of extreme cold. Again the good genius of the Physics Building was invoked, and a complete plant for making liquid air was presented. Within a quarter of an hour after the first 100 c.c. of liquid air were prepared the emanation had been condensed, and the material nature of this gas had been proved beyond question.

It is noteworthy that in the paper on the cause and nature of radio-activity in the *Philosophical Magazine* of November, 1902, the speculation was advanced that the presence of helium in minerals associated with uranium and thorium might be connected with their radio-activity. In 1904 this forecast was verified by the observation of the presence of helium in the spectrum of the radium emanation by Ramsay and Soddy in the laboratory of the former. In the meantime Rutherford had proved by magnetic deflection that the α particles carried a positive charge. The remarkable heating effects of radium, three-quarters of the total amount being due to the emanation, were investigated and measured. At a later date the heat generated by the γ rays was under observation and found to be very small, a result of importance in estimating the nature of the rays. In these heat determinations Prof. Rutherford was assisted by Dr. Barnes. In 1902 Mr. Soddy left McGill University, worked for a year with Sir William Ramsay, and was then appointed lecturer in physical chemistry at Glasgow University. Prof. Rutherford continued his research work with unabated energy and success. Radio-tellurium and polonium were relegated to their proper places among the products of radium, now grown to a family of six, the successive offspring of the emanation. The theory of rayless changes was advanced, and the complicated cases arising therefrom were thoroughly explored, and the results published in the Bakerian lecture delivered before the Royal Society in 1904. The brilliant work of Rutherford received recognition by the award to him of the Rumford medal. More recently he has again directed his attention to the α particles, deflecting in electric and magnetic fields the rays from radium C and other substances, thus determining the charge and mass of the particles, and endeavouring to account for their abrupt disappearance whilst their velocities are still very great.

So much work and such novel theories have naturally called forth criticism, but the discussions have always been chivalrous, buttons have been on the foils, and Rutherford's extreme care in verifying every step by thorough experimental evidence has saved him from error to a degree quite exceptional. A prominent physicist in the early days of radio-activity remarked that the subject was such a tangled skein that it was almost hopeless to unravel it. This sufficiently indicates the difficulty of the subject in the initial stages. It is fortunate that so much of the development centred in a man to whom the remarkable instinct is given of rarely following side-issues. As a result of this concentration a uniform system of nomenclature has been adopted, and experimenters are saved much time and trouble in following the work of others. Apart from such concentration, it is not difficult to imagine the state of chaos into which the whole subject would have lapsed. Rutherford's work, "Radio-activity," has passed rapidly through two editions, has kept pace with discoveries, and is the encyclopædia of the subject.

At the physics building Prof. Rutherford inspires research students with some of his own enthusiasm and energy. He follows their results closely, is ready with advice and criticism, and is as delighted with any of their discoveries as with his own. He is generosity itself in giving a full measure of credit to those who do research work under his guidance.

Reference may be made to some of the work done by research students. Miss Brooks has published several papers on various radio-active phenomena, and this lady was one of the most successful and industrious workers in the early days of the investigation of the subject. H. L. Cooke discovered penetrating rays from the earth, and made contributions on the activity of ordinary matter. R. K. McClung determined the coefficient of re-combination of ions, and worked with Rutherford on the energy required to produce an ion, and on allied problems. S. J. Allan worked at the active deposit derived from the atmosphere and from falling snow. Miss Gates ascertained the true nature of the discharge due to quinine sulphate. A. G. Grier detected the magnetic deviation of the β rays of thorium.

Others have come to Montreal from afar, attracted by the magnetic influence of Rutherford, such as Dr. Godlewski, of Lemberg, in Poland, who investigated in Montreal the products of actinium and some notable properties of actinium and uranium. From Frankfurt came Dr. Hahn, discoverer of radiothorium in the laboratory of Sir William Ramsay. Dr. Hahn, whilst working at McGill, also discovered radioactinium and a new product of thorium. Dr. Levin, from Göttingen, and Dr. Bronson, from Yale, have also done research work whilst at McGill, and the latter has increased our accurate knowledge of various radio-active constants by his modification of the electrometer giving direct and immediate readings. All these workers testify warmly to the inspiration kindled by Rutherford.

His own success as an investigator may be traced to a few well-marked characteristics. The first is the pertinacious and reiterated assault on the particular problem in hand. He does not grope in the dark for chance results, but bombards the particular point which he wishes to attack. He has also an instinctive insight which often makes his initial point of view more trustworthy than the deliberate conclusions of some befogged experimenter. He is not only an industrious, he is also a very rapid worker, but his experimental conditions are varied sufficiently to eliminate error, and his observations are repeated until he has perfect confidence in his results. Most noteworthy of all is the extreme simplicity and directness of his experimental methods. Some observers appear to grow happier as their apparatus becomes more complex. Rutherford selects some ingenious, straightforward attack, but the simplicity is supplemented by the genius which has enabled him to make such great contributions to our knowledge of the mutability of matter and of the atom in evolution.

In conclusion, the writer, who is an Englishman resident in Canada, ventures to emphasise the importance of research laboratories, so well equipped and so distributed that able men in Great Britain may not find themselves hampered through want of means and opportunity to pursue their work. The gift of the Cavendish Laboratory to the University of Cambridge by the late Duke of Devonshire has produced results which are recognised as holding the first place in recent advances in physical science. The Macdonald Physics Building has brilliantly started on its career. But there are other universities less fortunate, and there are other wealthy men.

A. S. Eve.

THE YORK MEETING OF THE BRITISH ASSOCIATION.

Provisional Programmes of the Sections.

The local arrangements for this meeting, which will be held at York from August 1 to 8, are progressing extremely satisfactorily, and a large assembly is expected, as nearly 1200 persons from a distance have already signified their intention to be present. The evening meetings will be held in the large hall of the Exhibition Building; 2200 numbered seats are already arranged, while there is space behind, making up a total accommodation of at least 5000 if necessary. All these will have a full view of the speaker, and the lantern screen, though, of course, those behind will be a considerable distance away. It will be well, therefore, for visitors to bring their opera glasses with them.

The neighbourhood of York affords many objects of interest, archæological, botanical, and geological, and many of these are more readily accessible by road than railway. Cyclists are therefore recommended to bring their machines with them, as the roads are mostly good and level. Hotel and lodging list can, as usual, be obtained of the local secretaries, Davy Hall Chambers, York. The following provisional programmes have been arranged by the committees of the various sections:

Section A (Mathematical and Physical Science).—This section will, as usual in recent years, meet in three departments. In the chief department a series of discussions has been arranged. Prof. Soddy will open one on the evolution of the elements, and a number of leading workers in radio-activity, including Sir Wm. Ramsay, are expected to follow. Mr. J. Swinburne will discuss the nature of the radiation from incandescent mantles; and Dr. H. Rubens, of Charlottenburg, will expound his views, and illustrate them experimentally. Representatives of the Chemical Section will be deputed to attend both these discussions. It is expected that they will prove of great value as well as of great interest. The Hon. R. J. Strutt has consented to give an account of his recent work on the internal structure of the earth as indicated by the phenomena of radio-activity, and Prof. J. Milne will also speak on it. It is probable that the Geological Section will collaborate in this discussion; hence it will be treated from various points of view. There will be a paper by the Earl of Berkeley on osmotic pressure, which will lead probably to renewed debate on the ever-interesting subject of the nature of solutions. Sir Wm. Ramsay and J. F. Spencer have presented a paper on chemical and electrical changes induced by ultra-violet light, which contains important new matter, as well as a summary of what is at present known on this subject.

There will also be papers by H. Stansfield on photographs of thin liquid films (with experiments); Prof. E. H. Barton and J. Penzer on photographic records of a string's vibrations and responsive motions in the air; Mr. C. E. S. Phillips on the production of an electrically conductive glass; and Prof. W. F. Barrett on entoptic vision. In the Department of Astronomy and Cosmical Physics, a joint discussion has been arranged with Section E (Geography) on the necessity for the re-measurement of the British geodetic arc. This will be opened by Major E. H. Hills, R.E. In the Department of Mathematics, Prof. A. R. Forsyth will read a paper on the different kinds of integrals of partial differential equations. Papers will also be read on a test for the convergence of multiple series, by Mr. T. J. Bromwich; on some notes on finite groups, by Harold Hilton; on Aleph numbers, by Dr. E. W. Hobson; and on the residues of hypereven numbers, by Lieut.-Colonel A. Cunningham. Prof. Henrici will open a discussion on the notation and use of vectors.

Section C (Geology).—The following are among the principal papers promised for this section: The problems of the Palæozoic glaciations of Australia and South Africa, Prof. J. W. Gregory; On a criterion of the glacial erosion of lake-basins, R. D. Oldham; Notes on recent earthquakes, Prof. J. Milne; On anthropods from the Coal-measures, Dr. Hy. Woodward; On the Jurassic flora of Yorkshire, A. C. Seward; Discussion on the origin of the trias, opened by Prof. Bonney and Mr. J. Lomas; On an artesian boring at Lincoln, Prof. Hull; On the post-Cretaceous stratigraphy of Southern Nigeria, J. Parkinson; On a peculiar variety of sodalite showing colour-change, T. H. Holland. Prof. P. F. Kendall will give a lecture on the geology of the country round York. The president's address will deal with the interglacial problem as it applies to the British Isles. A number of other papers have also been promised—relating mainly to the geology of the Yorkshire district. The following are among the number: On the limestone knolls of Craven, and on an intrusive rock near Grindleton in the West Riding, A. Wilmore; Notes on the glaciation of the Usk and Wye Valleys, Rev. W. Lower Carter; On faults as a predisposing cause of the potholes on Ingleborough, H. Brodrick; On a section in a post-glacial deposit at Hornsea, T. Sheppard.

SECTION D (ZOOLOGY).—President's address by Mr. J. J. Lister, F.R.S. *Papers.*—Conjugation of *Paramaecium caudatus*, Prof. Gary N. Calkins (Columbia Univ.); Breeding experiments in canaries—an exception to Mendel's law, Prof. Noorduijn; Preliminary note on a new conception of segregation, A. D. Darbyshire; On epigamic and aposematic scents in rhopalocera, Dr. F. A. Dixey; Outline sketch of what appears to be a periodic law in organic evolution, with a re-estimation of the cell, H. M. Bernard; Maturation of parthenogenetic eggs, L. Doncaster; The milk dentition of the primitive elephants, Dr. C. W. Andrews; Habits of galatheidæ in relation to their structure, Dr. Herbert J. Fleure and Miss E. F. Galloway; Some points of interest with reference to the mandible in mammals, and Some remarks on the manus of the dolphin, Prof. R. J. Anderson; Title not communicated, but dealing with the zoology of the Scottish Antarctic Expedition, W. F. Lanchester. *Discussions.*—Halolimnic faunas and the Tanganyika problems, J. E. S. Moore; it is hoped the following will speak: Prof. Pilseneer, Dr. Bordenger, Prof. Gregory, Mr. Cunnington, Mr. Hudleston, Dr. Calman, Mr. R. T. Gunther. Melanism in Lepidoptera, G. T. Porritt; the following will speak: Mr. J. Arkle, Dr. Dixey, Mr. W. Hewitt, and others. Prof. Gary N. Calkins will introduce a discussion on Protozoan life-histories. Spicule formation, Prof. E. A. Minchin; it is hoped the following will speak: Prof. Yves Delage, Prof. Sollas, Prof. Dendy, Mr. W. Woodland. Suggestions for the more systematic study of oceanic plankton, Dr. G. Herbert Fowler; probable speakers: Prof. Gibson (Louvain), Dr. Norris Wolffenden, Mr. Stanley Gardiner. On the relations of scientific marine investigations to practical fishery problems, Dr. E. J. Allen; it is hoped that in addition to men of science a number of persons practically interested in the fishing industry at Hull and Grimsby will take part in the discussion. On Monday morning (August 6) there will be a joint meeting with Section K (Botany) for the discussion of several cytological papers, among which will be Mr. Doncaster's (*vide supra*). There will also be two afternoon lectures illustrated with lantern slides (semi-popular), namely: The habits of tube-building worms, Arnold T. Watson; Birds and mammals of Yorkshire, Oxley Grabham (local secretary).

SECTION E (GEOGRAPHY).—*Discussions.*—Proposed measurement of geodetic arcs in Great Britain, opened by Major E. H. Hills, C.M.G., R.E.; Changes on the coast of England, especially at the mouth of the Humber, opened by Mr. Clement Reid. *Papers.*—The scientific results of the Scottish Loch survey, James Murray; The Chagos Islands, Indian Ocean, J. Stanley Gardiner; A journey across the Sahara, M. E. F. Gautier (not quite certain); The structure of Southern Nigeria, John Parkinson; The study of Social Geography, Prof. G. W. Hoke, of Ohio State Normal College; A journey in the Central Himalaya, T. G. Longstaff; The future of wheat-growing in Canada, Prof. L. W. Lyde; Geographical photography, John Thomson. *Afternoon Lectures.*—Past and present in Asia Minor, Prof. W. M. Ramsay; The visit of the Association to S. Africa, H. Yule Oldham; A tour in South-East Persia, Major P. M. Sykes.

SECTION G (ENGINEERING).—Address by Prof. J. A. Ewing, president of the Section; Modern armour and its attack, Major W. E. Edwards; The deformation and fracture of iron and steel, W. Rosenhain; Segregation in steel ingots, and its effect in modifying the mechanical properties of steel, J. E. Stead; Structural changes in nickel wire at high temperatures, H. C. H. Carpenter; Standardisation in British engineering practice, Sir John Wolfe Barry, K.C.B.; Recent advances in our knowledge of radiation phenomena, and their bearing on the optical measurement of temperature, J. B. Henderson; The removal of dust and smoke from chimney gases, S. H. Davies and F. G. Fryer; Glow lamps up-to-date, and the grading of voltages, Sir W. H. Preece, K.C.B.; The advent of single phase electric traction on railways, C. F. Jenkin; Some recent developments of the steam turbine, G. Gerald Stoney; Some recent experimental results with internal combustion engines, Prof. W. E. Dalby; A general supply of gas for heat, light, and power purposes, A. J. Martin; Experiments illustrating the balancing of engines, Prof. W. E. Dalby; An indicator for high speed engines, Prof. B. Hopkinson; A new form of transmission dynamometer, Prof. B. Hopkinson and L. G. P. Thring; The new engineering laboratories, Edinburgh University, and their equipment, Prof. T. Hudson Beare; Waterproof roads as a solution of the dust problem, Douglas Mackenzie; The central technical college lecture table testing machine, Prof. Ashcroft; The teaching of mechanics by experiment (with illustrations), C. E. Ashford.

SECTION H (ANTHROPOLOGY).—In this section the proceedings promise to prove as interesting as usual, and quite a large number of the communications are likely to give rise to considerable discussion. One of the most important items in the programme will be a discussion on the head-form of the prehistoric and early historic races in Britain which has been arranged to take place in connection with an exhibit of British crania, now in the possession of the Yorkshire Philosophical Society, and crania from Laver Hill. The discussion will be opened by Mr. J. Gray with a paper surveying the evidence, anthropological and collateral, bearing on the affinities and probable origin of the prehistoric and early historic races which have settled in Britain. Dr. F. C. Shrubsall has also promised to contribute, and Dr. W. Wright and others will take part in the discussion. In this connection considerable interest attaches to a paper on the relations between archæological and anthropographical data in the ethnology of Scotland by Dr. T. H. Bryce, and a paper by Mr. J. R. Mortimer on the relation between stature and head-form in the skeletal remains found in the round barrows of Yorkshire, based on data obtained from his own collections at Driffield. Mr. H. Brodrick will describe a skeleton recently discovered in Scoska Cave, Littondale. Two communications by Dr. W. L. H. Duckworth will deal respectively with a rare anomaly in human crania from Kawiawata Island, New Guinea, and observations on a eunuchoid subject in the Cambridge Anatomy School. Dr. C. S. Myers contributes, as an addendum to the report of the committee on anthropometric investigations among the native troops of the Egyptian Army, and notes on the distribution of cephalic and nasal indices in different provinces of Egypt.

In general ethnography communications are hardly as numerous as usual. Dr. Haddon will contribute a paper on the ethnology of South Africa, based principally on material collected during the visit of the association to South Africa last year, and Mr. S. Dornan, a South African member, sends a communication dealing with the Bushmen of Basutoland. Messrs. T. A. Joyce and E. Torday jointly will contribute a paper on the Ba-Yakka, a tribe in the Congo Free State. Among papers dealing with points of a more detailed character, Dr. Rivers offers, as a possible explanation, alternative, at least in India, of the importance of the maternal uncle among primitive races, a survival in the marriage customs of southern India, and an account of the astronomy of the Torres Straits islanders. Mr. H. A. Rose will contribute a paper on the custom of female infanticide in India, and Prof. Ridgeway will deal with the origin of the fiddle and guitar. Dr. T. H. Bryce and Mr. Newberry, of the Glasgow School of Art, will exhibit a number of examples of the "door-step" art—designs used by peasants to decorate their door-steps and dairy and kitchen floors in Scotland, which present many interesting features.

In archæology, Prof. W. M. Flinders Petrie will give an account of a Hyksos fortress and other discoveries in Egypt in 1906; Dr. R. C. Bosanquet will describe his excavations in Sparta, and a communication from Mr. J. L. Myres will deal with early traces of human types in the Ægean. Mr. D. G. Hogarth hopes to communicate an account of the treasures of the primitive Artemisia of Ephesus, should the interval before the meeting be sufficient to allow an examination of the objects from the site, which have only just arrived in England. Major P. M. Sykes will exhibit a collection of bronze weapons and implements from Persia, which are discussed in a communication by the Rev. Canon Greenwell. Dr. T. Ashby will read papers on the recent excavations in the Forum, and the excavations at Caerwent in 1904–6. Prof. R. S. Conway will contribute a paper on the Keltic weights found at Melandra, which throw considerable light on the subdivisions of the pre-Roman pound in Britain. Excavations on the interesting palæolithic site at Ipswich, of which accounts have on two occasions been presented to the section, have now brought to light a number of small implements which would appear to have been used as scrapers, and further evidence as to the relations of the implementiferous strata, which will be described by Miss Layard. Miss Layard also contributes an account of the excavation of an Anglo-Saxon cemetery at Ipswich, which has produced, among other objects, fibulæ of interesting types, rare in Great Britain. Mr. Rudler's paper on the "Red Hills" of the east coast salt-marshes will describe the low mounds of burnt earth of frequent occurrence on the estuarial marshes of Essex, which it is now proposed to examine systematically.

SECTION I (PHYSIOLOGY).—*August* 2: Address by the president, Prof. Gotch; Report of committee on The metabolic balance sheet of the tissues; Papers on physiology. *August* 3: The nitrification of sewage, Dr. George Reid; Papers on hygiene; Report of the committee for the investigation of the effect of climate upon health. *August* 5: Discussion on the physiological value of rest, opened by Dr. T. D. Acland. Dr. Rivers, Dr. Myers, Prof. McDougall are expected to take part. Papers on the special senses, psychology and electrophysiology. Dr. Bevan Lewis and Dr. Smith will give a demonstration on improved methods of studying the central nervous system, and a paper on the pericellular plexus and neuro fibrils of the cerebral cortex. *August* 6: Joint discussion with Section B (Chemistry) on the factors which determine minimum diet values, opened by Dr. F. Gowland Hopkins. This, of course, has special interest, as much sociological work has been done in York by Mr. B. Seebohm Rowntree on the limits of diet. Prof. Armstrong and other members of the chemical section will take part. Papers on pathology. *August* 7: General papers.

SECTION K (BOTANY).—At least three of the sessions of this section will be devoted to special topics of current interest, the proceedings in each opening with a general paper or address dealing with the topic as a whole, followed by more special papers and a general discussion. The three topics chosen for the present meeting are as follows:—(1) Some aspects of the present position of Palæozoic botany will be dealt with by Dr. D. H. Scott, F.R.S., and the conditions of growth of Carboniferous plants by Prof. F. E. Weiss, Miss M. C. Stopes, and others. (2) The nature of fertilisation and kindred problems, at a joint session with Section D (Zoology). Mr. V. H. Blackman will open the proceedings with a general address setting forth the present position of the subject. Prof. Farmer, F.R.S., is expected to contribute a paper on the cytological features of apospory, and Mr. Doncaster one on some cytological features of animal parthenogenesis. Several eminent foreign botanists, distinguished for their work on kindred topics, have promised to be present, among them being Prof. Tschermak, of Vienna, Prof. Johannsen and Dr. Ostenfeld, of Copenhagen, Dr. Rosenberg, of Stockholm, and Dr. Lotsy, of Leyden. (3) The phylogenetic value of the vascular system of seedlings. Mr. A. G. Tansley and Miss E. N. Thomas will open the proceedings, while Prof. Jeffrey, of Harvard, Messrs. A. W. Hill, T. G. Hill, and Miss Ethel Sargant are expected to contribute by papers or otherwise to the discussion.

Dr. T. W. Woodhead, who has been spending the last year at Zurich with Prof. Schröter, will communicate a paper on ecological work in Switzerland, Mr. C. E. Moss will give an account of survey work and mapping in Somersetshire, while Dr. Fritsch and Mr. Walker will contribute papers on algal ecology. Prof. Wyndham Dunstan, F.R.S., is expected to give a general account of his work on hydrocyanic acid in metabolism, but it is not yet certain whether this will be presented to the botanical or to the chemical section. Among other papers may be mentioned Prof. H. H. W. Pearson's on the habitats and habits of S. African cycads, communicated by Mr. A. C. Seward, F.R.S., and Mr. Hugh Richardson's on the vegetation of Teneriffe. It is hoped that Dr. Blakeslee may be able to be present and give an account of his work on sexual differentiation in the Mucorineæ, and also of his important recent discoveries of sexual differentiation in the spores of Marchantia.

SECTION L (EDUCATIONAL SCIENCE).—*August* 2: Presidential address, Prof. Michael E. Sadler; Report on health in schools, Prof. Sherrington; Medical inspection of schools and colleges, Sir Lauder Brunton, Sir Henry Craik; Physical training, Dr. Ethel Williams, Major Norman; The education of workpeople, Hugh O. Meredith. *August* 3: Curriculum of primary schools and the training of teachers in such schools; Report of committee on the courses of practical, experimental, and observational studies most suitable to elementary schools: general principles, Sir Philip Magnus, M.P., subcommittee report on arithmetic and mensuration, Prof. R. A. Gregory, subcommittee report on nature-study, Hugh Richardson. Contributions to the discussion will be made by Principal Burrell, T. S. Dymond, Prof. Green, J. C. Hudson. Training for the home duties of women. Report of subcommittee on Domestic studies, Geo. Fletcher. The following will contribute to the discussion:—Miss Mary E. Marsden, Prof. A. Smithells, Miss Maud Taylor, Prof. H. E. Armstrong, Mrs. Margaret Pillow, B. S. Rowntree, Mrs Marvin, Miss Romley Wright. *August* 6: The balance of subjects in the curriculum of the secondary school and the training of teachers for such schools, T. E. Page, Hon. and Rev. E. Lyttelton, Rev. E. C. Owen, Arthur Rowntree (Leisure pursuits), Gidley Robinson (Preparatory schools), C. M. Stuart, J. H. Leonard, Miss E. E. C. Tomes (Training), Prof. Raymont (Training); The uncertainty of educational values in the absence of scientific experiment, Dr. E. P. Culverwell; The demonstration school as a field for scientific research in school teaching, Prof. J. J. Findlay. *August* 7: Inspection and examination of schools, C. M. Stuart, J. L. Holland, Geo. Fletcher, and others; The teaching of modern languages, Prof. Wyld, Prof. Robertson; Experiments and results in elementary modern language teaching conducted since 1892, Prof. J. J. Findlay; (joint meeting with Sections A and G) The teaching of mechanics by experiment, C. E. Ashford.

NOTES.

THE death of Prof. Drude by his own hand at the early age of forty-three is a serious loss to physical science. Born at Brunswick in 1863, he made his mark first as a pupil of Voigt at Göttingen, and his series of papers in which he applied the electromagnetic theory of Maxwell, as developed by Herz, to the problems of light, stamped him as a physicist of the first rank. These appeared in *Wiedemann's Annalen* in the years 1896–9, and as more fully developed in the author's "Physics of the Ether" and his text-book of optics, have received recognition in these columns. Among them may be specially noted his theory of the magneto-optic phenomena of iron, nickel, and cobalt, 1897; the theory of anomalous dispersion, 1898; and of electric dispersion, 1899. Drude was also an experimenter, and was able to devise and carry out critical experiments to test, where necessary, fundamental points of his theory. In 1900 he succeeded Wiedemann as editor of the *Annalen der Physik*, and under his capable guidance that well-known journal has fully maintained its reputation, while only last year he was called to Berlin as professor of physics in succession to Warburg, now president of the Reichsanstalt. The physics school of the University of Berlin has suffered severely in recent years, and the loss of the brilliant physicist who had so recently joined them will be deeply felt by his friends and colleagues.

THE report on the civil hospitals and dispensaries in the United Provinces states, says the *Pioneer Mail*, that five cases of snake-bite have been successfully treated at Gorakhpur with Dr. Calmette's anti-venene and permanganate of potash. They seemed bad cases, and almost immediately recovered after the injection of the serum. Twenty-two cases were also treated in the Banda district, and in twenty-one cases the treatment was successful.

THE death of M. Edouard Piette in his eightieth year removes from the ranks of French anthropologists a tireless investigator. He began to write on prehistoric questions as long ago as 1869, and contributed numerous articles to periodicals, among which may be mentioned a supplement to *L'Anthropologie*, entitled "Les Galets coloriés du Mas d'Azil," splendidly illustrated in colours. Another work was entitled "Les Tertres funéraires d'Avezac-Prat"; but a great part of his material remains unpublished, though some of the plates illustrative of it were exhibited at the Trocadéro some years ago. He formed a magnificent collection of stone, bone, and early iron objects from Brassempouy, Mas d'Azil, and other places, and presented it about four years ago to the Museum of Saint-Germain, where it is arranged in stratigraphic order. He was an honorary fellow of many learned societies, but, his generous benefaction notwithstanding, he was neither a member of the Institute nor the recipient of a decoration.

THE death of the Rev. J. F. Blake will be felt by many British geologists as a personal loss. Prof. Blake was born in 1839. He was educated at Christ's Hospital and Caius College, Cambridge, where he was senior scholar. In the natural science tripos of 1862 he took a second class, and he was fifteenth wrangler. Following the profession of his father, the Rev. Robert P. Blake, he entered the Church, and held curacies at Lenton, near Nottingham, and at St. Mary's, Bryanston Square. Afterwards he went as mathematical master to St. Peter's School, York, a post he occupied for nine years. From 1876 to 1880 he was lecturer at Charing Cross Hospital on comparative anatomy. From 1880 to 1888 he held the chair of natural science at University College, Nottingham. In 1895 he went out to India to arrange the Baroda Museum. Prof. Blake was an active Fellow of the Geological Society of London, and in 1891-2 he was president of the Geologists' Association. His contributions to geological literature cover a wide field, but the ground he made particularly his own was the Jurassic of England. Many of his papers will be found in the Journal of the Geological Society, in the Palæontological Society's monographs, and elsewhere. A characteristic publication was the "Annals of British Geology," an excellent work, which doubtless failed through containing too fully the marks of Prof. Blake's strong critical capacity. His natural enthusiasm and integrity of character endeared him to all with whom he came really in contact.

MR. F. VICTOR DICKINS informs us that on August 21 the session of the Congrès préhistorique de France will open at Vannes, the curious old capital of the Morbihan, under the presidency of M. A. de Mortillet. All necessary information will be readily afforded by the general secretary, Dr. Marcel Baudouin, Paris, rue Linné 21. The subscription and cost of excursions are extremely moderate, and for ten francs a day, all comprised, the very best accommodation is procurable at Vannes. The session will close on August 26; and arrangements are made for a reduction of the fares on the French railways.

THE *Daily Chronicle* of July 6 publishes a Reuter telegram of the previous day from Rome announcing that the Duke of the Abruzzi had telegraphed to the King of Italy that on June 16 he reached the highest point of Mount Ruwenzori. The probable position of this peak, as deduced from a combination of the best data available, may be gathered from a paper by Lieut. T. T. Behrens, R.E., in the current number of the *Geographical Journal*. Lieut. Behrens makes use of (1) trigonometrical determinations of two tops of a summit; (2) trigonometrical rays to four other summits; (3) eight perspective views from sketches and photographs, with some magnetic bearings; (4) a map compiled from all available sources up to 1901, chiefly based on Dr. Stuhlmann's traverse and astronomical observations; and (5) information just received from Mr. A. F. R. Wollaston, a member of the zoological expedition sent out under the auspices of the Natural History Museum, who with two other members of the expedition made a number of ascents in this range during April last.

THE Country in Town Exhibition, which was opened by Princess Christian on July 5 in the Whitechapel Art Gallery, has proved in every way as successful as its promoters could have wished. The chief objects of the exhibition are to show how many interesting remnants of the country and its denizens there still remain in London, to suggest how much of the country can be brought back to town, and to indicate those places near the metropolis (which can be reached at trifling cost) where the beauties of nature can easily be enjoyed. In connection with the exhibition, a series of lectures was arranged, the first being given by Mr. Richard Kearton, on Nature at work and play. Dr. Henry, in dealing with the question of tree planting in London, showed that it was the way the trees were treated rather than the injury caused by the atmosphere which prevented them from growing. Mr. T. S. Dymond gave many useful hints in connection with the soil of London, Sir John Cockburn outlined the way in which Australian cities have been beautified by tree planting, Mr. Herrod dealt with bees, and Mrs. Dukinfield Scott showed her animated photographs of plants. The chairman of the executive committee is Mr. J. C. Medd, and the honorary secretary is Mr. Wilfred Mark Webb.

FROM a resolution published in the *Pioneer Mail* (June 15) it appears that the Government of India has had under consideration the desirability of making better provision for scientific research in connection with Indian forests. In order to provide a staff of experts who will be in a position to devote a large proportion of their time to the prosecution of scientific research connected with forest produce, as well as to give the best available training to candidates for the forest services, both of British India and of native States, the Indian Government has, with the sanction of the Secretary of State, decided to raise the status of the existing Imperial Forest School at Dehra Dun, and to add to its staff. The school will now be known as the Imperial Forest Research Institute and College, and the staff will include six officers of the Imperial Service holding the following posts:—(1) An Imperial sylviculturist, who will make sylviculture his special study. (2) An Imperial superintendent of forest working plans, who will collect and collate statistics of the results of forest management throughout India. (3) An Imperial forest zoologist, whose chief duty will be to investigate the damage caused by insects and other pests, and to suggest remedial measures. (4) An Imperial forest botanist, who will study the botany of forest plants, diseases of trees, and distribution of species. (5) An Imperial forest chemist, who will investigate the chemical properties of soils and of the produce of the forests. (6) An Imperial forest economist, who will make a special study of the best methods of rendering forest produce of all kinds available at the smallest cost to consumers, and will keep in touch with the commerce of India with the view of fostering and meeting the demand for forest products.

Communication by wireless telegraphy has just been established between the Australian continent and Tasmania by the Marconi system.

The foundation stone of the German Museum "für Meisterwerke der Technik" is to be laid in Munich about the middle of November, in the presence of the Emperor of Germany.

The Magdeburg civic authorities have decided to pay for the erection of a laboratory for the examination of food materials in connection with the new State bacteriological laboratory which is shortly to be built.

The income of the jubilee fund founded in Heidelberg in 1886, and to be awarded to teachers in the university in recognition of their scientific work, has been divided between Prof. Fr. Pockels, professor of physics, and Prof. A. Klages, professor of chemistry, to enable the latter to continue his investigations on optically active benzoyl derivatives.

Prof. K. Seubert has retired from the International Atomic Weights Subcommittee on account of over-pressure of work. His place will be taken by Prof. W. Ostwald, so that the subcommittee will now consist of Profs. T. E. Thorpe, H. Moissan, W. Ostwald, and F. W. Clarke, president.

A standing exhibition committee is to be formed in Berlin by the Zentralverband deutscher Industrieller, acting in conjunction with the Zentralstelle für Vorbereitung von Handelsverträgen and with the Bund der Industrieller. The duties of this committee will be to collect information with regard to all exhibitions of importance and to deal with questions affecting the interests of German exhibitors, both at home and abroad.

A legacy of 360,000 francs has been left to the French Academy of Sciences and a few other institutes under the will of the late Baron de Rey. To the Academy itself is bequeathed the sum of 150,000 francs, from the interest on which there is to be offered quinquennially a prize of 20,000 francs to the French investigators who, in the opinion of the Academy, have best contributed to the progress of physical science.

Pupils and friends of the late Prof. August Kekulé, who died in 1896, have handed over to the University of Bonn a sum of 31,500 marks, the yearly interest on which is to be given to a young investigator of the exact sciences, more especially chemistry and physics, on July 13 of each year, the anniversary of Kekulé's death. The first payment is to be made after the relatives of the deceased chemist have no further claim on the income of the fund as arranged.

The Deutscher Verein für öffentliche Gesundheitspflege will hold the annual general meeting this year on September 12 to 15 in Augsburg immediately before the beginning of the meeting of the Deutsche Naturforscher und Aerzte in Stuttgart which begins on September 16. The subjects to be proposed for discussion include:—(1) Precautions against hydrophobia, (2) the milk supplies of towns, with special reference to the milk supplies of young children, (3) invalid homes, (4) the dust plague in the house and on the streets, (5) the hygiene of small houses.

In No. 55 of the *Chemiker Zeitung* will be found some interesting details of the imports and exports of Germany for the year 1905; the estimated total value of the former is given as nearly 7500 million marks, and that of the latter as nearly 6000 million marks. Of these, 430 million marks are imported chemicals, including both raw and manufactured substances, and 473 million exported raw and manufactured chemicals; it is noteworthy that the imported raw stuffs for the chemical industries is put down at nearly 300 million marks in value, and the exported at 57 million.

With the view of cultivating an intelligent interest in meteorological science, the council of the Royal Meteorological Society appointed the assistant-secretary of the society, Mr. W. Marriott, last year to act in cooperation with scientific societies, institutions, and schools as a lecturer on meteorological subjects. The experiment has proved so successful that it is being continued, and a list of lectures for the coming lecture season has just been issued. Particulars can be obtained from the society, 70 Victoria Street, S.W.

An article on hybridisation and plant breeding in the July number of the *Monthly Review*, written by Mr. A. J. Bliss, affords a timely introduction to the subject that will shortly attract public notice when in the course of the month the third triennial conference on plant breeding will be held in London under the auspices of the Royal Horticultural Society. Premising that there are continuous variations and discontinuous variations, the writer proceeds to show how variations have been produced by cultivation and selection alone, as in the case of Shirley poppies, or more easily and rapidly by cross-fertilisation. To fix the type, thanks to Mendel, certain principles are being evolved for the guidance of the breeder. The elucidation of these principles and other problems will be discussed at the conference. The article concludes with some interesting details of results already obtained and future possibilities.

In their thirty-fourth annual report (for 1905) the directors of the Philadelphia Zoological Society state that they are considering a plan for lectures on animals to be given in the gardens at such times as they are most frequented by children. Special attention is directed to the valuable results attained by the introduction of a pathological laboratory. "No monkey is now placed upon exhibition unless it has successfully passed the tuberculin test, and it is hoped that by the employment of every practicable measure of prevention within the building, including prohibition of feeding by visitors, the occurrence of tuberculosis in these susceptible animals may be brought under control. A temporary result of the rigid system which has been put in practice is that the collection in the Monkey House is less complete than is usually the case. . . . Of those procured a considerable number failed to pass the tests and have not got beyond the quarantine-room."

In a paper on additions to the exhibited series of fossil vertebrates in the U.S. National Museum, published in the Proceedings (No. 1460) of that institution, Mr. C. W. Gilmore figures another specimen of a pterodactyle from Eichstatt showing the impressions of the wing-membranes, and also the skull of a new horned dinosaur of the genus Triceratops. Japanese fishes form the subject of a paper in the same serial (No. 1462) by Messrs. Jordan and Starks, while in No. 1464 the former writer reviews the sand-lances (Ammodytidæ) of Japan, and in No. 1470 he describes, in conjunction with Mr. R. C. McGregor, a new threadfin-fish of the genus Polydactylus from Japan.

Dr. Stejneger in No. 1471 describes a new tree-frog (Hyla) from Costa Rica; East African birds, by Mr. H. C. Oberholser, form the subject of No. 1469; while in No. 1472 Mr. E. S. Miller discusses mammals from Engano Island, off Sumatra. Certain American moths are described in Nos. 1463 and 1465 by Mr. A. Busck.

In a paper contributed to part iii. of vol. xxv. of Gegenbaur's *Morphologisches Jahrbuch*, Mr. J. E. V. Boas makes the startling announcement that a pleural cavity is absent in the Indian elephant. The author believes the feature to be constant, and that it will be found to hold good also for the African elephant, in which case we shall have a feature distinguishing the group from all other mammals. This paper is followed by one by Prof. G. Ruge on the shape of the thoracic cavity in the Indian elephant, and the relations thereto of the lungs. In a third paper Mr. A. Rauber contrasts the skull of Immanuel Kant with that of a member of the Neanderthal race. A striking difference between the two crania is to be found in the extreme brachycephalism of the one and the equally marked dolichocephalism of the other. If it be suggested that the shortness of the savant's skull was due to inheritance—from his ancestors in Scotland and Nürnberg—this is merely evading the main question, namely, When did the first brachycephalic man appear? It is noteworthy that if Kant's skull be plotted on the dolichocephalic lines of that of the Neanderthaler, and the Neanderthaler's cranium drawn on the brachycephalic proportions of that of Kant, the normals from a line connecting the "ophrion" with the "basion" will be very nearly the same in both cases.

The *Bio-Chemical Journal* for June (i., Nos. 6 and 7) contains several interesting papers. Prof. Moore and Messrs. Alexander, Kelly, and Roaf show that the secretion of gastric hydrochloric acid is very sensitive to any variation in general health of the body, any enfeeblement leading to decreased percentage of the acid. This reduction in acid-secreting power is much more marked in cancer than in any other condition. Prof. Moore and Mr. Wilson contribute a paper on a clinical method of hæmalkalimetry which seems to be a distinct advance on previous ones.

The longevity of *Bacillus typhosus* in natural waters and in sewage forms the subject of an important paper by Messrs. H. L. Russell and C. A. Fuller (*Journ. of Infectious Diseases*, Supp. No. 2, February, p. 40). Permeable sacs of celloidin, parchment, and agar were employed to imprison the typhoid organisms while exposed to the influence of water and sewage bacteria. When *B. typhosus* was exposed to the action of flowing lake water (Mendota), the longevity of the organism ranged from eight to ten days; when exposed directly to the action of sewage bacteria, its longevity was reduced to three to five days.

In Bulletin No. 104 of the Agricultural Experiment Station, Morgantown, West Virginia, Mr. J. L. Sheldon writes on the ripe rot or mummy disease of guavas, ascribed to the fungus *Glomerella psidii*. Brown spots appear on the ripening fruits causing them to shrivel, whence the term mummy disease; if not identical with the bitter rot of apples it is very similar, and it was found possible to inoculate apples with the fungus. Delacroix assigned the fungus to the genus Glœosperium, but on account of the ascigerous stage observed by Mr. Sheldon he refers it to the genus Glomerella.

Experiments on the tapping and preparation of rubber from Castilloa trees are in a less advanced stage than experiments with *Hevea latex*. As Castilloa promises to be more suitable for cultivation than Hevea in parts of the West Indies, considerable interest attaches to the preliminary results outlined in the West Indian Bulletin (vol. vii., part i.) by Mr. J. C. Moore for St. Lucia and Mr. J. Jones for Dominica. A variation in the semi-circumferential method of tapping is described, where, instead of a continuous cut, a series of incisions are made with a chisel. Castilloa is found to thrive on land suited to cacao, and may be grown on a shade tree for cacao; it possesses the further advantage of being able to withstand severe storms.

It is interesting to note how the trade of each of the West Indian Islands possesses its own special features. Dr. F. Watts reviews the changes that have occurred in the agricultural industries of Montserrat in the West Indian Bulletin, vol. vii., No. 1, of which the most prominent facts are the decadence of the sugar industry and the marked fluctuations in the production of lime and lime-juice. The raising of cattle and stock for export shows a steady increase, and a *papain* industry has been developed, which, however, is threatened by competitive production in the East. Cotton is regarded by Dr. Watts as the most hopeful industry for the future, but the peasant population has not, so far, taken to the cultivation. In the course of another article, Dr. Watts outlines the development of the cotton industry in the Leeward Islands since 1900, the greatest changes having been effected thereby in Nevis and Anguilla.

The completion of the Simplon Tunnel, 12¼ miles in length, at a cost of 3,100,000*l*., and at an average rate of two miles a year, has induced Mr. Lewis M. Haupt to publish in the Journal of the Franklin Institute (vol. clxi., No. 6) some comparative notes on other great tunnels. The Hoosac Tunnel, Massachusetts, five miles in length, was begun in 1854 and completed in 1876, with an average progress of 5·5 feet per day. The Mont Cenis Tunnel, eight miles in length, was begun in 1857 and completed in 1871, with an average progress of 8 feet per day. The Sutro Tunnel, Nevada, four miles in length, was begun in 1869 and completed in 1878, with an average progress of 10·24 feet per day. The St. Gothard Tunnel (1872–1881), 9¼ miles in length, was driven at the rate of 14·6 feet per day. The Arlberg Tunnel (1880–1884), 6·38 miles in length, was driven at the rate of 27·8 feet per day.

The third number of *Concrete and Constructional Engineering* (July) shows a marked improvement on the previous issues. The principal articles deal with reinforced concrete in France, reinforced concrete bridges, steel and concrete buildings in Scotland, reinforced concrete water mains, the theory of reinforced concrete, and hollow concrete blocks. The illustrations are excellent, and the articles are written by recognised authorities. An editorial note deals with the need for international standards in respect to reinforced concrete, and suggests that the International Association for Testing Materials should form a committee to collect international data. There is also a portrait and obituary notice of the octogenarian Joseph Monier, who died in Paris on March 13 last, almost unknown, almost forgotten, and in unfortunate circumstances, yet credit will always be due to him as the inventor of reinforced concrete.

The blackening of rocks in rivers has of late received some attention from geologists. Mr. A. Lucas, chief chemist to the Geological Survey in Cairo, sends us a paper on the blackened rocks of the Nile Cataract (National

Printing Department, Cairo, 1905; for the Ministry of Finance). The dark outer film is similar to that well recognised as a characteristic of stones in deserts. The desert-film has been examined separately, and Mr. Lucas agrees with Walther that "the colour is much the darker the more the silica content of the rock." "The depth of colour is dependent upon the amount of black oxide of manganese in the film, and this is conditioned first by the manganese content of the rock, and secondly by the opportunities presented for the manganese salts to be brought to the surface and oxidised." "A hot climate and a small rainfall are necessary to the formation and preservation of the film." In regard to the river-film, it is noted that certain incised stones at the First Cataract are equally black on their surface and in the hollows of the inscriptions. Silica is one of the minor constituents of the river-film, but is absent from the desert-film. Mr. Lucas, after discussing previous literature and his own analyses, concludes that the river-film arises from material in the rocks themselves, as in the case of the analogous desert-film. Dr. W. F. Hume contributes a description of the microscopic characters of the rocks examined, with the general result that no connection can be established between the surface-film and any special decomposition in the outer layers.

The June number of the *National Geographic Magazine* contains an account of a visit to Vesuvius after the eruption of April 8. The account is illustrated by a number of reproductions from photographs, of which we reproduce one showing the aspect of the cone after the eruption. The scoring of the slope of the cone is due to slipping of the loose ashes, not to stream action.

Fig. 1.—The new cone of Vesuvius from the road to the observatory, covered with white volcanic ash. From the *National Geographic Magazine*.

The current number of the *Home Counties Magazine* contains an interesting article on old pewter by Mr. H. M. Cooke. In a broad sense pewter is composed of tin alloyed in varying quantities with antimony and copper; lead, bismuth, and zinc are sometimes also employed. The variety and constant change of colour are due to the difference of alloys and to atmospheric influence. The colour is in some measure dependent on the surface being good. As a domestic article, pewter succeeded wood, and was used almost universally until earthenware became cheap. It did not come into general domestic use until the seventeenth century. On account of its fusibility pewter was used by goldsmiths to take castings of certain articles. Benvenuto Cellini is said to have used it for this purpose in connection with his work. It appears from Mr. Cooke's article that dealers nowadays, to enhance the value of their wares, often point to the small marks in shields of a lion rampant or a leopard's head crowned, and describe articles bearing these as "silver pewter." But such marks indicate no special value in the metal, and except for the infinitesimal quantity that there may be in the lead employed, it is safe to assume that old pewter contains no silver.

In a paper on the rapid measurement of geodesical bases published in part i. of the Bulletin of the French Physical Society, Dr. C. E. Guillaume gives details of the construction and use of the standards and measuring wires referred to in his article on invar (Nature, vol. lxxi., p. 138). An account is given, in particular, of the rapid, direct measurement of base lines by means of stretched wires of invariable length. This process is extremely rapid as compared with older methods; in good country, ten or twelve men can measure up 5 to 6 kilometres per day, whereas with a bimetallic scale fifty men are required, and the distance covered per day does not exceed 400 metres. Formerly the number of bases directly measured was kept as small as possible, nearly all the values being obtained by triangulation. The use of these measuring wires of invariable length affords a means of controlling the older data, and will change the character of future surveys by increasing the number of direct data at the expense of those obtained by triangulation.

The third volume of the contributions from the Jefferson Physical Laboratory of Harvard University for the year 1905 has been received. The previous volumes were described at some length in Nature for March 1 last (vol. lxxiii., p. 427). The results of the investigations published in the present volume were obtained largely by the aid of the Thomas Jefferson Coolidge fund for original research. Nine of the twelve papers have already appeared in the Proceedings of the American Academy, and most of the contributions have been dealt with already in notes published in these columns.

The *Electrician* Printing and Publishing Company, Ltd., is issuing a new series of *Electrician* primers at 3*d*. each, post free. A complete list of the primers will be sent on application. From an examination of specimens dealing with thermopiles, Röntgen rays and radiography, influence machines, the induction coil, the magnetic properties of iron and electrical units, it is clear that the series will prove of service to technical students.

The *édition de luxe* of the Great Eastern Railway Company's handbook, "Summer Holidays," by Mr. Percy Lindley, is provided with an excellent series of facsimiles of water-colour drawings of places of interest in the eastern counties. In addition to the illustrations in colour, the pen and ink drawings, the letterpress, the list of golf links, and other information provided, combine to make the publication a useful holiday guide.

OUR ASTRONOMICAL COLUMN.

REDISCOVERY OF FINLAY'S COMET (1906*d*).—A telegram from the Kiel Centralstelle announces the rediscovery of Finlay's comet by Herr Kopf on July 16. The position of the comet at 13h. 14·4m. (Königstuhl M.T.) on that date was :—

R.A. = 23h. 38·3m., dec. = 14° 3′ S.

The object is stated to be a bright one. Subjoined is an extract from the approximate ephemeris published by Herr Schulhof in No. 4100 of the *Astronomische Nachrichten* :—

12h. M.T. Paris.

1906	α (true) h. m.	δ (true) ° ′	log Δ
July 16	23 44	−13 7	9·5443
18	23 57	−12 10	9·5254
20	0 11	−11 6	9·5073
22	0 25	− 9 56	9·4902
24	0 40	− 8 40	9·4744
26	0 56	− 7 17	9·4602
28	1 13	− 5 47	9·4478
30	1 30	− 4 12	9·4376
Aug. 1	1 47	− 2 33	9·4299

A comparison of the observed and computed places on July 16 will give an approximate value for the corrections to be applied to the ephemeris positions. When rediscovered, the comet was about one degree north of ω Aquarii; at present (July 19) it is presumably about five degrees north of 2 Ceti, and is travelling in a north-easterly direction, so that it now rises above the south-east horizon at about 11.30 p.m.

THE ORBIT OF CASTOR.—An interesting paper on the quadruple system of Castor, by Dr. H. D. Curtis, appears in No. 5, vol. xxiii., of the *Astrophysical Journal.*

The discussion is based on the results obtained from a number of spectrograms, of each of the two double systems, taken with the Mills spectrograph at the Lick Observatory. For the fainter component, α_1, of the visual system, the final elements deduced give the period as 2·928285 days, the eccentricity as $0·01 \pm 0·0066$, and the velocity of the system as $-0·98 \pm 0·15$ km. The comparison of these elements with the observational results shows a satisfactory agreement. Reducing the observational results for the brighter component, α_2, Dr. Curtis obtained a final set of elements which give the period as 9·218826 days, the eccentricity as $0·5033 \pm 0·0112$, and the velocity of the system as $+6·20 \pm 0·17$ km.

Combining these results with those obtained for the visual system, it should become possible to obtain values for the parallax, masses, and other physical constants of this remarkable quadruple system, but the visual results, as shown in a table given by Dr. Curtis, are as yet so indeterminate that any values so obtained could not be looked upon as being in any way final. The relative velocity of the two components as derived from Dr. Curtis's discussion is $7·14 \pm 0·23$ km., and, taking Prof. Doberck's period of 347 years for the visual system, this would indicate a parallax of 0″·05. On a similar assumption the semi-major axes of the two systems are as follow :—

α_1 Geminorum, $a = 1,435,000$ km.
α_2 ,, $a = 1,667,000$,,

Although these results are mere hypotheses, they give some idea of the magnitude of each system, and show that they are probably of about the same dimensions.

PLANETS AND PLANETARY OBSERVATIONS.—In the first of a series of articles on "Planets and Planetary Observation" which he is contributing to the *Observatory*, Mr. Denning discusses the general problems to be attacked and also the instrumental equipment necessary for the work. After discussing the relative merits of refractors and reflectors, he points out that no amateur observer should be discouraged because he possesses only a relatively small instrument, and states that none of the largest telescopes yet employed in this branch of astronomy shows anything beyond what is readily distinguishable in an 8-inch glass.

THE SANITARY CONGRESS AT BRISTOL.

THE twenty-third Congress of the Royal Sanitary Institute was held at Bristol during the week ending July 14. Sir Edward Fry presided. The proceedings of the congress comprised the usual general meetings; meetings in three sections, (1) sanitary science and preventive medicine, (2) engineering and architecture, (3) physics, chemistry, and biology; and meetings of conferences of various classes of persons interested in sanitary science. This year there were conferences of municipal representatives, under the presidency of Councillor Colston Wintle, chairman of the health committee of the City of Bristol, who took a prominent part in the proceedings of the congress; of medical officers of health, under Dr. D. S. Davies, medical officer of health, Bristol; of engineers and surveyors to county and other sanitary authorities, under Mr. H. Percy Boulnois, of the Local Government Board; of veterinary inspectors, under Mr. Frank Leigh; of sanitary inspectors, under Mr. A. E. Hudson, chief sanitary inspector, Cheltenham; of women on hygiene, under Miss Mary Clifford, in the absence of the Duchess of Beaufort; and also a conference on the hygiene of school life, under the presidency of the Bishop of Hereford.

In the presidential address to the congress on Monday, July 9, Sir Edward Fry dealt clearly and concisely with the general history of sanitary works and the regulation of public health. After pointing out the increase of duties and responsibilities which had devolved upon the heads of modern households and upon local authorities in consequence of the recent developments of sanitary science, he referred in turn to the sanitary ordinances of the Greeks, the Jews, and the Romans up to the disappearance of all thought of sanitary science in the ruin of the Western Empire. Finally, he referred to the legislation on the subject in Great Britain since the middle of last century.

Sir W. J. Collins, president of Section I., sanitary science and preventive medicine, was detained in London by urgent parliamentary duties, and the address was read by Dr. Shingleton Smith. It protested against the too exclusive consideration of bacteriology, and appealed for greater attention to be paid to the soil in which bacteria are implanted, and upon which they depend for their development. In Section II., engineering and architecture, the president, Mr. Edwin T. Hall, referred to a number of points in which the architect could assist the promotion of sanitation by the design of buildings. Dr. W. N. Shaw, president of Section III., physics, chemistry, and biology, took for his subject climate and health. After referring to the work of Sir Arthur Mitchell, Dr. Buchan, and Dr. Longstaff, he indicated the climatological material available for the study of questions upon the relation of health to climate, and discussed the methods of using it. In the course of the address he showed a meteorological section of the British Isles from north to south, Sumburgh Head to Hastings, and another from west to east, Valencia to Margate. He also exhibited some interesting diagrams of the average diurnal variation of relative humidity for certain selected months at four observatories in the United Kingdom, and some autographic records of the same element at Cambridge, showing remarkable fluctuations of humidity within the period of twenty-four hours.

The subjects of the addresses at the various conferences and of the papers and discussions were for the most part of a technical character. Questions concerning milk supply and its regulation were raised in Section I. by Dr. J. Fortescue-Brickdale and by Mrs. C. Hamer Jackson, at the conference of medical officers of health by Prof. H. Kenwood, and at the conference of veterinary inspectors by Dr. W. G. Savage and by Mr. J. S. Lloyd. The question of dust, particularly of motor dust, also came up in various forms. In the conference of engineers it was raised by a paper by Mr. A. P. I. Cotterell, and in Section III. the influence of dust on health was a subject of discussion opened by Dr. P. Boobbyer. Of the suggestions made for dealing with the question, some of them could only be called fantastic. The discussion of various aspects of the bacterial treatment of sewage also found a place in several sections or conferences. The necessity for the extension of employment of women as health visitors or in other ways in connection with the carrying out of provisions for public health also appeared on more than one occasion.

Subjects to be treated from the more specially scientific standpoint fall, as a rule, to Section I., sanitary science and preventive medicine, or to Section III., physics, chemistry, and biology. In the former, Fleet-Surgeon Bassett-Smith suggested various ways in which disease might be disseminated in a paper on present knowledge of the etiology of Mediterranean fever, with special reference to the Royal Navy. The other papers were by Dr. R. S. Marsden, on scarlatina and certain other diseases in relation to temperature and rainfall; by Dr. J. Fletcher, on post-scarlatina diphtheria and its prevention; and by Dr. F. T. Bond, on some points of interest in the treatment of outbreaks of diphtheria. In Section III., besides the discussion on the influence of dust, may be mentioned a paper by Prof. M. Travers, F.R.S., on the absorption of gases in solids, which showed how, following the analogy of the absorption of carbonic anhydride by carbon, the absorption of water vapour by wool and by cotton varied with the pressure of the vapour up to saturation point, and also how the absorption of water vapour by cotton at the same pressure diminished with increase of temperature.

Mr. J. H. Johnston described some experiments upon the determination of the amount of organic colloids in sewage and their partial removal by surface action. Mr. J. W. Lovibond sought for a more precise chemical definition of "pure beer," and indicated the use of his tintometer to identify the quality of beers. Dr. Rideal described the effect of copper sulphate in preventing the growth of algæ in water supplies, and proposed the use of electrolytic chlorine for the purpose. The other papers were of a technical character.

In an evening lecture Prof. Lloyd Morgan set forth very clearly the distinction to be drawn between the deterioration of the individuals composing a race and the degeneration of the stock, and dealt with the bearing of the theory of evolution upon the question of degeneration. A popular evening lecture was also given by Baillie Anderson, of Glasgow, on the wastage of human life.

Ample provision was made for the entertainment of those attending the congress by visits to works and institutions in the neighbourhood, as well as by garden-parties or excursions to the numerous places of interest in the district. The excellence of the arrangements and the smoothness of the working were effective testimony to the admirable organisation of the congress as carried out by a local committee with Councillor Colston Wintle as chairman and Mr. T. J. Moss-Flower as secretary, in conjunction with the officers of the Sanitary Institute, of whom Colonel Lane Notter is chairman of council, Mr. W. Whittaker, F.R.S., chairman of the congress committee, and Mr. E. White-Wallis secretary.

MIGRATIONS INTO NEARER AND FURTHER INDIA.[1]

IT was philologists who first borrowed the name "Dravidian" from Sanskrit and applied it to a well-known family of languages, mostly spoken in southern India, but of which an interesting member, Brâhûi, is found far to the north-west, in Baluchistan. In the hills of Central India, to the north of the main Dravidian group, there is another and totally distinct family of languages which philologists call "Mundâ."

It happens that the speakers of the south-Indian Dravidian languages and the speakers of Mundâ languages possess a common ethnic type—nose thick and broad, low facial angle, thick lips, wide, fleshy face, low stature, figure squat and sturdy, skin dark, and so on. This ethnic type ethnologists have called "Dravidian," an unfortunate piece of nomenclature, for (1) if language can ever be taken as a criterion of race, speakers of Mundâ languages are certainly different in racial origin from the speakers of Dravidian, and (2) *some* speakers of Dravidian languages, the Brâhûîs, do not possess the so-called Dravidian ethnic type, but possess that of the Iranians. At any rate, if we put the Brâhûis out of consideration for the present, it is better to name the ethnic type "Mundâ-Dravidian," *i.e.* the type common to the people known as Mundâs and to the people known as "South-Indian Dravidians." The type is almost certainly a mixed one. Judging from the fact that all Mundâs possess it, and that it is not possessed by all Dravidians (witness the Brâhûis), the probability is that the Mundâ-Dravidian ethnic type belongs mainly to the Mundâs, and has been acquired through intermarriage by Dravidians originally endowed with a less persistent type.

When the Aryans entered India they found it inhabited by people of the Mundâ-Dravidian type. The Aryans were the more highly civilised, but as they migrated further and further into the country they intermarried with the people, and themselves commenced to acquire their physical characteristics while they retained their own language and customs, which they in turn imposed upon the Mundâ-Dravidas with whom they came in contact. We see traces of the same interchange occurring even at the present day between the Dravidians and the Mundâs. The Nahâls of the Mahâdêo Hills were once a Mundâ tribe. They came into contact with the relatively more civilised Dravidians, and adopted a mixed speech in which Dravidian predominated. Nowadays this tribe is coming under Aryan influence, and is adopting an Aryan language.

It is impossible to say whether the Mundâs or the Dravidians, or both, were aborigines of India or not. Assuming that the Dravidians were immigrants, the probability is that they entered the country from the south, and not from the north-west, as was maintained by Caldwell and others. Relationship has been alleged, with some appearance of truth, between the Dravidian languages and those of New Guinea and Australia. This subject has not yet been thoroughly gone into, and is at present under examination, but the above seems to be the conclusion which will most probably be reached.

As for the Mundâs, if they were immigrants, they must certainly have entered India proper from the north-east. Pater Schmidt, of Vienna, who attacked the question from without, and the Linguistic Survey of India, which has approached it from within, have arrived at the same result. There was once a race spread widely over Further India of which we find remains amongst the forest tribes of Malacca, in Pegu and Indo-China, and along the Mé-kong and Middle Salwin. The languages which they speak are members of what is known as the Môn-Khmêr family. Forms of speech closely connected with Môn-Khmêr are Nicobarese, Khasi (spoken in the central hills of Assam), and the various Mundâ tongues of India proper. That there is an ultimate connection between these widely separated languages must now be taken as firmly established by the latest researches of comparative philology. The matter admits of no further doubt. But this is not the limit of the discoveries. The languages of the Himalaya are, it is well known, Tibeto-Burman in character. Nevertheless, there are dialects spoken on the southern slope of these mountains, from Kanâwar in the Punjab almost to Darjeeling, which have a basis similar to this old Mundâ-Nicobar-Môn-Khmêr-Khasi language, that has been, so to speak, overwhelmed, but not entirely hidden, by a layer of Tibeto-Burman. Then, on the other side, Pater Schmidt has shown an intimate connection between Môn-Khmêr and the languages of the south-eastern Pacific, so that there is evidence to show the existence in very early times of a people and a group of speeches extending from the Punjab right across northern India and Assam down to the extreme south of Further India and Indo-China, and thence across Indonesia, Melanesia, and Polynesia up to Easter Island, which is not so very far from the coast of South America.

In India, Nearer and Further, the fate of these speeches has been the same. In Nearer India the Mundâ languages, which were certainly once spoken in the northern plains, have been driven to the hills by Dravidians or Aryans. In Assam and Burmah the Khasis and Môn-Khmêrs have been either driven to the hills, where they survive as islands in a sea of alien tongues, or else to the coast of Pegu by the Tibeto-Burmans, and in Indo-China the Môn-Khmêrs have again been driven to the sea-board by the Tais.

[1] Extension of part of a paper on "The Languages of India and the Linguistic Survey," read before the Society of Arts on March 15 by Dr. G. A. Grierson.

The earliest seat of the Tibeto-Burmans seems to have been the head-waters of the Yang-tse-kiang. From here they migrated in successive waves along the valleys of the great rivers of eastern India, the Salwîn, the Irrawaddy, the Chindwin, and the Brahmaputra. The first three led them to Burmah, which they conquered, and where they founded a comparatively stable kingdom. Down the Brahmaputra they entered Assam, peopling the river valleys and the mountains in successive waves, failing only to occupy the Khasi Hills. Some of those who had entered Burmah settled in the Chin Hills, and, finding no room for expansion, were forced into becoming a backwash to the north, entering Assam from the south—tribe after tribe, in raid after raid—until the migration was stopped by the strong arm of British authority. Other Tibeto-Burmans went up the Brahmaputra into Tibet, which they peopled, getting as far west as Baltistan and Ladakh, and also occupying the Himalaya between Tibet and India proper. It was here that they found and partly gave their speech to the Mundâ-Môn-Khmêr tribes already mentioned.

The most recent Indo-Chinese immigration was that of the Tais. They first appear in history in Yunnan, and thence they began to occupy Upper Burmah some two thousand years ago. A great wave of immigration occurred in the sixth century A.D. Not only did they effectively conquer Upper Burmah, but they invaded Assam. They peopled the Shan States, and in the fourteenth century established themselves in the delta of the Mé-nam, driving the Môn-Khmêrs before them so as to form a Tai wedge between those of Tenasserim and those of Cambodia. This was the foundation of the Tai (or Thai) kingdom of Siam. At the present day the Tais are represented in British India by the Shans, the Khamtis, and other tribes of north Burmah and Assam.

A few words may be devoted to the latest great migration into India proper, that of the Aryans from the north-west. We cannot tell when this commenced. All that we can say is that parts of their earliest literary record, the Vêda, which was composed in the Punjab, have been considered by competent scholars to date from so far back as B.C. 2000, while others date them a thousand years later. The main line of approach was over the most western passes of the Hindu Kush, and along the valley of the Kabul River into the Punjab. Thence they spread over northern India. The entry into the Punjab was a very gradual one, extending over centuries. When the latest comers arrived they found that the language and the customs of their earliest predecessors had developed to such an extent that the former was unintelligible, and the latter were unsympathetic to them. This is reflected in the condition of the Aryan languages of India from the earliest times to the present day. There have always been two sharply differentiated groups of Indo-Aryan languages, one representing the speech of the earliest invaders, and the other that of the latest, while between the two there is a band of intermediate forms of speech which can be referred to the dialects spoken by those who were neither first nor last.

Some Aryan hordes entered the western Punjab from the Pamirs directly to the north. Most of these settled *en route* in the country round Gilgit, Kashmir, Chitral, and in Kâfiristân. Here the inhospitable character of the mountains in which they took up their abode, and their own savage nature, hindered communication with their cousins in the plains, and their customs and language developed on independent lines. The latter presents extremely archaic features. Words which were used three thousand years ago in India proper, and which have since fallen into disuse in that country, have been preserved by it almost letter for letter. These Aryans from the Pamirs have lately been identified with the Pisâchas or "Ὠμοφάγοι," who in later years became the subject of legend, and were looked upon, in the time of Sanskrit literature, as a race of demons.

RESEARCH IN TERRESTRIAL MAGNETISM.[1]

THE Department of Research in Terrestrial Magnetism of the Carnegie Institution, if we may judge from its report for 1905, does not intend to let the grass grow under its feet. The work it has on hand at present comprises, *inter alia*, an examination, partly theoretical, by Dr. Bauer into the secular variation of terrestrial magnetism, a discussion of magnetic disturbances observed during the eruption of Mont Pelée, a general study of the laws of the diurnal variation, a special investigation into magnetic storms, and a discussion of magnetic observations made during the eclipse of the sun on August 30, 1905.

In some researches the cooperation of eminent foreigners has been secured. The investigation into magnetic storms, for example, is being prosecuted under the direction of Dr. Ad. Schmidt, of Potsdam. The scheme, however, which figures most largely on the programme for the immediate future is a magnetic survey of the North Pacific Ocean. Arrangements have been made for observations in countries adjacent to it, *e.g.* China, and a wooden sailing vessel, the brig *Galilee*, has been specially adapted for work at sea. The brig, of which a general idea will be obtained from the picture here reproduced, is of about 600 tons, and carries a crew of eleven in addition to magnetic observers. The bridge shown between the masts is intended to supply a specially favourable site for magnetic observations. The vessel has already made preliminary trips which are considered satisfactory.

FIG. 1.—The *Galilee*.

The survey of the Pacific is primarily intended to furnish data for researches in which Dr. Bauer is interested, but the results should also be of immediate practical use in the improvement of charts. In addition to terrestrial magnetism, the department is providing for work in atmospheric electricity, and cooperation is intended with the new solar observatory of the Carnegie Institution, near Los Angeles, in studying the correlation between solar phenomena and terrestrial magnetism. With the financial support which the department enjoys, it may look forward to an important sphere of usefulness, especially if it concentrates its efforts, and prefers substantiality to rapidity of achievement.

There are other institutions in America, *e.g.* the Coast

[1] Report of Department of Research in Terrestrial Magnetism, by L. A. Bauer, Director. Extracted from the Fourth Year-book of the Carnegie Institution of Washington. (Washington, D.C., 1906.)

and Geodetic Survey and the Weather Bureau, the lines of research of which, existing or proposed, do not seem wholly distinct from those indicated in the programme. Even European magneticians might feel some slight uneasiness lest a department of so novel a kind, and displaying such unusual readiness to "pay the piper," might not display a corresponding proclivity to "call the tune." One can thus understand the occasion for the director's assurance that the general policy of the department is "not to supplant any existing organisation . . . but rather to supplement and to cooperate in the most effective manner."

REPORT UPON THE CALIFORNIAN EARTHQUAKE OF APRIL 18.

A PRELIMINARY report of the commission appointed by the Governor of California on April 21 to obtain information concerning the earthquake of April 18 has reached us. The commission includes Prof. A. C. Lawson, State University of California, chairman; Prof. G. K. Gilbert, U.S. Geological Survey; Prof. Fielding Reid, Johns Hopkins University; Prof. J. C. Branner, Stanford University; Profs. A. O. Leuschner and George Davidson, State University; Prof. C. Burkhalter, Chabot Observatory; and Prof. W. W. Campbell, director of the Lick Observatory.

The scope of the work of the commission in its preliminary stages embraced the questions as to the origin, position, and character of the disturbance in the earth's crust which gave rise to the Californian earthquake. Having decided upon the scope of its work, the commission appointed three subcommittees to deal respectively with isoseismals, coseismals, and the geophysics of the earthquake. The cooperation of the San Francisco branch of the American Association of Civil Engineers was secured, and the work of its members greatly simplified the collection of data.

The committee on coseismals, being concerned with the records of times at which the earthquake was felt, had to depend largely upon correspondence for information, and for times automatically registered the committee is indebted to seismologists in many countries. Numerous other observations were supplied by officers in the various public services. The committee on isoseismals has also received assistance from many sources.

Subjoined is a summary of the chief results obtained up to the present.

One of the remarkable features of the Coast Ranges of California is a line of peculiar geomorphic expression which extends obliquely across the entire width of the mountainous belt from Mendocino County to Riverside County. The peculiarity of the surface features along this line lies in the fact that they are not due, as nearly all the other features of the mountains are, to atmospheric and stream erosion of the uplifted mass which constitutes the mountains, but have been formed by a dislocation of the earth's crust, or rather a series of such dislocations, in time past, with a differential movement of the parts on either side of the plane of rupture. In general, this line follows a system of long, narrow valleys, or where it passes through wide valleys it lies close to the base of the confining hills, and these have a very straight trend; in some places, however, it passes over mountain ridges, usually, at the divide separating the ends of two valleys; it even in some cases goes over a spur or shoulder of a mountain. Along this line are very commonly found abrupt changes in the normal slope of the valley sides giving rise to what are technically known as scarps. These scarps have the appearance of low, precipitous walls, which have been usually softened and rounded somewhat by the action of the weather. Small basins or ponds, many having no outlet, and some containing saline water, are of fairly frequent occurrence, and they usually lie at the base of the small scarps. Trough-like depressions also occur, bounded on both sides by scarps. These troughs and basins can only be explained as due to an actual subsidence of the ground, to an uplift of the ground on one side or the other, or on both sides. The scarps similarly can only be ascribed to a rupture of the earth with a relative vertical displacement along the rupture plane. Frequently small knolls or sharp little ridges are found to characterise this line, and these are bounded on one side by a softened scarp and separated from the normal slope of the valley side by a line of depression. In many cases these features have been so modified and toned down by atmospheric attack that only the expert eye can recognise their abnormal character; but where their line traverses the more desert parts of the coast range, as, for example, in the Carissa Plains, they are well known to the people of the country, and the aggregate of the features is commonly referred to as the "earthquake crack."

This line, which can be traced from Point Arena to Mount Pinos, in Ventura County, has a length of 375 miles, is remarkably straight, and cuts obliquely across the entire breadth of the Coast Ranges. To the south of Mount Pinos the line either bends to the eastward, following the general curvature of the ranges, or is paralleled by a similar line offset from it *en echelon*; for similar features are reported at the Tejon Pass, and traceable thence, though less continuously, across the Mojave Desert to Cajon Pass and beyond this to San Jacinto and the south-east border of the Colorado Desert. The probability is that there are two such lines, and that the main line traced from Point Arena to Mount Pinos is continued with the same general straight trend past San Fernando and along the base of the remarkably even fault scarp at the foot of which lies Lake Elsinore. But, leaving the southern extension of the line out of consideration as somewhat debatable, we have a very remarkable physiographic line extending from Point Arena to Mount Pinos which affords every evidence of having been in past time a rift, or line of dislocation, of the earth's crust, and of recurrent differential movement along the plane of rupture. The movements which have taken place along this line extend far back into the Quaternary period, as indicated by the major, well-degraded fault scarps and their associated valleys; but they have also occurred in quite recent times, as is indicated by the minor and still undegraded scarps. Probably every movement on this line produced an earthquake, the severity of which was proportionate to the amount of movement.

The cause of these movements in general terms is that stresses are generated in the earth's crust which accumulate until they exceed the strength of the rocks composing the crust, and they find a relief in a sudden rupture. This establishes the plane of dislocation in the first instance, and in future movements the stresses have only to accumulate to the point of overcoming the friction on that plane and any cementation that may have been effected in the intervals between movements.

The earthquake of April 18 was due to one of these movements. The extent of the rift upon which the movement of that date took place is at the time of writing not fully known. It is, however, known from direct field observations that it extends certainly from the mouth of Alder Creek, near Point Arena, to the vicinity of San Juan, in San Benito County, a distance of about 185 miles. The destruction at Petrolia and Ferndale, in Humboldt County, indicates that the movement on the rift extended at least as far as Cape Mendocino, though whether the rift lies inland or off-shore remains as yet a matter of inquiry. Adding the inferred extension of the movement to its observed extent gives us a total length of about 300 miles. The general trend of this line is about N. 35° W., but in Sonoma and Mendocino counties it appears to have a slight concavity to the north-east, and if this curvature be maintained in its path beneath the waters of the Pacific it would pass very close to, and possibly inside of, Capes Gordo and Mendocino. Along the 185 miles of this rift where movement has actually been observed, the displacement has been chiefly horizontal on a nearly vertical plane, and the country to the south-west of the rift has moved north-westerly relatively to the country on the north-east of the rift. By this it is not intended to imply that the north-east side was passive and the south-west side active in the movement. Most probably the two sides moved in opposite directions. The evidence of the rupture and of the differential movement along the line of rift is very clear and unequivocal. The surface soil presents a continuous furrow generally several feet wide with transverse cracks which show very plainly the effort of torsion within the zone of the movement. All fences, roads, stream courses, pipe lines, dams, conduits, and property lines which cross the rift are dislocated. The amount of dislocation varies. In several instances observed it does not exceed 6 feet. A more common measurement is 8 feet to 10 feet. In some cases as much as 15 feet or 16 feet of horizontal displacement has been observed, while in one case a roadway was found to have been differentially moved 20 feet. Probably the mean value for the amount of horizontal displacement along the rift line is about 10 feet, and the variations from this are due to local causes, such as drag of the mantle of soil upon the rocks, or the excessive movement of soft incoherent deposits. Besides this general horizontal displacement of about 10 feet, there is observable in Sonoma and Mendocino counties a differential vertical movement not exceeding 4 feet, so far as at present known, whereby the south-west side of the rift was raised relatively to the north-east side, so as to present a low scarp facing the north-east. This vertical movement diminishes to the south-east along the rift line, and in San Mateo County is scarcely, if at all, observable. Still farther south there are suggestions that this movement may have been in the reverse direction, but this needs further field study.

As a consequence of the movement, it is probable that the latitudes and longitudes of all points in the Coast Ranges have been permanently changed a few feet, and that the stations occupied by the Coast and Geodetic Survey in their triangulation work have been changed in position. It is hoped that a reoccupation of some of these stations by the Coast and Geodetic Survey may contribute data to the final estimate of the amount of movement.

The great length of the rift upon which movement has occurred makes this earthquake unique. Such length implies great depth of rupture, and the study of the question of depth will, it is believed, contribute much to current geophysical conceptions.

The time of the beginning of the earthquake as recorded in the observatory at Berkeley was 5h. 12m. 6s. a.m., Pacific standard time. The end of the shock was 5h. 13m. 11s. a.m., the duration being 1m. 5s. Within an hour of the main shock twelve minor shocks were observed by Mr. S. Albrecht, of the observatory, and their time accurately noted. Before 6h. 52m. p.m. of the same day thirty-one shocks were noted in addition to the main disturbance. These minor shocks continued for many days after April 18, and in this respect the earthquake accords in behaviour with other notable earthquakes in the past. The minor shocks which succeed the main one are interpreted generally as due to subordinate adjustments of the earth's crust in the tendency to reach equilibrium after the chief movement.

The destructive effects of the earthquake are in the main distributed with reference to the line of rift. The exact limits of the area of destruction have not yet been mapped, but it is known to extend out about twenty-five or possibly thirty miles on either side of the rift. On the south-west side the greater part of this area to the north of the Golden Gate lies in the Pacific. This area extends from Eureka, in Humboldt County, to the southern extremity of Fresno County, a distance of about 400 miles.

Beyond this area of destructive shock the earthquake was felt in its milder manifestations over a wide territory. Our reports to date show that it was felt in Oregon as far north as Coos Bay, and on the south as far as Los Angeles. To the east it was felt over the greater part of middle California and eastern Nevada, particularly along the eastern flank of the Sierra Nevada. It was felt at Lovelocks, and we have unconfirmed reports of its having been felt at Winnemucca. Far beyond the region within which it was apparent to the senses, however, the earth wave was propagated both through the earth and around its periphery, and some of the most valuable and most accurate records of the disturbance which we have are those which were registered at such distant seismographic stations as Washington, D.C.; Sitka, Alaska; Potsdam, Germany; and Tokyo, Japan.

Within the area of destructive effects, approximately 400 miles by 50 miles in extent, the intensity varied greatly. There was a maximum immediately on the rift line. Water pipes, conduits, and bridges crossing this line were rent asunder. Trees were uprooted and thrown to the ground in large numbers. Some trees were snapped off, leaving their stumps standing, and others were split from the roots up. Buildings and other structures were in general violently thrown and otherwise wrecked, though some escaped with but slight damage. Fissures opened in the earth and closed again, and in one case reported a cow was engulfed. A second line of maximum destruction lies along the floor of the valley system of which the Bay of San Francisco is the most notable feature, and particularly in the Santa Rosa and Santa Clara valleys. Santa Rosa, situated twenty miles from the rift, was the most severely shaken town in the State, and suffered the greatest disaster relatively to its population and extent. Healdsburg suffered to a nearly similar degree. San José, situated thirteen miles, and Agnews, about twelve miles, from the rift, are next in the order of severity. Stanford University, seven miles from the rift, is probably to be placed in the same category. All of these places are situated on the valley floor, and are underlain to a considerable depth by loose or but slightly coherent geological formations, and their position strongly suggests that the earth waves as propagated by such formations are much more destructive than the waves which are propagated by the firmer and highly elastic rocks of the adjoining hill lands.

One of the lessons of the earthquake which seems peculiarly impressive is the necessity for studying carefully the site of proposed costly public buildings where large numbers of people are likely to be congregated. In so far as possible such sites should be selected on slopes upon which sound rock foundation can be reached. It is probably in large measure due to the fact of their having such a rock foundation that the buildings of the State University, at Berkeley, escaped practically uninjured.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

PROF. DOELTZ, privatdocent for metallurgy in the Bergakademie in Klausthal, has been appointed professor of metallurgy in the Charlottenburg Technical High School in succession to Geheimrat Weeren, and will enter on his new duties on October 1.

THE council of the University of Birmingham has approved of a scheme for the foundation of a department of economic zoology, and has appointed Mr. Walter E. Collinge the special lecturer on that subject. By this arrangement, Mr. Collinge will vacate his lectureship in zoology and comparative anatomy, and take over the new department at premises at present being fitted up at 55 Newhall Street. These comprise an inquiry office, consultation room, research laboratory, and museum.

ONE of the most satisfactory features of American university education is the keen interest shown by old students in their respective colleges. We learn from *Science* that at the recent alumni meeting at Harvard University it was stated that during the year graduates had contributed about 360,310*l.* to the productive funds of the University, and that 17,623*l.* had been received for immediate use. This sum does not include the more than 22,600*l.* that the class of one year has given to the University to be used as the corporation sees fit. An anonymous gift of 12,000*l.* from a graduate was also announced. Another instance of the same enthusiasm is shown by President Hadley's announcement at the Yale alumni dinner that the total of the alumni fund for the year amounted to 25,847*l.*, as compared with the 10,700*l.* announced a year ago. From our contemporary we also learn that a fund of 30,000*l.*, of which Mr. Carnegie contributed 15,000*l.*, has been raised at Amherst College, and will be used to provide for the work in geology and biology. Mrs. Louisa N. Bullard, too, has given Harvard University Medical School 10,400*l.* to establish a chair of neuropathology.

MR. HALDANE, Secretary of State for War, distributed the prizes on July 13 to the students and nursing probationers of the London Hospital and Medical College. During the course of an address he delivered subsequently, he said the surgeon, the physician, the nurse, require science to-day in a way in which they never required it before, and science has influenced and affected profoundly their whole teaching. That is why the standards of a generation ago are no good to us, and why any dealing, not merely with the physical organism, but with the great organism of the community, is so much more difficult and far-reaching than used to be the case. Those who are responsible for dealing with the organisation of society know, or ought to know, that unless they have clear principles and plain ends before their minds they can make no advance, and they require economic science, and legislative science, and science of different kinds before they can get those views in a definite fashion. They would do well, Mr. Haldane continued, to take a lesson from the science of medicine, which has taught that the healing of the body is absolutely dependent on the understanding of the principles upon which life is governed. There are new ideas which penetrate deeper and deeper as year succeeds year. To-day we know that science is the guiding star of work. It is in such men and women as those studying in medical colleges that we have the hope of the future, the security that the story of our race may yet be a story of progress, and that in the generation to come we may see yet a higher state of things realised than even that which we have realised at the beginning of the twentieth century.

THE new buildings of Armstrong College, Newcastle-on-Tyne, described in NATURE of July 5 (p. 232), were opened by the King, who was accompanied by Queen Alexandra, on July 11, in the presence of a large and representative assembly. Addresses to the King were presented by the governors and council of the college, the professors, and the students. In the first-named the president referred to the electrical engineering laboratories, and stated that it is desired to bring this department to as high a level as that of the mechanical engineering of which the college is so justly proud. The liberality of the shipbuilders of the district, it was added, is now being exercised in the establishment of a school of naval architecture befitting the north-east coast as one of the chief seats in the world of the shipbuilding industry. In the course of his replies, the King expressed his admiration of the magnificent buildings; he commended the wisdom of adapting the teaching of the college to the practical needs of the students, and, in mentioning the name of Armstrong as identified with scientific discovery and industrial success, stated that scientific principles are now more than ever necessary for the mental training of all who hope for success in the great engineering works for which Newcastle is famous all the world over. The Earl of Carlisle presented the Queen with a casket made on the premises by the Newcastle Handicrafts Company, a practical offshoot of the art department of the college. Afterwards the Dean of Durham and Mrs. Kitchin, Sir Isambard and Lady Owen, attended their Majesties in a visit to the electrical engineering laboratory, where Prof. Thornton had arranged several interesting demonstrations.

THE summer meeting of the Association of Technical Institutions was opened at Oxford on July 13, with Sir William Anson, president, in the chair. In his presidential address, Sir William Anson said technical associations are comparatively new in our educational system, and an increasing endeavour should be made to accommodate the old to the new, and to find a place for that which is new without dispossessing the old, where that which is old is not worn out, where it combines, as the ancient universities combine, vitality and the promise of the future with the stability which comes of great traditions drawn from the past. The two elder universities are sometimes thought, Sir William Anson continued, to be aloof from the activities of modern life, and Oxford perhaps more so than Cambridge, because of the devotion which Cambridge has always shown to mathematics. Though a university may legitimately specialise in the direction of certain studies, where it can develop those studies in close contact with the operation to which scientific investigation is applied, it ought never to forgo the general scientific teaching which is an essential feature of a university course. What is the relation of the universities to the work of the technical institutes, which, in one form or another, form such a prominent feature in the educational system of municipalities? Sir William Anson thinks it is twofold. In the lower stages the schools of science and technical institutes attended by boys may give such a training as will qualify for scholarships at the universities, and the universities, being thus the goal of the technical institute in its more rudimentary form, should be the starting-point for technology in its more advanced form. The man of science may make discoveries which others may utilise, but the student, if not a man of action himself, helps and befriends the man of action, and technology, if it is to go on advancing, must go hand in hand with those studies which every university, however situated, is able to promote.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, July 2.—M. H. Poincaré in the chair.—An addition to the notes of May 21 and June 11 relating to the discontinuity of the specific heats of fluids: E. H. **Amagat.**—The action of sulphuretted hydrogen on some oxides. Applications to volcanic phenomena and hot springs: Armand **Gautier.** At a white heat, sulphuretted hydrogen reacts with both the magnetic oxide and peroxide of iron, giving iron sulphide and a mixture of hydrogen and sulphur dioxide. A small quantity of sulphuric acid is formed simultaneously, even when oxygen is absent. With alumina, sulphuretted hydrogen gives an oxysulphide of aluminium, together with a mixture of the same gases as above. Sulphuretted hydrogen and carbon dioxide at a red heat give carbon oxysulphide, water, carbon monoxide, and hydrogen, the reaction being the same whether the gases are initially dry or wet. The bearing of these experiments on the composition of volcanic gases is pointed out.—The lava produced by the recent eruption of Vesuvius: A. **Lacroix.** The general phenomena characterising the recent eruption have been described in earlier papers; in the present note the composition of the products corresponding to each phase of the eruption has been studied.—The earthquake in California according to the preliminary official report: A. **de Lapparent.** The evidence is distinctly against the view which has been put forward that there is any connection between the earthquake and volcanic phenomena. The Californian earthquake was essentially an orogenic phenomenon, there being signs of dislocation for a distance of more than 600 kilometres along the Californian coast. The connection between the damage done to buildings and the nature of the soil upon which they were built has also been clearly brought out by the preliminary investigations.—Some synthetical reactions of pinacoline: Louis **Henry.** A study of the products of the reactions between pinacoline and magnesium-methyl bromide and hydrocyanic acid. Both the reactions are normal.—Families of Lamé with plane trajectories, the planes passing through a fixed point: S. **Carrus.**—H. C. Vogel was elected a correspondant for the section of astronomy in the place of the late Prof. Langley.—The classification of irrationals: Ed. **Maillet.**—Researches on armoured concrete and the influence of the removal of the charge: F. **Schüle.**—The influence of surface tension on the propagation of waves parallel to the surface of a liquid plate: M. **Alliaume.**—An optical arrangement generalising the use of the telescope of 1 metre diameter at the Observatory of Meudon: G. **Millochau.** The arrangement consists of an objective of three divergent lenses, placed between the telescope mirror and its focus. By varying the position of the lenses, images can be obtained having the dimensions of those which would be produced by a mirror of a metre diameter and a focal distance capable of variation from 15 metres to 25 metres.—The colorations of fringes localised in a thin plate limited by a grating: Georges **Meslin.**—Phosphorus chloronitride: MM. **Besson** and **Rosset.** An advantageous method of preparing this substance is described, and details given of its reactions with water, ozone, sulphur trioxide, and nitrogen peroxide.—The isomorphism of mercuric iodide with the iodides of zinc and cadmium: A. **Duboin.** Iodide of mercury is capable of crystallising in all proportions with the iodides of zinc and cadmium.—The non-existence of phosphorus trisulphide: R. **Boulouch.** Definite sulphides of phosphorus having formulæ between P_4S_3 and P_3S_5 do not exist, and the latter is not necessarily a definite compound.—The crystallography of iron: F. **Osmond** and G. **Cartaud.**—The determination of the transformation points of some steels by the electrical resistance method: P. **Fournel.** The wire under examination (0·3 mm. diameter) was wound on mica and heated in a vacuum by an electric furnace, the temperature being measured by a thermocouple, and the resistance measured by the potentiometer method. Previous researches in which the same method was used have only shown clearly the point called A_3 by Osmond. In the present research the additional points A_1 and A_2 were also clearly defined.—The solubility of carbon in calcium carbide: H. Morel **Kahn.** The amount of graphite recoverable from calcium carbide increases with the temperature to which the carbide has been subjected in the presence of an excess of carbon. It also increases with the duration of the heating.—The action of urethane and urea on ethylglyoxylate. A new synthesis of allantoin: L. J. **Simon** and G. **Chavanne.**—The formation of indazyl derivatives starting with *o*-hydrazobenzoic acid: P. **Carré.**—Ethyl dioximidosuccinate: A. **Wahl.**—A mode of reaction of some acid anhydrides: R. **Fosse.**—A new method of estimating casein in cheese: A. **Trillat** and M. **Sauton.** The method is based on the fact that the casein is rendered insoluble by the addition of formaldehyde. Details of the control experiments are given.—The composition of the soils of French Guinea: Alex. **Hébert.**—The malacological fauna of the lakes of Rodolphe, Stéphanie, and Marguerite: R. **Anthony** and H. **Neuville.**—The development of the egg of *Ascaris vitulorum* in an artificial medium: L. **Jammes** and A. **Martin.**—The seminal apparatus of Helix: A. **Popovici-Baznosanu.**—The action of the leguminose on the excretion of uric acid: Pierre **Fauvel.**—The utilisation of carbohydrates in arthritic diabetes: René **Laufer.**—The auto-adaption of abnormal embryos and the tendency to anomaly: Etienne **Rabaud.**—New attempts on the maturation of the egg in *Rana fusca*.—Parthenogenesic segmentation provoked by freezing and distilled water: E. **Bataillon.**—The fundamental unit of the black races: the radio-pelvic index: Louis **Lapicque.**—Fibrillary structure in the Bacteriaceæ: J. **Kunstler** and Ch. **Gineste.**—Thyroid grafts: MM. **Charrin** and **Cristiani.**—Radium in gynæcology: MM. **Oudin** and **Verchere.** Details are given of the use of radium in nine cases, three of which were cured and the remainder improved.

CAPE TOWN.

South African Philosophical Society, March 28.—Dr. J. C. Beattie, president, in the chair.—Morphological research on the surviving members of the ancient group, the cycads: Prof. H. H. W. **Pearson.** The relationship of the group to the Pteridophyta was discussed, and microscopic slides showing (*a*) pollen tubes, (*b*) the ciliated spermatozoid, (*c*) the karyokinesis of the nucleus of the central cell of the archegonium prior to the formation of the canal-cell-nucleus, of *Encephalartos Altensteinii* were exhibited. A specimen of *Stangeria paradoxa* with an apogeotropic root and a microscopic section showing the endophystic "nostoc" were also shown.—The nature of effect of the sun-spot frequency on the variation of the magnetic elements at the Cape of Good Hope: G. H. H. **Fincham.** By a consideration of Sabine's observations at the Cape of Good Hope obtained in 1842–6, it is shown that the sum of the sun-spot effect on the declination is a maximum in winter; the same result was found for the horizontal intensity.

April 25.—Dr. J. C. Beattie, president, in the chair.—The round perforated stones (tikœ) alleged to have been made by Bushmen for the purpose of giving weight to the "kibi" or digging stick: L. **Peringuey.** That some aborigines, Bushmen or Hottentots, made use of these stones for the aforesaid purpose was now proved. Although Kolben did mention the digging stick as a part of the Hottentot household utensils, he never said anything about the perforated stone being used. Sparrmann, however, does so. Then follows Burchell, who figures the tikœ and the kibi. Livingstone, in his last Journal, gives evidence on the subject, but quotes from memory. In the figures given in that work the stone is a flat disc. That the stones were used for the alleged purpose by some aborigines is, however, made more clear by Bushman paintings, tracings of which were exhibited by permission of Prof. Young, of Johannesburg.

May 30.—Dr. J. C. Beattie, president, in the chair.—Rock etchings of animals, &c., the work of South African aborigines, and their relation to similar ones found in Northern Africa: L. **Peringuey.** These etchings are not uncommon along the Orange River, also the Vaal River, in the Asbestos Mountains, and other parts of the colony, Beaufort West, Clanwilliam, Humansdorp, &c., also in the Transvaal, and the author proceeded to compare these with etchings of a similar nature discovered and reproduced by the Geological Survey of Algeria.—Observations on the functions of the ethereal oils of xerophytic plants: Dr. R. **Marloth.** Since the observations of Tyndall on the great diathermancy of the vapours of ethereal oils, many biologists think that the main function of these oils is to produce a protective atmosphere around the plants, thereby reducing their transpiration. If that were the case, one would expect that the excretion of oils would be largest in the driest season and the hottest part of the day. But just the reverse is the case, for many aromatic plants do not betray their presence at such times, while the atmosphere becomes filled with their aroma during foggy weather. Such plants are many Rutaceæ, Compositæ (wormwood), Umbelliferæ (Bubon), Pelargonium, and even the rhenosterbush. These facts are, however, in perfect accordance with the view that the oils are a protection against the attacks of herbivorous animals, especially also against snails and slugs, which appear only during wet weather.

CONTENTS.

THURSDAY, JULY 26, 1906.

SIR HENRY ROSCOE'S REMINISCENCES.

The Life and Experiences of Sir Henry Enfield Roscoe, D.C.L., LL.D., F.R.S. Written by Himself. Pp. xii+420. (London: Macmillan and Co., Ltd., 1906.) Price 12*s.* net.

SIR HENRY ROSCOE, who is known to us all as one of the most genial figures among the band of great discoverers who gave a peculiar distinction to the reign of Queen Victoria, has been persuaded by his friends to give to the world a charming book of memories, which were written originally, as he tells us, for the use of his family. Now Sir Henry Roscoe is, it appears, a "Sport" among the Roscoes in his taste for science, and the result is that we get from him, on this occasion, not a mere history of chemistry, nor even a mere record of scientific affairs in his own times, but something which will appeal, and appeal strongly, to a far wider audience than that provided by his scientific friends and admirers, numerous, indeed, though these must be.

We suppose many of our readers are aware that whether Sir Henry Roscoe is or is not a "Sport," as he puts it, in his taste for science, he comes of a family which for a century and a half has been distinguished for the literary power and for the capacity for affairs exhibited by many of its members, and that in spite of his joke upon the subject, even scientific power has not been altogether unknown among them, his grandfather, William Roscoe the historian, being still so well remembered among botanists that Sir Henry had the odd experience, only a few years ago, when on a visit to Egypt, of being mistaken for the former, by a professor, who thought he recognised in the great chemist the author of a monograph on the Monandrean plants published so long ago as the year 1826.

The William Roscoe alluded to above, Sir Henry's grandfather and the founder of the reputation of the family, is, however, far more widely remembered as a historian than as a botanist. In the former capacity he achieved a European reputation by laying the foundations of a new era in the history of the Renaissance, and will long be remembered for his "Lives of Lorenzo de' Medici and Leo X." He was the first man of real mark in literature produced by the city of Liverpool, and his unique position in that city led Washington Irving to describe him in the "Sketch-book" as the literary landmark of the place, where, "like Pompey's Column at Alexandria," he towered "alone in classic dignity." Sir Henry Roscoe's father was also a man of great powers; he became Judge of the Court of Passage at Liverpool, but died young, leaving his son at the age of three to the sole care of his mother. This lady, like her son's father and grandfather, evidently possessed not a little literary ability, as is shown by her "Life of Vittoria Colonna," which was published in 1868 by Messrs. Macmillan and Co., and with it a capacity for affairs which enabled her to preside over the early education of her son with singular judgment and success.

Most of those who have read Lord Roberts's "Forty-one Years in India," must have been struck, as they perused its pages, by his singular good fortune in meeting interesting people and making delightful friends at every turn—a feature of his life which was due, no doubt, to his possessing the happy gift of a quick eye for what is best and brightest in those with whom he is thrown in contact. As one reads Sir Henry Roscoe's experiences, one cannot but conclude that he too was born under a happy star; for not only does he appear to have met "good fellows" at every stage of his life, a fact which we may venture to ascribe to his own genial temperament, but some good fairy seems to have presided over his affairs, with the express object of making him a chemist, and to have taken care that at every stage he should be flung against real chemists, makers of discoveries, and enthusiastic teachers, just the men, in short, who were best calculated to keep alive in him that capacity for asking "foolish" questions, which often worried his maternal grandfather, and to excite in him the secret desire which we suspect every discoverer of Sir Henry's rank has hugged to his heart at an early age—to make, some day, just one discovery, at least, in his favourite science. But, however that may be, it is clear that from Balmain, the discoverer of boron nitride, Roscoe "picked up his love of chemistry" in the laboratory of the High School of the Liverpool Institute, and that his scientific tastes could not have been fostered by better guides than Thomas Graham and W. C. Williamson, whom he found at University College a few years later, and Bunsen, his life-long friend, with whom he worked and did great things at Heidelberg, when he betook himself in due course to that beautiful home of science to be soaked in research in the splendid German manner. At Heidelberg Sir Henry Roscoe's progress was rapid; after six months' work he passed the examination for the doctorate "summa cum laude," this being the first time this highest degree was granted to an Englishman, and it was here, partly in 1855 and partly in later years during vacations, that he carried out his well-known work on the chemical action of light. In 1857 he became professor of chemistry at the Owens College, and thereafter, as everyone knows, he played a leading part, for well-nigh half a century, in English science, and in not a few departments of public life connected therewith, helping on pure science by his researches and by his books, promoting the usefulness of chemistry in education by his "Little Roscoe," as it used to be called, which has been the guide, philosopher and friend of thousands upon thousands of English students, and advancing generally national efficiency in a dozen different directions by his public labours both in and out of Parliament.

But considerations of space forbid us from pursuing the attractive theme provided by Sir Henry Roscoe's manifold activities, and compel us to return to the subject of his latest book. Briefly, we may say that all who read it will find it delightful. It is full of information about men and matters, an epitome in non-technical language of that part of the history of our own times in which Sir Henry has played a distinguished part. It is enlivened with many good stories, especially of his great master and lifelong friend Baron Bunsen, and adorned with many excellent portraits of the scientific giants of the nineteenth century. Though written, as we have said, for the use of his family in the first instance, this book of memories is essentially a public document, a record of many matters, not commonly known, during an important period. For details of these the book itself must be consulted, since a mere enumeration of the names of those with whom its author has worked in public affairs, or a list of the debates, scientific, educational, industrial and political, in which he has taken part would overcrowd the space available for this notice. In its pages will be found records of student life in Germany in the distant days when it was scarcely possible, or at any rate very difficult, to become a chemist in any other country; stories about University College in the heyday of its youth, when De Morgan, Sharpey, Graham, Liston, and others of equal eminence were among the professors, and Lister, Farrer-Herschell, Bagehot, Jessel, Hutton, Henry Thompson, and Edward Fry were, or recently had been, among its students; much about the early history of Owens College, which, when Roscoe joined the staff, could boast only of thirty-five students, of whom but fifteen were at work in the laboratory, and of the gradual growth of the college in size and dignity until it became the first of the new English universities; a rich mine of information about the progress of technical education from the year 1883, when a Royal Commission consisting of "Mr. Bernhard Samuelson, Mr. John Slagg, Mr. (now Sir) Swire Smith, Mr. (now Sir) Philip Magnus, Mr. William Woodall, and Sir Henry Roscoe" was appointed to study and report on the then state of technical education at home and abroad, and, again, about the recent history of the University of London, of which Sir Henry was for some time Vice-Chancellor, and many other important matters. The book closes, as such a book should, with a few pages which give us a glimpse of the life of Sir Henry and Lady Roscoe at Woodcote Lodge, their Surrey home.

Apart from his scientific work, and the part he took in founding Owens College, Sir Henry Roscoe's share in the labours of the Royal Commission on Technical Instruction and his subsequent labours on behalf of technical and secondary education represent the great feature in his public life. Sir Henry and his colleagues not only spent many months travelling in this country and all over Europe for the public good, but they did this at their own expense; and, after their report was published, many of them spared neither time nor trouble in spreading abroad the knowledge they had acquired of what was being done by our competitors in other countries. One trembles to think what might still be the state of technical education in this country but for them and their unstinted labours. We should like to quote a few passages from this part of the book, but want of space makes this impossible. But there is one side of the matter to which attention may well be directed at this moment, when the question of national defence, or some part of it, goes daily into the pot, and daily comes out of it again.

It has often been said that the success of the Germans in the Franco-German War depended on the German schoolmaster. After the war this opinion found voice also in France, and Sir Henry illustrates this by telling us that at Rouen he saw, to his surprise, in the school museum a Prussian soldier's helmet. On asking why this was there, he was told by the director that when the scholars did not attend to their work it was his custom to bring this helmet down, put it on the desk, and say, "Now, if you do not make progress and learn properly this will happen to you again. The surest way to bring it upon you is to neglect your studies and grow up in ignorance, and become inferior in intellectual training." "The display of this helmet," said the director, "never fails to bring the blush of shame to the cheeks of my students, and to rouse their patriotism and their zeal for their studies." May we recommend this story to the attention of Mr. Haldane, and still more to that of the Minister for Education, and to politicians in general, and suggest that it has for us in England a moral also? Only here, alas! the men need to learn the lesson it conveys as well as, and, indeed, even more than, the boys.

We cannot conclude without expressing our admiration of Lady Roscoe's contribution to this charming volume, viz. the excellent reproduction of her photograph "The Fisherman," which was recently pronounced, by a very competent authority, to be the best photograph by an English amateur that they could suggest for insertion in an American journal, and our hearty wish that Sir Henry and Lady Roscoe may long remain among us to enjoy their retreat in sunny Woodcote, where the great chemist has crowned his scientific career by the almost unique achievement of making both ends meet as an amateur farmer.

W. A. S.

WITH WIRES AND WITHOUT.

Telegraphy. By T. E. Herbert. Pp. xx+912. (London: Whittaker and Co., 1906.) Price 6*s.* 6*d.* net.

The Principles of Electric Wave Telegraphy. By Dr. J. A. Fleming. Pp. xix+671. (London: Longmans, Green and Co., 1906.) Price 24*s.* net.

Wireless Telegraphy. By Dr. Gustav Eichorn. Pp. x+116. (London: Charles Griffin and Co., Ltd., 1906.) Price 8*s.* 6*d.* net.

Wireless Telegraphy. By W. J. White. Pp. x+173. (London: T. C. and E. C. Jack, 1906.) Price 1*s.* net.

Of the numerous achievements of which the electrical engineer can boast, telegraphy is the one of which he has the greatest reason to be proud. If we combine with telegraphy the sister subject of telephony there can be little doubt but that by the application of these two sciences he has effected a greater revolution in human affairs than by all his successes in the way of heavy engineering. He may "electrify" our railways, especially the suburban lines, to the great advantage of both the travelling public and the shareholder, but he is still only doing for us in another way what the mechanical engineer has already accomplished. He may harness the great waterfalls and transmit their power over hundreds of miles to localities at which it can be more easily utilised, but he is only saving Mahomet the trouble of going to the mountain. He may provide for us in the arc lamp and the glow lamp the most efficient means of producing artificial light, but he is only supplying us with an alternative to the cheaper productions of the gas engineers. But with telegraphy he has given us something entirely new—an art which, whilst actually annihilating distance, virtually annihilates time. So familiar have we become with the operations of the telegraphist that few probably ever realise how closely dependent upon them is every detail of modern civilised life. We speak of the twentieth century as being, or as promising to be, the electrical age, and we think of the railways, the lighting, and the development of power, whereas in reality it is the electrical age because of the telegraph and the telephone. If the vast network of thin wires which stretch over the civilised world like the threads of a spider's web were suddenly wiped out to-morrow, we should as suddenly realise with the non-appearance of the morning paper what it meant to be thrown back into the age before electricity.

In spite of the enormous influence which telegraphy exercises in our daily life, we hear a great deal less about it than we do of a number of unimportant things. Few people write papers upon it. The Journal of the Institution of Electrical Engineers, originally the Society of Telegraph Engineers, will be found almost free from such papers during the past ten years. Fewer people write books. The reason is not far to seek. Every applied science passes through three stages—the stages of incubation, of growth, and of maturity. In the first stage the outsider hears little about it; some few who are specially interested in scientific research may be aware that some observations of the natural philosopher are being developed along lines that promise results of great practical utility. At length a point is reached when the practical value of the work becomes so self-evident that even the halfpenny paper realises it, and the world is provided with a new nine-days' wonder. From now begins the period of growth during which publicity is excessive. Everyone talks about the new discovery. Everyone who can makes experiments in connection with it, and publishes his results in papers, and those who cannot afford the time to experiment write books on the subject. After a period more or less protracted public interest wanes, and is diverted, we will say, to a scandal of tinned meat, and, what is more important, the science, from being experimental and much talked of, becomes practical and much used.

In the art of telegraphy we see a science which reached, long ago, the last stage. If anyone wishes for a general idea of the extent of telegraphy at the present day let him read Mr. Herbert's book. Unless he is an expert, or studying to become one, he will probably realise more from the style in which the book is written than from the study of it in detail. He will see that here he is dealing with something which is firmly established, in which methods and apparatus have become almost stereotyped, and in which progress can only be exceedingly slow because everything is already so highly developed and because the interests which are vested in the methods now in use are so gigantic that only a revolution can warrant their overthrow. Mr. Herbert's book is full and concise, and a vast amount of information is condensed into its pages. At the same time it is simple, as befits a book intended for young students and dealing with a subject in which simplicity has been reached through complexity.

In the three books on wireless telegraphy before us we see good illustrations of what has been said above of the stage of growth of an applied science. Mr. White's book is a somewhat belated arrival, belonging properly to a few years back. It is purely descriptive, almost purely popular, and should have been written when the general public had a keen and living interest in the subject. Inasmuch as it describes the latest systems it has a certain claim to existence. But wireless telegraphy has almost reached the third stage, and before long we shall cease to hear anything more about it, and, taking it for granted, will concern ourselves only with grumbling at its cost. That it has not fully reached the final stages is sufficiently shown by Dr. Fleming's and Dr. Eichorn's books. Of Dr. Eichorn's book we can only say that we should have greatly welcomed its appearance had it not been for the almost simultaneous publication of Dr. Fleming's work. Dr. Eichorn was manager of the large experimental stations for Prof. Braun, and writes specially about the systems which have been developed by Slaby, Arco and Braun into the "Telefunken" system, which shares, we suppose, with the Marconi system the honour of being the most important and most practical systems yet developed. The book is well written, and combines with a good deal of description a careful investigation of the fundamental theoretical phenomena.

But in Dr. Fleming's book we have undoubtedly the one to be recommended to students specially interested in wireless telegraphy, and the practical development already attained warrants the existence of a certain number of such students. If technical education were organised in an ideal manner there would exist a professorial board the duties of which would be to prescribe exactly the literature which a student should and should not read. Such a body would allow anyone to write and publish books, and would not prohibit reading them until the tentative efforts of various authors resulted in the production of one or more books containing all the information on the subject which could be regarded as necessary and sufficient. Then they would say to the student:

You may read this and that book, but on no account are you to waste any time on any others; you may consult such and such original researches, but the remainder are useless. We have no doubt that this body would notify in the present instance that the student of wireless telegraphy must confine his attention to the books by Hertz and Dr. Fleming. We are not speaking of the student of electromagnetic waves. In Dr. Fleming's book is to be found a treatment of the subject which is exhaustive and thorough both on the theoretical and practical sides. It is a book which has been long wanted, and will be warmly welcomed.

One may notice, however, by a careful study of the book that wireless telegraphy practice is still to a certain extent tentative. The *best* methods are not yet decided upon, and methods differ because there is still much ignorance. But there are signs that the approach to more exact results is being made with the advent of apparatus based on wider knowledge and capable of allowing accurate measurements. Just as telegraphy needed the development of very special apparatus before full advantage could be taken of its powers, so wireless telegraphy calls for its own special apparatus. The process of development is necessarily slow, but in our present state of technical attainments it is sure.

It is quite evident from the perusal of the books before us that there is room in our complex civilisation both for ordinary telegraphy and wireless telegraphy. There are very few new discoveries which succeed in displacing old ones. We have room for many technical developments, and are capable of using all to their best advantages in the spheres for which they are particularly suited. For telegraphy over land there is little, if any, fear that wires will be displaced. There is little fear either that for communication between continent and continent the cable will give way to the overgrown "antennæ." Wireless telegraphy has found its special sphere in communication with ships, and soon will succeed in bringing us as close together at sea as we now are on land. When we consider that any man in any civilised country will be able to get into almost instant communication with any other, either on land or sea, we can realise something of the benefits conferred by telegraphy with wires and without.

Maurice Solomon.

THEORETICAL BIOLOGY.

Les Problèmes de la Vie. Part iii. La Fécondation et l'Hérédité. By Prof. Ermanno Giglio-Tos, 1905. Pp. vii+189. Part ii. L'Ontogénèse et ses Problèmes. 1903. Pp. 368; 36 figures. (Chez l'Auteur à l'Université de Cagliari.)

In the third volume of his treatise on the problems of life, Prof. Giglio-Tos proposes to elucidate all the puzzling problems of maturation, fertilisation, and heredity in the light of a fundamental phenomenon which he calls "biomolecular addition." Biologists, he tells us, have been too much preoccupied with the interpretation of particular chapters in the history of the germ-cells, and have neglected to inquire into the fundamental cause which unifies the whole. They have reached partial interpretations, usually "artificial and teleological," of details, but a connected general theory is lacking. They have been like geologists interpreting the course of a river, and ignoring gravitation. The unifying secret is "biomolecular addition," which seems to mean the power that the living molecule (whatever that may be) has of adding to itself another molecule "so that the biomolecule resulting from the addition has double the number of atoms, and may, in consequence, divide into two biomolecules similar to one or the other of the added biomolecules." Thus a male biomolecule and a female biomolecule (identified with paternal and maternal biomolecules) may add together and then divide into two biomolecules which are either male *or* female. We do not profess to understand this, though the author assures us that biomolecular addition is "nothing but a chemical reaction of the greatest simplicity between the biomolecules constituting the genetic cells," and we regret that we do not understand it, for we are told that "it suffices to explain even in their minor details all the interesting manifestations accompanying the function of sexual reproduction." These are brave words, but the author's "explanation" seems to us far removed from the present-day scope of biology, in Britain at least.

The author cannot accept Weismann's theory of germinal continuity, believing, on the contrary, that the ancestors of the germ-cells become histologically differentiated, like ordinary somatic cells, along special lines of "monodic" development. At a certain epoch—"the genetic moment"—however, they come under the influence of special substances in the internal milieu, and are shunted back on a sort of return journey which brings them, or their descendants rather, to or near their starting point of resemblance to the parental ovum from which they are by cell-lineage derived. If the germ-cells can return perfectly to the state of the original fertilised ovum, with its dual equipment of male and female biomolecules, then parthenogenesis may occur. But this complete return implies very favourable nutritive conditions in the internal milieu, and, as a matter of fact, what usually occurs after the "genetic moment" is a process of internal biomolecular addition as the result of which the male *or* the female biomolecules in the germ-cells disappear, and two kinds of genetic cells are differentiated (with female *or* male biomolecules respectively). Thus fertilisation is necessary to restore the integral constitution of the original parental ovum. "The primitive cause of sexuality and of fertilisation is to be found in the phenomenon of biomolecular addition." In a laboriously ingenious fashion the author uses his key to read the mysterious ciphers of maturation and fertilisation, and he finds that it unifies everything—hermaphroditism and parthenogenesis, secondary sex characters, and the rejuvenescence of infusorians. But we have not been able to use his key, and his distinctions between pregenetic and metagenetic parts of the body, neuter and sexual paragenetic cells, external and internal biomolecular additions, are not readily borne in mind. We have not been more successful with a previous volume dealing with development, which explains that there is "one fundamental principle" controlling the detailed ontogenetic phenomena, namely, "the principle of monodic development." Though it is "of extraordinary simplicity, like all the principles of natural phenomena," we have failed to detect its luminiferous quality.

But as the author emphasises the fact that if his argument is to be appreciated there must not be "the least omission of any part of the book, even if it seems a superfluous repetition," and as he "has consecrated all his intellectual activity and all his scientific passion" to working out an interpretation which seems to him "to explain the fundamental phenomena of life on absolutely scientific principles," we feel bound, in fairness, to recommend the author's painstaking work to all biologists who may have the leisure and patience which a study of "Les Problèmes de la Vie" requires. Perhaps another requisite which we cannot pretend to possess is a clear apprehension of the biomolecule. J. A. T.

ECONOMIC ZOOLOGY.

Report on the Injurious Insects and Other Animals observed in the Midland Counties during 1905. By Walter E. Collinge, M.Sc. Pp. 58+xxxii figures. (Birmingham: Cornish Brothers, Ltd., 1906.) Price 2*s*.

MR. COLLINGE, in his third report on the injurious insects and other animals of the Midland counties, again deals with many varied subjects. The report is well illustrated, except for the figure of a weird bird and its egg supposed to represent a barn owl. Why a valuable page was wasted on such an unnatural production is impossible to understand.

One of the most interesting parts of the report is that dealing with "big-bud" in black currants, and the treatment of diseased bushes (pp. 6 and 7). In a summary Mr. Collinge tells us that he "feels convinced that the application of lime and sulphur will keep this mite in check, and if the dusting or spraying is continued will entirely eradicate it." Later he tells us that the results have been checked by many large growers, and that they clearly point to the fact that "the application of lime and sulphur offers an effective remedy." He does not tell us how many times we have to dust or spray the bushes. That "we know completely the life-history of the mite" is certainly not the fact; some dozens of points have yet to be found out.

An interesting account is also given of the plum Aphides (*Hyalopterus pruni* and *Aphis pruni*). Something is wrong, however, in the account of *Aphis pruni*, for the young coming from the winter eggs, which are very few in number, and hatch very early in the year, are not green. In early spring we find this Aphis as a large plum-coloured "mother-queen," and she produces green living young. The treatment recommended, namely, early spraying, is nevertheless most imperative.

Among other insects this useful report deals with we find notes on the pea and bean thrips, woolly aphis, currant-shoot moth, raspberry moth, cockchafers, furniture beetles, and book-lice. There are also short accounts of the lilac Gracilaria and the larch Coleophora. The abundance of eel-worms during the past year is also dwelt upon, and a list of woodlice found in the Midlands is given.

Amongst so much of value, such as the account of the snow-fly (*Aleyrodes vaporarium*, p. 22) and the larch and spruce chermes (p. 14), that this report contains, we are sorry to see some wrong statements being carried forward. For instance, on p. 23, caustic alkali wash is *still* recommended for mussel scale in winter. Recent work has shown that it has no effect at all, even when used at treble the normal strength.

A few pages are devoted to the subject of the preservation of wild birds, illustrated by figures from the Board of Agriculture and Fisheries leaflets. There is also a short appendix dealing with the employment of hydrocyanic acid gas and bisulphide of carbon.

This report, like its predecessors, is one of much interest, but some of the remedial measures for such things as wire-worm and "big-bud" must surely not be taken too seriously by agriculturists.

FRED. V. THEOBALD.

THE FEELING FOR NATURE.

The Development of the Feeling for Nature in the Middle Ages and Modern Times. By Alfred Biese. Authorised Translation. Pp. vi+376. (London: Routledge and Sons, Ltd., 1905.) Price 6*s*.

"NATURE in her ever-constant, ever-changing phases is indispensable to man, his whole existence depends upon her, and she influences him in manifold ways in mind as well as body." Such being the relation of nature to man, as set forth in the introduction, it has been the author's endeavour to trace in this volume the development of human thought in regard to the phenomena of nature from the introduction of Christianity downwards, in the same way that was done in a previous volume for the time of the Greeks and Romans. This has been done mainly by the study of writings, both in prose and poetry, in which natural phenomena, whether connected with scenery, weather, birds, or flowers, are spoken of with admiration. That the task of writing the book was a difficult one is freely admitted by Prof. Biese, and it is scarcely to be wondered at if at the end the book strikes the reader as somewhat less attractive than he would naturally expect from the title.

The book is largely made up of quotations, and many of these quotations do not, after all, prove very much. Then, again, as we approach recent times the quantity of literature at a writer's disposal tends to become for practical purposes infinite, and in such circumstances anything might be proved by choosing suitable quotations. Again, in quoting poetry as an indication of popular feeling at various times it must not be forgotten that poetry is, from the very nature of things, essentially conservative, so that the poetry of one age necessarily reproduces the thoughts and modes of expression of previous ages.

It thus appears that the method of treatment which undoubtedly was admirably adapted to the study of the Greek and Roman period becomes less and less satisfactory as the present day is approached. The early chapters are, therefore, by far the most interesting. They deal with the effects of Christianity in turning man's thoughts from the things of this world to spiritual matters, and with the revival of the feeling for nature among the German races, who, living in a northern climate, were naturally led to appreciate and value the beauties associated with the coming of summer. But it may be reasonably urged that evidence of later-day developments of the feeling for nature should be sought in science rather than in art, in the interest taken in the study of natural phenomena rather than in the recantation of praises of sunshine, sea, and the nightingale's song.

It is fairly certain that if some readers do not find this book as interesting as they expect, there will be others who will enjoy its perusal more than this review suggests, and we may safely apply to Prof. Biese the Yorkshire quotation, "He did his best and he couldn't do owt else."

OUR BOOK SHELF.

A Handbook of York and District. Prepared for the Seventy-fifth Meeting of the British Association for the Advancement of Science, 1906. Edited by Dr. G. A. Auden. Pp. xvi+365. (York: J. Sampson, 1906.)

The handbook which has been prepared for the benefit of those attending the forthcoming meeting of the British Association at York will be found to be exceedingly useful. The volume is neatly bound and printed on suitable paper, is of the size now usually adopted by the local committees, and has a most appropriate design on the cover. Undoubtedly most of the members attending the York meeting will take an interest in the relics of the past with which this ancient city abounds. It is natural, therefore, that by far the greater portion of the book should be devoted to a description of the various antiquities from prehistoric to mediæval times. The editor, Dr. Auden, describes the prehistoric remains, Mr. H. M. Platnauer refers to the relics of the Roman and Danish occupations, and other writers continue the story.

The second part of the volume, which is restricted to 100 pages, contains an account of the geology, botany, zoology, and meteorology of York and district, and, as might be expected from the space allotted, this part of the work is much more condensed, and is not so readable as the earlier portion. The Rev. W. Johnson describes the geology of the district in a chapter exceedingly brief, possibly due to the fact that "the geology of York is, in one sense, of the simplest kind." Dr. W. G. Smith, of the Leeds University, gives an interesting general survey of the botanical features of the district. This chapter is particularly appropriate in view of the leading part being played by Dr. Smith and his colleagues in Yorkshire in reference to botanical survey. Lists of flowering plants, algæ, fungi, Hepaticæ, Sphagnaceæ, Musci Veri; mammals, birds, reptiles, amphibians, fishes, beetles, butterflies, moths, and land and fresh-water shells are given by various York workers. In most cases, unfortunately, the exigences of space prevent much more than lists of species, but it can be safely said that this portion of the handbook forms an epitome of the natural history of the district. Mr. J. E. Clark brings the volume to a close by some meteorological notes.

There are three maps sent with the volume, all of which are excellent. It was a happy thought to reproduce Skaife's archæological map of York, and with the help of the Ordnance Survey department a really charming map of the greater part of Yorkshire is produced. The third is obviously principally for the use of the geological section, and is coloured so as to show the glacial lakes, moraines, &c.

T. S.

Bacteria in Relation to Plant Diseases. By Erwin F. Smith. Vol. i. (Washington, D.C.: Carnegie Institute, 1905.) Pp. xii+285.

An authoritative account of bacterial plant diseases has long been a desideratum, and no investigator more competent than Mr. Erwin Smith, of the U.S. Department of Agriculture, who has himself made important original contributions to the subject, could be found to undertake such a task. The bacterial diseases of plants are, however, only incidentally mentioned in this, the first volume of the work, which is mainly devoted to methods of investigation and to a bibliography of the general literature of bacteriology, exclusive of plant diseases. As a guide to general bacteriological methods we know no better, though, as it is a preliminary to plant bacteriology, methods specially applicable to pathogenic organisms attacking men and animals are necessarily not to be found. Sterilisation, the preparation of culture media, methods of infection, the investigation of chemical products, keeping of records, and equipment of the laboratory are all dealt with very fully, explanatory figures being used liberally. A considerable section is also devoted to an account of photomicrography. The difficult question of the nomenclature and classification of bacteria is critically discussed at considerable length, and forms an excellent summary of the whole subject. At the end of the volume a number of useful formulæ for stains, etc., is collected, and the bibliography, which extends over sixty-four pages, and index complete the work. The volume is excellently illustrated with thirty-one plates and 146 figures in the text. We congratulate Mr. Smith on this, the first, though perhaps the easier, portion of his task, and shall await the appearance of the next volume with considerable interest.

R. T. Hewlett.

Outlines of Zoology. By Prof. J. A. Thomson. Fourth edition, revised and enlarged. Pp. xix+856. (Edinburgh and London: Young J. Pentland, 1906.) Price 15*s*.

This book has very great positive merits and very slight defects. Though it is packed with facts, and can be recommended to students preparing for examinations, yet it is never dull. Prof. Thomson describes animals, not as corpses, but as living creatures with interesting habits that depend largely on their structure. The method leads to expansion, and yet this excellent zoological text-book is a single royal octavo of hardly more than eight hundred pages. Though our author, to use an American term, "enthuses" his readers, he does not waste words over it.

In his general survey in the first chapter he begins with monkeys, as being the animals most like man, and works down to the Protozoa. In the body of the book, reversing the order, he proceeds from the lowest to the highest. This is an ingenious compromise between two methods each of which has something to recommend it. The early chapters, that deal with the functions of animals, the modern conception of protoplasm, the elements of structure, reproduction, the evolution of sex, and heredity are particularly good. The chapter on palæontology is, owing to the necessary limitations, far too short for the subject, but a table makes clear the order in which the different classes of animals appeared upon the earth. When we come to the body of the book we notice, as in the opening chapters, the remarkable clearness of the style; and though morphology is in no way neglected, yet some room is always found for the description of the habits of the animals in question. For instance, there are some eight pages devoted to the habits and functions of birds, their modes of flight, their courtship, their nests, moulting, diet, migrations.

One or two minor points may now be mentioned that seem to be open to criticism. Plants and animals, Prof. Thomson says, "represent the divergent branches of a V-shaped tree of life." But plants originated before animals; the nature of their food proves this beyond a doubt. Animals we must look upon as a branch from the primitive vegetable stem. The account of the Hydromedusæ would be much better for an illustration—a figure of a hydroid with the Medusa of the alternating generation or of Tubularia with its Actinula. Such additions would, of course, increase the bulk of the book, but the figure of a frog (p. 560) is superfluous, since everyone knows what a frog is like. Again, the process of natural selection is easily intelligible without Fig. 378.

F. W. H.

Animal Heroes; being the Histories of a Cat, a Dog, a Pigeon, a Lynx, two Wolves, and a Reindeer. By E. T. Seton. Pp. 362; illustrated. (London: Archibald Constable and Co., Ltd., 1906.) Price 6s. net.

MR. SETON has always something fresh and interesting to tell his readers, and in the present beautifully illustrated volume breaks new ground in attempting to reveal some aspects of the strenuous side of the lives of animals, both wild and domesticated. Every one of the stories, we are told—although of course amplified and set out with the picturesque surroundings the author knows so well how to portray—is founded on the actual life of some individual bird or quadruped; the biography of the lynx being based on the author's own backwood experiences. Where all is so good, fresh, and entertaining, it seems almost invidious to select one portion of the book for special commendation. To our thinking, however, the almost pathetic story of "Arnaux," the homing-pigeon, is far ahead of the rest in sustained interest; but some may prefer the history of the tame wolf, while to others, again, the narrative of the wild reindeer may appeal more strongly. Alike to young and old the book may be heartily commended as an excellent example of the best style of animal biography.

R. L.

Some Facts about the Weather. By William Marriott. Pp. 32. (London: Edward Stanford, 1906.) Price 6*d*.

THIS pamphlet supplies just the information about meteorological phenomena likely to be useful to the general public. The instruments in use in climatological stations are enumerated, and the determining factors of climate are explained in order. The booklet should be the means of stimulating interest in the scientific study of weather.

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.*]

Osmotic Pressure.

PROF. KAHLENBERG's letter published in NATURE on July 5 shows that, as so often happens, the controversy about osmotic pressure is based on a difference in meaning assigned to that term.

We may adopt what now appears to be Prof. Kahlenberg's conception, and regard the osmotic pressure of a solution as a real experimental pressure reached with some actual membrane in certain practical conditions. Such a definition gives us a conception of great interest and importance, especially from a physiological point of view. But unfortunately it has no bearing on the thermodynamic theory of solution—or the allied theories of fusion and evaporation—which apparently Prof. Kahlenberg still wishes to attack by its means, after he has insisted that "the formation of crystals from a solution, or the concentration of a solution by evaporation are not osmotic processes." Of course they are not osmotic processes in Prof. Kahlenberg's sense of the term. But the theory of fusion and evaporation, which, as I pointed out in my letter published on May 31, has been verified experimentally in the case of the depression of the freezing point to an accuracy of nearly one in a thousand, depends on the hypothetical separation of solvent by some ideal and perfect semi-permeable process.

It is such considerations as these that demand the other conception of osmotic pressure, which, suggested no doubt by Pfeffer's experiments on osmosis, has now, in accordance with the usual course of development of the concepts of physical science, come to possess an ideal significance, towards which the actual experimentally measured quantity can but tend as the experimental conditions approach the ideal state postulated in the theoretical definition.

Defining osmotic pressure as the hydrostatic pressure needed to keep a solution in equilibrium with its solvent across an ideally perfect semi-permeable membrane, we obtain a conception, possibly of less chemical and physiological importance, which nevertheless enables us to develop a thermodynamic theory of solution; and this theory has been verified experimentally in cases where we have reason to suppose that the actual conditions approach the ideal.

I have found that this confusion of ideas as to the conception of osmotic pressure has occasioned trouble in other cases. It would be well if a new name could be applied to osmotic pressure when used in one or other of its meanings; but I suppose that each side in the controversy would insist on the rights of possession and customary usage. Hence I would suggest that, at the cost of some complexity of nomenclature, one of the two meanings should be emphasised as "experimental osmotic pressure" and the other as "thermodynamic osmotic pressure."

Prof. Kahlenberg remarks that "in creating the theory of electrolytic dissociation, the actual phenomena of electrolysis have played a minor part," and wishes thus to invalidate my statement that "the theory rests on electrical evidence, and by such evidence it must be tried." I can hardly believe that Prof. Kahlenberg would wish seriously to commit himself to the opinion that the historical train of ideas by which a given hypothesis may have been reached necessarily supplies the only (or even the best) logical basis for its support. We do not always doubt the stability of our houses because it has been necessary or convenient to remove some of the scaffolding used in their construction.

It is true that the abnormally great osmotic pressures and freezing-point depressions of electrolytic solutions originally suggested that the molecules of their solutes were dissociated; but such observations clearly can give no information on the electrical state of the dissociated structures. A valid test for an electric ion must depend on some electrical property, such as motion in an electric field.

At the request of Prof. Armstrong, I have summarised already what seems to me the electrical evidence for the dissociation theory, and I will not repeat what appeared in your columns of May 31; but I wish again to express a hope that someone who rejects the theory will put forward an alternative scheme to explain the mechanism of electrolytic conduction. W. C. D. WHETHAM.

Trinity College, Cambridge, July 13.

The Fertilisation of Pieris.

ON May 20, near Chindi, in the State of Sukét, North-Western Himalaya, I was able to make notes on the pollination of *Pieris ovalifolia* by *Pieris brassicae, Pieris soracta,* and other insects. *Pieris ovalifolia,* D. Don, at Chindi, grows to be a small tree in forests of *Pinus longifolia* and *Pinus excelsa* on hill-sides about 6000 feet, where in May thousands of *Pieris soracta,* and hundreds of *Pieris brassicae,* flit through the trees.

My first observations were made about 6 a.m., before the sun was fully on the hill-side; and then the Pieris flowers were visited by *Bombus haemorrhoidalis,* Smith, in a very diligent way. Later, after the sun was well up, came *Pieris brassicae,* Schrank, to the flowers, and then many individuals of *Pieris soracta,* F. Moore, which is in May a most abundant butterfly. With the butterflies a large steel-blue and orange wasp came to the Pieris bushes, and bit holes in the corollas, which later little Aphids also used for stealing the honey.

Pieris branches stand horizontal, with the leaves on a plane above the racemes of flowers. There are twenty to thirty flowers on a raceme, and the topmost open as the lowest die. Each flower is a bell, like that of one of our common English Ericas, 10 mm. long, and very slightly constricted at the middle; the mouth is only 2 mm. in diameter. Pierids and Bombus suck honey hanging under the bells, except where some fortuitous circumstance brings the flowers of one branch close to the leaves of another; and then the butterflies are very ready to try to get the honey without having to hang back downwards to reach into the bells. When once back downwards they walk as on a causeway along the long, regular racemes, generally from younger to older flowers, *i.e.* towards the base.

Pieris anthers are two-horned, as are so many of the anthers in the Ericaceæ, and with the help of their filaments make an entanglement at the constriction of the bell. The filaments are much more bent into an S than is usual in the Ericaceæ, and form a spring which, by pressing with the lower curve of the letter against the corolla, holds the anther pores against the style, in such a firm manner that they can only free the powdery pollen when the pressure of the spring is interfered with. This the visiting insects do, and receive a shower of pollen on their heads or probosces. As it is impossible to slit the corolla without causing pollen to fall, the part it plays in keeping closed the anther pores is evident; and it is also impossible to push a needle past the ring of anthers without liberating pollen. The stigma is close to the mouth of the flower, and is bound to be touched by an insect's tongue before it touches the anthers. When mature it is 4·5 mm. beyond the anther-ring. The stigma matures after the opening of the flower, and the style grows 1·5 mm. between the opening of the bud and its maturity, but the anther-pores appear in the bud. Honey is secreted very abundantly behind the slightly broadened bases of the filaments. The duration of the flowers is several days. After the fall of the corolla, the sepals close over the ovary, and the pedicel ultimately turns upwards.

I have communicated the above actual observations to NATURE in the hope that both zoologists and botanists may read them, and be reminded of the possible inconveniences resulting from using the same generic name for two even very distinct organisms. I admit that we are not at present at all likely to rule that a previous use of a name in zoology or botany precludes its use in botany or zoology; but it is desirable to do what one can to avoid using used names, and to forward that end indexes like Durand's "Index Generum Phanerogamarum" become the more and more wanted, especially from the zoologists.

I give here just a few instances of the double use of a generic name. Liparis is the nun moth of Europe and an orchid of Europe; Iris is an insect and the well-known plant; Lælia is a moth and an orchid; Adesmia is a beetle and a shrub; Castalia is a beetle of India and the water-lily, while Castalius is an Indian butterfly; Graeffea is a Phasmid of Fiji and a plant of Fiji; Empusa is an insect and an insect-killing fungus; Prosopis is a bee and a plant; Stilbum is a Chrysid and a fungus; Acrocephalus is a bird and a herb; Taphria is an insect and the legitimised form of Taphrina, a fungus. To emphasise my point it will be my endeavour to ascertain if a fungus of the genus Empusa can destroy the insect Empusa, if Castalius visits Castalia, and if Acrocephalus eats the seed of Acrocephalus.

I. HENRY BURKILL.

Indian Museum, Calcutta.

AUSTRALIAN ORIGINS.[1]

IF the enthusiasm which leads a man of science to travel at midsummer to one of the hottest regions of the world may be taken as evidence, geology will soon have much to say on Australian anthropological problems. Prof. Gregory, at the instigation of Dr. Howitt, visited the Lake Eyre region, with a prospect of encountering a temperature of some 120° F., in order to throw light on the legends of the aborigines and the problem of their original home. All over Australia are found stories of monsters like the Bunyip; but in the Lake Eyre region they present peculiar features; the animals, called Kadimakara, are said to be extinct, and are represented as arboreal in their habits according to one form of the legend, aquatic in another. The latter is of no special interest, but it is difficult to see how the idea of sky people and animals could have originated in Australia, the vegetation of which is not apt to suggest the idea. Prof. Gregory sees in it evidence of migration, either of legends or of their narrators, from tropical parts.

It is certain that at the present day transmission of the dramatic performances known as corroborees is very common. The expedition saw on the Peak Station, west of Lake Eyre, a corroboree known to have travelled from North-west Central Queensland since the year 1893. From a photograph in the possession of the present writer it is certain that the dance called Molongo in Queensland and Tji-tjingalla near Lake Eyre was known to the Arunta at Alice Springs in 1903 or 1904; but whether it came *viâ* the Peak or from the north-east cannot be determined. From Dr. Howitt and others we learn that new songs are passed from tribe to tribe, their meanings being forgotten; and the tendency seems to have existed in the 'thirties of the last century, so that it cannot be put down to European influence and easier communication. There is, however, no similar evidence of transmission of myths; *prima facie,* therefore, there is no ground for supposing that the Kadimakara story is of foreign origin; to raise the presumption it would be necessary to find its analogue elsewhere.

The argument for the foreign origin of this myth rests in part on the assumption that the geographical conditions of the region have been unchanged since its present, or rather, in only too many cases, late occupiers reached it. In proof of this Prof. Gregory quotes legends explaining the origin of natural features and representing them as the same when they were first known as they are at the present day. But it is clear that we are not entitled to assume the

[1] "The Dead Heart of Australia; a Journey round Lake Eyre in the Summer of 1901–2, with some Account of the Lake Eyre Basin and the Flowing Wells of Central Australia." By Prof. J. W. Gregory, F.R.S. Pp. xvi+384. (London: John Murray, 1906.) Price 16s. net.

same age for all items in a stock of folk-tales; and in any case the evidence of myths is untrustworthy in matters of history. It seems possible that man was in the area before the great climatic changes described in the work before us; the failure to find worked stones associated with the extinct marsupials cannot be regarded as decisive until a wider search has been made.

Unfortunately, Prof. Gregory was unable to see more than a portion of the Tji-tji-ngalla corroboree. Its transmission raises interesting problems; in Queensland the Molongo is a kind of evil spirit, and it would be interesting to know whether it is in this light that the principal performer is regarded in Central Australia. Some of the words are recorded, and the author is disposed to see in the fact that they are untranslatable by the performers evidence of rapid changes in language. But it is the unintelligibility which causes the changes, and not *vice versa*. The song passes from tribe to tribe, and is unintelligible a few miles from its centre of origin. The change in corroboree words is therefore comparable to the variations introduced by children into counting-out rhymes, &c., which they have learnt, parrot fashion, from a foreigner; these changes would not be evidence of modifications in European languages.

By discovering dingo bones in association with those of the Thylacinus, now found alive only in Tasmania, Dr. Gregory has added force to the argument that the dingo was not introduced by man. He also argues that the Tasmanians must have been in Australia before the dingo if, as Dr. Howitt argues, they passed into Tasmania by land. On the relation of the Tasmanians and Australians Prof. Gregory has seen reason to change his view. He now holds that there is no evidence of intermixture, and points to the singular uniformity of type in Australia as evidence of racial purity. Against this it may be said that there is considerable variation in hair, as may be seen by comparing Taplin's South Australian types with Spencer and Gillen's Central tribesmen. As Prof. Gregory points out, the skull is more variable than hair; similarity of physical conditions may have more to do with similarity of skull-type than any original uniformity of physical type.

The latter half of the book is devoted to a discussion of how the dead heart of Australia can be revived, and of the origin of the water supply of the so-called artesian well in Australia. It appears that the scheme for an inland sea, to be formed by supplying Lake Eyre with water from the Southern Ocean, is impracticable. It would cost little less than the amount of our national debt. Prof. Gregory protests against the waste of water from the wells, justifiable only on the supposition that they will never cease to flow. Experience shows that they are already diminishing their supplies, not from any choking of the bores, but from more radical causes, and it is suggested in the work before us that the real source of the supply is not meteoric, but plutonic; in other words, Australia is recklessly drawing on a banking account which has been steadily piled up for tens or hundreds of thousands of years. Unless measures are taken to check youthful extravagance, future generations of colonists will have cause to regret that no heed is paid to the warnings of geologists.

The work is excellently illustrated by numerous maps, plans, and plates. Anthropologists will look forward to the other work on the aborigines which Prof. Gregory promises in the preface. N. W. T.

Fig. 1.—The Tji-tji-ngalla Corroboree, as performed at Kilalpaninna. From "The Dead Heart of Australia.

SOME RESULTS OF THE "BELGICA" EXPEDITION.[1]

THE voyage of the *Belgica* is an important landmark in Antarctic exploration, for, in addition to its adventurous journey and its valuable geographical discoveries, it was the first expedition to make deep-sea collections within the Antarctic circle. The scientific results of the expedition are in process of publication in a fine series of volumes which will long be an indispensable work of reference on Antarctic geography and biology. The three memoirs the titles of which are given below contain further instalments of the geographical, botanical, and zoological contributions.

FIG. 1.—The stream falling into Torrent Bay, Beagle Channel.—Magellan Strait.

The second part of the first volume of the "Rapports scientifiques" of the expedition gives the technical geographical observations, and some account of the methods. Every effort has been made to remove uncertainty as to the geographical positions attained, as the calculations for some of them are repeated at length. The text is mainly devoted to detailed descriptions of the harbours and coasts visited in the Magellan Archipelago, and in the subsequent journey past Graham's Land and through Gerlache Strait, and there is a full account of the long drift of the *Belgica* in the ice, from February 19, 1898, to March 15, 1899. The volume is accompanied by an atlas of seven charts, of which those of Gerlache Strait and of the drift in the ice contain most new information. The text is illustrated by twenty-nine photographs and plates, many of which are of unusual merit. Most of the photographs were taken by Dr. Cook, others by M. Lecointe, and some by M. Arctowski.

M. É. de Wildeman's report on the phanerogams of the Magellan Archipelago is based upon the material collected by M. Racovitza, during a short stay there, before the departure of the expedition to the south. The report begins with a description of M. Racovitza's collection, and, as many of the species were imperfectly known, the author has taken this opportunity of giving a detailed account of them, illustrated by a series of fine plates. Then follows a systematic enumeration of the phanerogamic flora of the southern part of Patagonia and of the adjacent archipelago, and a detailed table of distribution. The author concludes that the new collections show that the flora of Tierra del Fuego is less primitive and distinct from that of the mainland of South America than had been thought. All the species are found on the American continent, and some of them have a wide distribution. Amongst other British species there are *Rumex maritimus*, on Tierra del Fuego, while *Urtica dioica* and *Veronica arvensis* occur on the mainland.

The memoir by M. Dollo on the fish collected by the *Belgica* discusses problems of more general interest

FIG. 2.—Sierra Du Fief (Wiencke Island).

than those of the two other reports. It includes a systematic description of the fish collected by the expedition, including three new genera—Cryodraco, Gerlachia, and Racovitzaia. The Cryodraco is of some historic interest, as a specimen no doubt belonging to this genus was caught frozen against the bow of the *Erebus* during Ross's expedition. The fish was sketched at the time by Robertson, but it was devoured by the ship's cat before it could

[1] "Expédition Antarctique Belge. Résultats du Voyage du S.Y. *Belgica* en 1897–99 sous le Commandement de A. de Gerlache de Gomery." Rapports scientifiques. Travaux hydrographiques et Instructions nautiques. Vol. i., part i. By G. Lecointe. Pp. 110, xxix plates, with a portfolio of 7 charts. (Antwerp, 1905.)
"Botanique—Les Phanérogames des Terres Magellaniques." By É. de Wildeman. Pp. 222, xxiii plates. (Antwerp, 1905.)
"Zoologie—Poissons." By L. Dollo. Pp. 239, xii plates. (Antwerp, 1905.)

be preserved. The fishes collected by the *Belgica* in the Weddell Sea were all pelagic. One species, a Nematonurus, came from a depth of 2800 metres. In addition to the account of the first deep-sea fish collected within the Antarctic circle, there is an account of a larger collection made in the Magellan Archipelago, accompanied by a bibliography and full account of the fish fauna of that area. The fish are not only described and illustrated with M. Dollo's usual skill and care, but their significance is discussed in the very interesting chapters devoted to their zoo-

FIG. 3.—Cryodraco, according to Robertson's sketch made on the *Erebus*.

logical and geographical relations. M. Dollo maintains that the Antarctic fish are of modern development and highly specialised, and are not, as has been thought, a primitive fauna. He discusses the problem of bipolarity, which has commanded wide attention owing to its advocacy by Sir John Murray. M. Dollo maintains that the evidence of the fish gives no support to this theory. Thus he points out that in the Antarctic area the predominant family of fish is that of the Nototheniidæ, whereas in the Arctic Ocean the dominant group is the Cottidæ. In the wide distribution of the Nototheniidæ in the Southern Ocean and the South Pacific M. Dollo sees further support of the existence of the assumed Miocene Antarctic continent, connected with New Zealand, Australia,

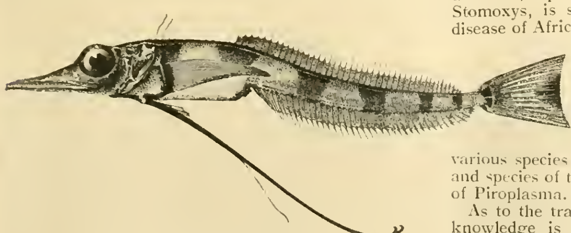


FIG. 4.—Cryodraco, according to Dollo.

and South America, but separated from South Africa; for eleven-twelfths of the Nototheniidæ are littoral species, and, according to Dollo, they can only have spread along the former shores of this sunken land.

J. W. G.

YELLOW JACK.[1]

THE main facts established regarding yellow fever and mosquitoes can be summed up in a few propositions.

(1) The cause of yellow fever is unknown.

(2) Yellow fever is transmitted by one particular mosquito, known to science as *Stegomyia fasciata*, and by no other mosquito or in any other way.

(3) In order to transmit the infection, the Stegomyia must have sucked the blood of a patient during the first three days of the fever, not earlier (during the incubation period), and not later.

(4) The infection is transmitted after an incubation period in the mosquito of not less than twelve days, and the mosquito may still be infectious fifty-seven days after its first infection.

It is a peculiar fact that although there are many species of Stegomyia, so far as is known it is only *S. fasciata* that is capable of transmitting the disease. If we may accept this as established, it points to a peculiar relationship between the mosquito and yellow fever which is not exactly paralleled by the case of any other disease-transmitting agent, be it mosquito, fly, or tick.

In the case of malaria, filariasis, and trypanosomiasis there is not this absolutely limited correlation between the disease and the agent that transmits. Malaria we know is transmitted only by mosquitoes of the subfamily Anophelina of the Culicidæ. This subfamily is divided into a number of genera, and not only do different species of the same genus, *e.g. Myzomyia culicifacies* and *Myzomyia funesta*, transmit malaria, but also species pertaining to different genera, *e.g. Pyretophorus costalis* and *Anopheles maculipennis*, or, if we do not accept these as different genera, and classify them all as belonging to a single genus, Anopheles, still we have the fact of transmission by different species. In filariasis the correlation between Filaria and the mosquito is still less definite; thus not only various species of Culex, but various species of Anopheles all permit of the development of the microfilariæ (filarial embryos) in their tissues. (It may be well to say in passing that the proof that mosquitoes actually do transmit Filaria is still wanting.)

Our knowledge of the correlation of trypanosomes and flies, especially species of Glossina, Tabanus, and Stomoxys, is still incomplete. Ngana, the tsetse-fly disease of Africa, is transmitted by species of Glossina, but not by Stomoxys or Tabanus. The trypanosome of sleeping sickness is transmitted by *Gl. palpalis* mainly, but also by other species; but it is not yet known which exactly these are.

Again, in the transmission of various species of Piroplasma by ticks, various genera and species of ticks suffice to transmit the same species of Piroplasma.

As to the transmission of Spirochætes by ticks, our knowledge is at present incomplete, and it would be especially interesting to discover if the relationship were as strict as it appears to be in yellow fever, for Spirochætes (invisible) have been suggested by Schaudinn as the possible cause of yellow fever.

The fact, then, that yellow fever appears to be transmitted by only one genus of mosquitoes, and only one species in that genus, points to some very peculiar relationship, and would suggest an organism as the cause, of a different kind from any of those we have mentioned, and, indeed, this is no doubt the case, as, if it had not been so, the cause would have been already discovered.

Yellow fever, then, is transmitted by a particular and practically world-wide mosquito, *Stegomyia fasciata*. The fact still requires emphasis that mosquitoes only *transmit* disease from the sick person to the healthy after certain changes have proceeded in the tissues of the mosquitoes, and that mosquitoes

[1] Report to the Government of British Honduras upon the Outbreak of Yellow Fever in that Colony in 1905, together with an Account of the Distribution of the *Stegomyia fasciata* in Belize, and the Measures necessary to stamp out or prevent the Recurrence of Yellow Fever. By Rubert Boyce, M.B., F.R.S. Pp. ix+104+13 Plates. (London: Waterlow and Sons Ltd., 1906.)

do not get malaria, yellow fever, &c., from the water of pools or marshes.

The author in this report emphasises the necessity for the knowledge of these facts, for, as he points out, it is useless to expect an intelligent carrying-out of prophylactic measures by those ignorant of the present state of our knowledge, or by those who have a "conscientious belief" that malaria is due to marshes and yellow fever to digging the soil.

FIG. 1.—Operations in yellow fever prophylaxis at New Orleans. An outhouse completely closed with paper.

The *Stegomyia fasciata* is essentially a domestic mosquito, *i.e.* it frequents houses, it breeds in domestic utensils, pots, cisterns, tubs, tins, calabashes, boats, flower-pots, &c., in fact, in any collection of water about a house.

The destruction of larvæ is, therefore, a comparatively simple matter, and if the water were emptied out, thousands of potential mosquitoes would be at once destroyed. Where it is impossible to empty any collection of water, then the simple device of covering the receptacle with suitable gauze has the same effect. So that the destruction of larvæ of Stegomyia can readily be effected if only people will or can be compelled to do it!

We may express some doubt, however, as to what would happen supposing Stegomyia suddenly by some governor's edict found all their breeding tubs emptied of water or covered over. Would they be content to die, or would they now breed in ditches, canals, slowly-flowing streams, &c., as Anophelinæ do? We think they would choose the latter course, and this point is not solely of academical interest, for the most vigorous campaign against tubs and cisterns might have been carried out, and yet the Stegomyia might now be enforced to breed in drains, canals, &c., and if these existed in the midst of the town it is conceivable that the condition of things might be no better than before. For the doing away with canals, &c., implies drainage and re-levelling, and is a far more expensive matter than mosquito-destroying in back-yards. But no considerations of this kind should restrain us from doing our utmost absolutely to free a town of its tub-bred larvæ, and that this is possible is shown by experience at Havana and New Orleans.

Not only must the larvæ be proceeded against, but also all adult mosquitoes, and that this is not the impossible task it might at first sight appear has also been shown by the Americans.

By very simple means, by pasting up a house with sheets of paper, and by the use of a suitable fumigating mixture (camphor and carbolic acid), not only rooms, but outhouses and sheds can be expeditiously and completely freed from mosquitoes.

By these means the epidemic of yellow fever in New Orleans of 1905 was rapidly brought to an end. The history of the epidemic shows what can be done by systematised effort supported by the intelligent cooperation of the whole of a city.

The present very able and comprehensive report sets out at length the conditions prevailing in British Honduras, showing how in Belize, the capital, and other towns all those conditions exist which in the light of our present knowledge should not exist. *Stegomyia fasciata* exists in profusion, and breeds freely, and so far without hindrance, in water vats, tanks, wells, barrels, tins, and a multitude of other receptacles.

In considering the origin of the outbreak of the disease in British Honduras, the author adopts the view that the disease was imported, and does not discuss another possibility. It is well known, however, that among the native population in yellow-fever areas the children suffer from extremely mild attacks of fever, and, indeed, many of these cases are not recognised as such. By this means an endemic supply of yellow fever may always exist, and it may be only at some years' interval that the disease breaks out again in epidemic form.

Apart from this, however, the outbreak of the epidemic is minutely traced, and the difficulty of detection of early cases, and the resulting fatality under such conditions, emphasised.

FIG. 2.—House in Belize with waterlogged yard. Numerous water receptacles consisting of barrels and kerosene tins.

The necessity for efficient sanitary survey, especially in the matter of breeding-places, is pointed out.

Finally, we have a complete account of the influence on shipping and disturbance of trade of such an outbreak, and a full discussion of quarantine regulations of various authorities.

For the administrator and sanitarian in yellow-fever zones the report is indispensable. For permission to reproduce the above two plates we are indebted to the courtesy of the Colonial Office.

J. W. W. STEPHENS.

SCIENTIFIC WORK OF THE SURVEY OF INDIA.[1]

IF any apology were needed for the maintenance of the scientific work of the Indian survey it will be found in No. 9 of the series of professional papers of that department, which has been especially prepared for the use of the Survey Committee of 1905 by Lieut.-Colonel S. G. Burrard, R.E., F.R.S., the Superintendent of Trigonometrical Surveys in India. That committee was appointed for the purpose of examining into the existing system of the Indian Survey Department with the view of rendering it more efficient as a topographical institution, having regard to the increasing demand for more accurate military mapping in India, and the necessity for more perfect revision of those maps which are gradually falling out of date with the advance of public works developments. India is an unscientific country. The scientific members of the Anglo-Indian community would hardly fill a first-class carriage on any railway line, and they exist only as paid servants of the Government, living in constant fear of "reduction" when any financial crisis occurs. They have to justify their existence from time to time, and Colonel Burrard is to be congratulated on the very effective justification which he has given to the public for the maintenance of the scientific branches of his own department. It is all the more valuable for the reasons that the booklet which contains his opinions is written in clear and simple language, intelligible even to the most unscientific reader, and that it appeals directly to a far wider circle of men of science than can be found in any one department. The various sections of the scientific work which Colonel Burrard superintends are principal triangulation, levelling, astronomical, pendulum, magnetic and tidal observations, and solar photography. He deals with them all in turn concisely, showing their relative interdependence and their practical utility.

No distinction is drawn by Colonel Burrard between scientific and practical work. He maintains rightly that their relations are constant. "The primary object of a national survey is the making of maps, and all operations are subordinated to that end. It is for topographical purposes that a national survey measures its allotted portion of the earth's surface. If, however, these measurements be combined with astronomical determinations, the size and shape of the earth can be deduced, and a knowledge of this size and shape is essential to astronomers, geographers, geologists and meteorologists, all of whom look to surveys for information." Here, then, is the principle of geodetic triangulation enunciated, and the wholesome doctrine recalled to mind that it is the measurement of "areas," and not "arcs," which will be found most useful for the geodesist as for the practical topographer. The connection between the principal triangulation and secondary methods is well illustrated, and incidentally we are shown the relative degrees of accuracy of the triangulations of different countries. Taking the ratio between precision and length of the triangulation of Great Britain as a unit, we find that ratio to be 0·6 in Russia and 0·7 in India, the only two countries which can claim a superior degree of accuracy; while in France and Prussia it rises to 2·5 and 2·6 respectively, and we are told that South Africa and the United States are equal in precision to France and Prussia. This is something of a surprise, for we were always under the impression that the triangulations of these two last countries was of a very high degree of accuracy as compared with that of older systems.

Colonel Burrard proceeds to show that we have by no means arrived at an ideally accurate framework for the basis of our mapping even yet. Accurate as the process of measurement may be, inaccuracies in the data for reducing observations introduce very considerable and very practical errors. The deflection of the plumb line, the deformation of the earth's figure (which has upset the original calculations of the earth's size, giving it a diameter which is two miles too short), and other physical causes of initial error have this effect, amongst others, viz., that we are 1000 feet too far north with our position of Peshawar in northern India, and two and three-quarter miles too far east with our position of the Salween River in Burma. This is of little consequence until we come to an international junction with other surveys. It has already had a certain effect in the junction of the geographical surveys of Afghanistan and Russia, which (after making due allowance for these errors) was fairly satisfactory. When, however, a connection between the principal triangulations of these two countries is effected, it may become necessary to revise our Indian data; but, as Colonel Burrard wisely points out, unless we are to continue systematically to combine with other countries (notably South Africa and America) in the elucidation of those scientific problems which form the basis of the world's mapping, we shall never reach the possibility of a final revision which will place our international boundary pillars in the same terms as regards their position on the earth's surface.

No practical surveyor will quarrel with Colonel Burrard's conclusions, or be disposed to criticise his plea for extending the principal triangulation of India far enough to cover the Indian borderlands, where it is of almost paramount importance that we should possess a substantially accurate basis for topography. After all, this preliminary work of the most scientific class only adds 10 per cent. to the final cost of the survey.

The interdependence of astronomical, pendulum (for investigating the eccentricities of the force of gravity), and levelling operations is duly emphasised, and in connection with the latter some interesting details are given regarding the probable heights of the highest peaks in the Himalayas. These details have already been referred to in the pages of NATURE. Investigations into magnetic phenomena and solar physics speak for themselves. They cost little, and add greatly to the sum of our scientific knowledge of the data surrounding certain most obscure and elusive natural forces.

As a unit in the series of professional papers of the Indian survey, this is perhaps the most important that has yet appeared, and it is one which appeals to a world-wide community of practical surveyors.

[1] Survey of India, Professional Papers, Serial No. 9, 1905:—An Account of the Scientific Work of the Survey of India, and a Comparison of its Progress with that of Foreign Surveys prepared for use of the Survey Committee, 1905. A pamphlet by Lieut.-Col. S. G. Burrard, R.E., F.R.S. (Calcutta: Office of the Superintendent of Government Printing, 1906.) Price 1s. 6d.

NOTES.

THE knighthood just conferred upon Dr. W. H. Perkin, F.R.S., has given much satisfaction in scientific circles. The great interest being shown in his services to science and industry, on account of the celebration of the coal-tar colour jubilee to-day and to-morrow, makes this official mark of recognition of his work particularly welcome. It was fifty years ago when Sir William Perkin discovered the first anilin dye—mauve—and so founded the coal-tar colour industry, which has been so profitably developed in Germany. His knighthood, with the other honours and addresses which will be presented to him at the Royal Institution to-day, thus form an appropriate crown to his successful career.

THE University of Oxford has recently taken a new departure in scientific teaching. Under the energetic conduct of Prof. Sollas, a contingent from the geological class started to spend a week among the Alps for the purpose of studying on the ground the structures which have in recent years been so keenly studied and discussed, especially the recumbent folds that are claimed to play a large part in the architecture of the mountains. At Lausanne on June 30 they were met by the enthusiastic explorer of Alpine geology Prof. Lugeon, who took charge of the excursion, and enabled the members of the party to see with their own eyes some of the gigantic disturbances to which the region has been subjected. They followed one after the other the folds and internal structure of the Préalpes médianes, and finished up with a glimpse of the successive vast folds of the central crystalline region. Starting sometimes as early as 5 a.m., they spent long days in climbing and viewing the disposition of the rocks from favourable points of view, and, thanks to the clear expositions of the eminent Swiss professor, learnt more in a few days on the ground than they could have acquired by months of sedulous reading.

THE Matteucci medal for 1906 of the Società Italiana della Scienze, the president of which is Prof. Cannizzaro, has been conferred upon Sir James Dewar.

THE Paris correspondent of the *Times* announces the death, at the age of sixty-nine, of Dr. Brouardel, for many years professor of legal medicine at the University of Paris and president of the consultative committee of hygiene.

WE regret to announce that Sir Walter L. Buller, K.C.M.G., F.R.S., distinguished by his work on "The Birds of New Zealand" and other contributions to science, died on July 19 at sixty-eight years of age.

THE death is announced of Mr. J. A. Wanklyn, at the laboratory, New Malden, Surrey, in his seventy-third year. Mr. Wanklyn was a member of the Bavarian Academy, and was well known as an analytical chemist.

A MESSAGE from Danes Island reports that Mr. Wellman has now established wireless communication from within 600 miles of the Pole *viâ* Hammerfest. Everything is progressing favourably at the camp. The construction of the balloon-house is being continued. It is hoped that the expedition will start on its aërial voyage toward the Pole in the middle of August.

ON the east coast patches of burnt earth occur scattered along the margin of many creeks and saltmarshes, especially in Essex. A committee has been formed under the auspices of the Essex Archæological Society and the Essex Field Club for the systematic study of these interesting relics of antiquity, generally known as "red hills," and the settlement, if possible, of the many questions relating to them. Among the members of the committee are Mr. Miller Christy, Mr. William Cole, Mr. T. V. Holmes, Prof. R. Meldola, F.R.S., Mr. F. W. Rudler, and Mr. H. Wilmer, hon. sec. and treasurer. The chairman of the committee is Mr. I. Chalkley Gould.

THE well-known balloon journey made by Comte de Lavaux, the French aëronaut, at the time of the Paris Exhibition in 1900, when the distance from Paris to Moscow was traversed in forty-one hours, was recently surpassed by the brothers Wegener, of the German aëronautical observatory at Lindenberg. The details of their ascent have now been published in the Strassburg *Aeronautische Mittheilungen*. The balloon, of 36,000 cubic feet capacity, and inflated with hydrogen, started from Berlin at 9 a.m. on April 5 last, and descended at 9 p.m. on April 7 six and a half miles east of Aschaffenburg. During their journey of at least 900 miles, the Wegeners crossed the Baltic Sea and Jutland twice, once travelling north and again on the return journey. The route was determined by astronomical observations at night and by visual and photographic observations during the day. The altitudes at which the journey was performed were as follows:—during the day of April 5, 1200 metres; on the night of April 5–6, from 200 metres to 800 metres; from sunrise to midday on April 6, up to 2900 metres; from midday to sunset of the same day, 300 metres to 1000 metres; during the next night, from 100 metres to 800 metres, except when in the vicinity of Hamburg, where the balloon was taken to a height of 2900 metres. The greatest altitude, of 3700 metres, was reached on April 7. The lowest temperature recorded was $-16°$ C.

THE seventh International Zoological Congress will be held in America in August or September, 1907, under the presidency of Mr. Alexander Agassiz. The arrangements for the congress are in charge of a committee of the American Society of Zoologists. The meetings will open in Boston, where the scientific sessions will be held, and from which excursions will be made to Harvard University and to other points of interest. At the close of the Boston meeting the members will proceed to Woods Hole, Massachusetts, visiting the station of the United States Bureau of Fisheries, the Marine Biological Laboratory, and the collecting grounds of the adjacent seacoast. The journey to New York will be by sea through Long Island Sound. In New York the congress will be entertained by Columbia University, the American Museum of Natural History, and the New York Zoological Society, and excursions will be made to Yale University, to Princeton University, and to the Carnegie Station for Experimental Evolution. From New York the members will proceed to Philadelphia and Washington. The first formal circular announcing the preliminary programme of the congress will be issued in October next. All inquiries should be addressed to Mr. G. H. Parker, Seventh International Zoological Congress, Cambridge, Massachusetts, U.S.A.

WITH the recent motor-bus accident on Handcross Hill fresh in our memories, and the discussion that has arisen in the Press in consequence, it is satisfactory to find that at least one note of improvement has been struck, according to the description of an electrically controlled petrol motor-bus given in the *Standard* of July 21. The demonstration referred to was given on the scene of the recent disaster, and the descent was made in perfect safety without the use of any brakes whatever, the driver keeping his feet above the splash board to prove that no pedal brake was in use, and the side hand-brake was tied and sealed before starting the descent. The omnibus in question was driven by an ordinary four-cylinder petrol engine, but was practically under electrical control. The engine is started by an electrical device, and the variations of speed are under electrical control, the clutch and foot-brake being electromagnetic and controlled by one pedal. The speed control is obtained by shunt regulation of the dynamo in combination with the ignition and carburation, and gives the driver—it is claimed—perfect control without the use of brakes. Various tests for pulling up and starting were made and proved satisfactory, and the steepest portion of the hill was taken at a snail's pace without the use of brakes. We can only hope that, should this new method of control continue to prove so satisfactory, it will be adopted by the motor omnibus companies, and thus help to re-establish public confidence in one of the most useful innovations of recent years.

THE provisional programme of Section B (Chemistry) of the British Association meeting at York has just reached us; it is as follows:—*August* 2. Presidential address, Prof. W. R. Dunstan; chemical research in the Dutch East Indies, Dr. Greshoff; utilisation of nitrogen in air by plants, T. Jamieson; the electrical discharge in air and its commercial application, Sidney Leetham and William Cramp; the action of ammonium salts upon clay and kindred substances, A. D. Hall; oxidation in soils and its relation to productiveness, Dr. F. V. Darbishire and Dr. E. J. Russel. *August* 3.—Report, present position of the chemistry of gum, H. H. Robinson; on a gum (*Cochlospermum gosipium*) which produces acetic acid on exposure to air, H. H. Robinson; report, hydrolysis of sugars, R. J. Caldwell; papers by the president and Dr. T. A. Henry and by Dr. Greshoff. Joint discussion with Section K, the production of hydrocyanic acid by plants. *August* 6.—Report, present position of the chemistry of rubber, S. S. Pickles; the constitution of caoutchouc, Prof. Carl Harries (Kiel); paper by Prof. W. A. Tilden; report, the study of hydroaromatic compounds, Prof. A. W. Crossley. *August* 7.—Joint discussion with Section I, the factors which determine minimal diet values, opened by Dr. F. Gowland Hopkins.

A SPELL of the hottest weather this summer has been experienced since the middle of the month over the Midland and south-eastern districts of England. At Greenwich the thermometer in the shade has exceeded 80° on four days since July 17, while there was only one day previously this summer, June 20, with a temperature above 80°. On July 18 the thermometer in the screen registered 86°·2, and on July 23 it registered 84°·7. On three days this month the thermometer in the sun's rays at Greenwich has exceeded 145°. In the northern and western portions of the kingdom the temperature has been generally below the average. At Greenwich the total rainfall this month, to July 24, only measured 0·22 inch, which is about one-tenth of the average. The weekly weather report issued by the Meteorological Office shows that on July 17 and 18 an exceedingly heavy fall of rain occurred in the north-west of Scotland, the aggregate amount for the two days measuring 4·9 inches at Fort William and 4·4 inches at Glencarron. An exceptionally important storm area for the time of year had its centre near the Shetlands on July 19, and strong westerly gales were experienced on the northern coasts of Ireland and Scotland and in the North Sea.

MR. G. A. HIGHT, writing from Audisques, Pas de Calais, states that among the peasantry of that district there is a universal belief that the magpie is a dangerous enemy to poultry, and it is shot by the farmers as vermin. His own observation seems to show that the stories of the magpie's depredations are unfounded, or at least greatly exaggerated, and he would be glad to know whether there is any authority for the belief.

IN the Proceedings of the United States National Museum, vol. xxx., Mr. T. W. Vaughan describes three new species of corals belonging to the genus Fungia, the one a fossil species from Japan, the others being recent forms.

NEW or rare scombriform fishes form the subject of a paper by Mr. H. W. Fowler in the March issue of the Proceedings of the Philadelphia Academy, in the course of which several forms are described as new, while the genus Lepodus of Rafinesque is made the type of a new family. The same issue contains the second portion of a paper by Messrs. Pilsbry and Ferriss on the land-molluscs of the south-western United States.

THE Natural History Museum has just received an important collection of bird and mammal skins from Mount Ruwenzori, East Central Africa, obtained with the aid of subscriptions from a number of persons interested in natural history. The collection, we believe, includes a number of new forms, or of forms previously known only by a single specimen or so of each.

WE are indebted to Prof. K. Heider for a copy of an obituary notice of the late Dr. Fritz Schaudinn, published at Innsbruck, and reprinted from the *Innsbrucker Nachrichten* for June 26. Dr. Schaudinn's career, although brief (1871–1906), was a memorable and active one. Among the subjects to which Schaudinn specially devoted his attention was the study of blood-parasites, his last achievement in this line being the discovery of *Spirochaeta pallida*, which he believed to be the bacterium of syphilis.

A COPY of an illustrated guide to the German section of the International Exhibition at Marseilles devoted to the illustration of subjects connected with the study of the ocean and sea-fisheries has reached us. In the German section, a prominent place is occupied by exhibits connected with the recent deep-sea and South Polar expeditions, and also by others displayed by the German Sea-fisheries Union of Hanover. The frontispiece to the guide represents a reproduction of an Antarctic scene, with seals and penguins on the ice.

IN the summer number (vol. ii., No. 2) of *Bird Notes and News* attention is directed to the wholesale collecting of eggs of the great skua in Iceland, as demonstrated by a photograph in a German ornithological serial, in which a collector is represented with no less than 240 eggs of that species. If egg-hunting is permitted on such a scale, it seems scarcely probable that the skua will long survive in the island. In another article gratification is expressed at the support accorded by Her Majesty the Queen to the crusade against the wearing of "osprey" plumes.

AT the date of publication (1880) of Dr. Günther's "Study of Fishes," but three representatives of the genus Chimæra were known to science. By the description in the Journal of the College of Science of Tokyo University (vol. xx., art. 2) of two new Japanese forms, Mr. S. Tanaka has brought up the number to no less than ten. The author seems to have had abundant material—no less than twenty-one specimens—for the description of his first species, although in the case of the second he had to be content with a couple of examples. Mr. Tanaka has found that the form and direction of the lateral line afford excellent characters for the discrimination of species.

According to the June number of the *Museums Journal*, Salford has acquired a new natural history museum. Photography enters largely into the scheme of arrangement of the galleries, this being employed to illustrate the nesting of birds, and likewise to display the contrast presented by deciduous trees in summer and in winter. Attention is directed in another paragraph to the charge made by the trustees of the British Museum for permission to photograph plates and books in the print-room. It is urged that since publishers—who are compelled to supply the museum with a copy of the most expensive edition of each of their books—are the chief applicants for such permission, the new charge is inadvisable.

The rose-breasted grosbeak, of which a coloured plate is given, forms the subject of the latest educational leaflet (No. 2) issued by the U.S. National Association of Audubon Societies. The following statement in favour of this bird is given:—"The spread of the potato-beetle pest caused an enormous loss to the farmers of the country, not only by the failure of the potato crops, but also by the cost of insecticides, principally Paris green, used to destroy this voracious beetle. It is doubtful whether the farmers of the country would have been able successfully to contend with the potato-beetle had not Nature interposed one of her powerful checks. As the beetle extended its range and became more numerous, the Rose-breasted Grosbeak developed a newly acquired taste for this pest."

A beautiful coloured plate (by Mr. H. Grönvold) of hitherto undescribed or unfigured eggs of South African perching-birds forms an attractive feature in the first number of vol. ii. of the Journal of the South African Ornithologists' Union. The accompanying notes are by Messrs. J. A. Bucknill and G. H. Grönvold. In a paper on bird-migration in South Africa (originally read at last year's British Association meeting), Mr. W. L. Sclater directs attention to the occasional breeding of the bee-eater during its (northern) winter sojourn at the Cape. The evidence is indisputable, but the question as to whether the same individual birds breed in May in the northern, and again in October in the southern, hemisphere has yet to be definitely answered. Possibly there are two phases of the bird—the one a northern and the other a southern breeder. Those interested in parasitism among birds should read an article by Messrs. Haagner and Ivy on the breeding-habits of certain South African cuckoos of the genus Chrysococcyx.

There is an interesting note by Dr. Raymond Pearl in No. 3 (1906) of the *Journal of Comparative Neurology and Psychology* on the correlation between intelligence and the size of the head. The note is based on the measurements, published last year by Drs. Eyerich and Loewenfeld, of the head-circumferences of 935 Bavarian soldiers, who were also classified according to intelligence. These observers came to the conclusion that there was no relation between the head-circumference and the grade of intelligence, but Dr. Pearl, using more efficient statistical methods, finds a correlation which, though small, is quite sensible. It is pointed out that the result is in accordance with those obtained by Prof. Pearson (Proc. Roy. Soc., vol. lxix.), and it is suggested that the interpretation is probably "physiologic rather than psychologic," the larger size of head and the greater vigour in mental operations being both the consequences of good conditions of nurture.

A revised list of the group of red algæ known as Corallinæ is contributed by Mr. K. Yendo to the Journal of the College of Science, Tokio (vol. xx., article 12). The writer, after making a careful study of the generic distinctions laid down by previous authorities, enumerates seven genera, of which Cheilosporum is divided into three, and Amphiroa into four sections.

Writing in the *Monthly Review* (July) upon the subject of instinct in the lower animals, Mr. C. B. Newland mentions a number of cases illustrating the actions and ways of instinct as manifested in animals, birds, and insects. When the faculty of intelligence is developed the instinctive faculty is diminished. Instinct is perhaps most pronounced in insects, and as an instance of remarkable development Mr. Newland describes the systematic method in which a small ichneumon fly bores into oak-apples with the purpose of depositing its eggs in the grubs of the gall-fly that lie concealed within.

The second edition of the volume on north Yorkshire, by Mr. J. G. Baker, dealing with the botany, geology, climate, and physical geography, that has been appearing in instalments in the Transactions of the Yorkshire Naturalists' Union since November, 1888, is completed with the part published last April. This part is chiefly devoted to the mosses and hepatics, that have been revised and brought up to date by Mr. M. B. Slater. The name of Dr. Spence is closely associated with the early investigations of these plants, and in Yorkshire he laid the foundations of that knowledge that was put to advantage during his explorations in tropical America. The nomenclature and arrangement of the mosses are based on Braithwaite's "British Moss Flora," and for the hepatics Mr. Slater adopts the arrangement given in Pearson's "Hepaticæ of the British Isles."

The scientific aspect of what has been designated in the United States as "dry-farming" consists in utilising to the best advantage all the water that falls in semi-arid regions. An article by Mr. J. L. Cowan in the July number of the *Century Magazine* presents the main features of the system, and explains how it is possible to produce fine crops in regions where the rainfall averages only about 12 inches in the year. The first essential is thoroughly to break up the subsoil and collect in it all the rain-water; then, in order to prevent evaporation, the upper layers of the soil are kept in a finely pulverised condition, so that the water cannot rise to the surface by capillary action. Apart from these physical considerations, dry-farming requires continuous and intelligent husbandry. Another hope of the farmer in dry regions lies in finding or producing drought-resistant varieties, and this field of inquiry is yielding a bountiful harvest. In the case of wheat, a hard wheat, recognised in America as a distinct species, *Iviticum durum*, has been introduced from Russia; this gives a better yield in a dry than in a humid climate. Among other suitable "dry-farming" crops are Kafir corn, emmer (a variety of wheat), dwarf milo maize, and varieties of oats and barley.

The valedictory address delivered by Prof. J. G. M'Kendrick, at the close of the summer session of the University of Glasgow, on the occasion of his resignation of the professorship of physiology, provides a striking account of the progress of physiological science during the past thirty years. In 1861, when Prof. M'Kendrick attended a course of lectures at Aberdeen, there was no attempt at demonstration except by diagrams and a few microscopes on a side-table. There were no experiments, and the only instrument displayed was a sphygmograph. But a little later Goodsir, of Edinburgh, brought from Continental schools of physiology to the University of Edinburgh such instruments as myographs, kymographs, electrical appliances and other apparatus, and the teaching of practical physiology was soon firmly established under Argyll Robertson. Prof. M'Kendrick himself installed similar teaching in the University of Glasgow in 1870, the date of his appointment to the chair of physiology. The requirements of modern physiological teaching are shown by a statement in the address that while Prof. M'Kendrick has worked and taught for thirty years in five roo twenty-five are apportioned to physiological work in the new buildings. Reviewing the progress of physiology, Prof. M'Kendrick detailed the advances made in hist and expressed the doubt whether much more progress can be expected. Graphic methods have been elaborated during the same period, and the action of electrical stimuli on muscle and nerve elaborately worked out. The study of the functions of living isolated organs, modern vivisectional methods, our knowledge of the nerve paths in the central nervous system, and the subject of internal secretions, are all among the triumphs of physiological science during the past thirty years, and were each passed in review. In conclusion, Prof. M'Kendrick indicated physiological chemistry as the direction in which progress will be made during t next few decades.

THE Engineering Standards Committee has issued a specification for structural steel for bridges and general building construction (report No. 15). The draft of the specification, drawn up by a sectional committee of which Sir Benjamin Baker is president, was submitted to the science standing committee of the Royal Institute of British Architects, and certain modifications have been introduced into the specification as a result of the cooperation of that committee. In view of the authoritative positions held by members of the committee, the specification cannot fail to meet with general adoption.

THE *Engineering Review* (July) contains a series of special original articles dealing with the engineering development of several British colonies. The contributions have been limited to Canada, Western Australia, Queensland, New Zealand, New South Wales, and Natal. Farming and mining no longer constitute the only pursuits worthy of notice in these colonies. Railways, roads, and bridges are being constructed, harbour, river, canal, and irrigation schemes are being undertaken, and municipal and sanitary engineering projects are everywhere in evidence. All these developments furnish occupation for professional men and skilled labour.

WE have received from the publishers, MM. Gauthier-Villars, Paris, a set of tables and formulæ compiled by M. J. de Rey-Pailhade for the practical use of instruments graduated in *grades* instead of degrees. The compiler urges the employment of the decimal system in astronomical and navigation tables, and points out that errors constantly occurring in ephemerides, &c., would probably be eliminated if the simpler method were employed. Formulæ for obtaining interpolated values and for calculating star positions, tables for the conversion of sexagesimal into decimal values, and the decimal values of numerous astronomical constants are included in the brochure.

Deutsche Arbeit (vol. v., p. 352) contains an account of a visit to Vesuvius after the late eruption, by Dr. E. Trojan, illustrated by reproductions of photographs, two of which are of some interest as representing the mountain from about the same point of view before and after the eruption. By the courtesy of Prof. R. von Lendenfeld and the editor of *Deutsche Arbeit* these illustrations are given here; they show the changes by which the graceful

(1) Photograph taken on Apri 4.

(2) Photograph taken on April 18.

Vesuvius before and after the recent eruption. From photographs taken by Dr. E. Trojan from Santa Lucia.

outline of the cone has been destroyed and the mountain converted into a hump-backed mound of distinctly lower elevation.

THE volumes which have now appeared of the Proceedings of the Royal Society of London, as divided about a year ago into two series, are vols. lxxvi.–lxxvii. of series "A," containing papers of a mathematical and physical character, and vols. lxxvi.–lxxvii. of series "B," containing papers of a biological character; each volume runs into about 600 pages royal octavo, with illustrations. A main object of this new arrangement was to render the Proceedings more accessible to workers by placing the two groups of subjects on sale separately, at a stated price attached to each separate part of a volume when it first appears. Moreover, with the view of promoting the circulation of the complete series, it has been directed that a subscription paid in advance to the publishers at the reduced price of 15*s*. per volume, for either series, shall entitle subscribers to receive the parts as soon as published, or else the volumes when completed, in boards or in paper covers, as they may prefer. With a view to increase further the accessibility of the various publications of the Royal Society, each number of Proceedings now contains an announcement on the cover of the more recent memoirs of the Philosophical Transactions as published separately in wrappers, and the prices at which they can be obtained. It is hoped that by this arrangement the difficulties which have been found to impede the prompt circulation of the journals of the society, which are of necessity published in a somewhat different manner from a regular periodical, may be finally removed.

An important contribution to our knowledge of the liquefaction of gases is contained in a paper on the liquefaction of air and its application to the manufacture of oxygen and nitrogen, by M. Georges Claude in part i. of the Bulletin of the French Physical Society for session 1906. M. Claude adopts the principle of expansion *with* external work instead of expansion *without* external work as utilised in the plant devised by Linde, Hampson, and others. The result, it is contended, is to effect a surprising economy, while it becomes possible to employ very much smaller pressures than those hitherto considered necessary and to dispense with auxiliary cooling. The liquid air, obtained in this way at very small cost, can be used as a commercial source of oxygen and nitrogen. The two elements are separated by a process of fractional distillation; in the apparatus devised for this object, M. Claude displays remarkable ingenuity. The principle of "recuperative cooling" is adopted, liquid air in one vessel being caused to evaporate by means of gaseous air compressed at 2 to 3 atmospheres circulating in pipes surrounded by the cold liquid. The nitrogen distils off more readily than the oxygen from the liquid air in the one vessel, whilst in the other oxygen is liquefied before nitrogen during the condensation of the air. Finally, nearly pure oxygen and nearly pure nitrogen are obtained. A machine has been constructed capable of supplying 1000 cubic metres of oxygen, containing 96 per cent. to 98 per cent. of the pure element, per day, with the expenditure of an amount of energy equal to only 1/20th or 1/30th that required in the processes based on the electrolysis of water. It is contended that the results obtained invalidate the assumption made by Dewar and confirmed by Linde that in the liquefaction of air the two component gases condense simultaneously; in reality, the more volatile nitrogen is condensed after the oxygen, and the process of liquefaction is strictly the inverse of vaporisation.

The fourteenth volume of the Bulletin of the Philosophical Society of Washington has now been completed by the publication of the brochure entitled "Organisation and Proceedings." This volume contains abstracts of papers and other communications brought before the society during the sessions 1900–1904.

A second edition of the Class List and Index of the periodical publications in the Patent Office library has been published, price 6d., at the Patent Office, 25 Southampton Buildings, Chancery Lane.

Mr. Edwin Anthony has issued through Messrs. George Routledge and Sons, Ltd., a pamphlet, price sixpence, on decimal coinage, weights, and measures, in which he discusses the question as to whether this country should adopt them, and passes in review the various arguments for and against the use of decimal coinage and weights and measures.

Messrs. Charles Griffin and Co., Ltd., have published a fifth, revised edition of Prof. G. A. J. Cole's "Aids to Practical Geology." The work has been brought up to date without increasing its size, so that it will maintain the leading position it has gained among manuals of determinative geology.

OUR ASTRONOMICAL COLUMN.

Reflecting Telescopes of Short Focus.—In No. 5, vol. xxiii., of the *Astrophysical Journal*, Prof. Vogel discusses the relative efficiency of short-focus reflectors for astrographic work.

Prompted by the discovery of the Nova Persei nebula, Prof. Vogel turned his attention to the subject of reflectors, and finally obtained an excellent parabolic mirror, of 40 cm. effective aperture and 93 cm. focal length, from Mr. B. Schmidt, of Mittweida, Saxony.

With this instrument numerous problems of practical interest in reflector work have been investigated, and the results are tabulated in the present paper. Prof. Vogel also compares the efficiency of an instrument of this type with that obtained from other types of photographic telescope. For instance, he found that with an exposure of thirty minutes on the Pleiades nebula he obtained a photograph showing all the detail seen on Keeler's plates with four hours' exposure using the Crossley reflector. The nebulæ around γ Cassiopeiæ appear quite as distinctly in forty minutes as on the plates taken by Dr. Roberts with ninety minutes' exposure on October 25, 1895.

The Astronomical Society of Canada.—The Transactions, for 1905, of the Royal Astronomical Society of Canada contain a number of papers of astronomical interest, a few of which are mentioned below. In the presidential address Mr. C. A. Chant made a summary review of the progress of astronomy during 1905, referring, among other things, to the spectroheliograph work which is being systematically prosecuted at the Yerkes, Meudon, South Kensington, and Potsdam observatories, and to the important results which these researches in solar physics may lead us in the study of terrestrial meteorology. Other papers selected for publication deal with sun-spots and magnetic storms, colour photography of the corona, stellar classification, and the new problem in solar physics recently enunciated by Dr. C. L. Poor.

Magnitudes and Places of 251 Pleiades Stars.—At the desire of Prof. Wolf, Herr K. Schiller has continued the researches of Dr. Dugan on the photographic magnitudes and mean places of the fainter stars of the Pleiades group, and now publishes his results for 251 stars in No. 4102 of the *Astronomische Nachrichten*. The places for 1900, and a formula connecting the magnitude scale of the present series with that employed by Dr. Dugan, are given in the paper.

Elements and Ephemeris of Jupiter's Seventh Satellite.—In No. 4101 of the *Astronomische Nachrichten*, Dr. F. E. Ross publishes the following elements of the orbit of Jupiter's seventh satellite, derived from observations made during the two most recent oppositions, and corrected for the principal perturbations:—

1906 January 0·0 G.M.T. Elements referred to Earth's Equator.

$g = 18^{\circ}\cdot9$	$e = 0\cdot208$
$\pi = 118^{\circ}$	$n = 1^{\circ}\ 386$
$\Omega = 291^{\circ}$	$\log a = 8\cdot8946$
$i = 25^{\circ}\ 28'$	Period = 259·7 days

This satellite is only about 2 per cent., or 170,000 miles, more distant from Jupiter than the sixth, but, on account of their large eccentricities, they do not approach within two million miles of each other. The inclination of their orbits to each other is 28° 1'.

In addition to the foregoing elements, Dr. Ross also publishes an ephemeris, corrected for perturbations and giving the position angle and distance of the seventh satellite, for every fifth day between August 15, 1906, and April 27, 1907.

Observations of Minor Planets and Comets.—The results of a large number of observations of minor planets, comets, and comparison stars, made by Dr. J. Palisa with a wire micrometer attached to the 27-inch refractor of the Vienna Observatory, are given in Nos. 4099 and 4100 of the *Astronomische Nachrichten*, by Prof. E. Weiss. The list of objects includes comets 1904 i and ii, and 1905 ii, iii, v and *c*, and 296 comparison stars.

OPENING OF A NEW LABORATORY AT THE ROTHAMSTED EXPERIMENTAL STATION.

On July 20 Earl Carrington opened the "James Mason" laboratory for agricultural bacteriology at the Rothamsted Experimental Station. Sir John Evans, chairman of the Lawes Agricultural Trust Committee, presided, and among those also present were Mr. J. F. Mason, M.P., the donor of the laboratory, Sir T. H. Elliott, Sir Michael Foster, Sir R. P. Cooper, Mr. Laurence Hardy, M.P., Mr. F. A. Channing, M.P., Mr. Abel Smith, M.P., Mr. Phipson Beale, M.P., Prof. R. Meldola, president of the Chemical Society, Sir Charles Lawes Wittewronge, Dr. Hugo Müller, Dr. H. E. Armstrong, Dr. J. A. Voelcker, and Mr. J. Bowen Jones.

Sir John Evans, in his introductory remarks, explained that the building they were asking Lord Carrington to declare open was the gift of Mr. J. F. Mason, and was to be devoted to a class of work that had grown up since the original Rothamsted experiments were started, but which had become of cardinal importance in the study of the growth of crops. The difficulty of the Lawes Agricultural Trust Committee, carrying out as it was by private benefactions the work which in every other country was regarded as the duty of the State, was to find funds for such new developments, and he trusted that the President of the Board of Agriculture might soon be able to obtain a grant for the proposed council of agricultural research, and so furnish some assistance to themselves and other bodies concerned in similar investigations.

Lord Carrington expressed the pleasure it gave him to find himself at Rothamsted, which had been the pioneer of agricultural research, not only in England, but in the world. Agriculture was rapidly ceasing to be a rule-of-thumb business, and as a highly skilled industry was more and more requiring the assistance of such scientific investigations as were being carried out at Rothamsted. He sincerely hoped that some money might be found for the proposed council of agricultural research, but he felt bound to remind them that the income tax still stood at a shilling in the pound; but both he and the Government of which he was a member had every sympathy with the work represented by Rothamsted.

Sir Michael Foster then expressed the thanks of the Lawes Trust Committee to Mr. Mason for his munificent gift of the laboratory, and explained how the bacteria, the existence of which almost was unsuspected when the Rothamsted laboratory was built, were year by year being found to be of fundamental importance, not only to ourselves directly, but to the crops and to the soil. Sir Thomas Elliott, the Secretary of the Board of Agriculture, seconded the expression of thanks, and declared that gifts like Mr. Mason's were the best argument he could have in approaching the Treasury for assistance for the work of Rothamsted.

Mr. Mason then replied, and explained how he was led to establish this laboratory as the best means of securing the continuance of the work to which his father had devoted so many years and had so much at heart. He also trusted that it might be a means of stirring public opinion, both generally and in the House of Commons, to recognise the necessity of research if agriculture was to maintain its position in this country.

After the meeting the company was shown round the laboratories, and afterwards visited the experimental plots, where the wheat and barley in particular were showing very interesting results.

The new laboratory takes the form of a wing added on to the Lawes Testimonial Laboratory, which was built in 1855; it is built of brick from the designs of Mr. V. T. Hodgson. It owes its origin to Mr. James Mason, of Eynsham Hall, Oxon, who for many years carried out on his own estate extensive experiments on such questions as the utilisation of leguminous plants in increasing the fertility of the soil, and the unlocking of fertility stored up in the subsoil, a summary of which may be read in the Journal of the Royal Agricultural Society for 1904. Mr. Mason died in 1902, and in his memory Mr. J. F. Mason, M.P., presented the trust with 1000*l*. for the building and equipment of a bacteriological laboratory, together with a further sum of 50*l*. a year toward its working expenses. The building contains a main laboratory looking north, 25 feet by 15 feet, fitted with teak-topped working tables and slate slabs to carry the incubators; a preparation room, where the working tables are covered with lead; a dark-room for photography, polariscope work, &c.; and a room for the director. The whole is floored with pitch-pine blocks, and heated by steam from the old laboratory adjoining.

RECENT RESEARCHES IN REGIONAL GEOLOGY.

The Geological Survey of Great Britain has issued a memoir (price 1*s*.) by Mr. A. J. Jukes-Browne, to accompany the colour-printed geological map, Sheet 282. The country dealt with lies south and east of Devizes, and contains exposures of almost horizontal strata, from the Middle Jurassic to the Lower Eocene. The author refers the superficial "clay with flints" to the weathering of Eocene material, and urges that its presence at any particular point shows that we are "not far below the ancient plane of erosion on which the lowest Eocene deposits were laid down." He has sustained this position more recently in an important paper (Quart. Journ. Geol. Soc., 1906, p. 159). Notes are given on economic geology, including the general character of the soils.

Another memoir of the survey, also issued in 1905, is by Mr. Fox-Strangways and Prof. Watts (price 2*s*.), on the country between Derby, Ashby-de-la-Zouch, and Loughborough, included in Sheet 141. The description of Charnwood Forest will probably attract most attention, and it is to be supplemented in a forthcoming memoir. Prof. Watts, from mapping the ground, finds that the famous "porphyroids" of the region are not lava-flows, but are intrusive (p. 9); they have, however, shared in the general cleavage and shearing, and thus were in place before the Charnwood mass became a mountainous knot in the Carboniferous sea. We find the term "fjord" hardly a happy one when applied to the inlet of a Triassic lake (p. 11), which has become revealed by latter-day denudation. But Prof. Watts's reconstruction of the Charnwood landscapes of Triassic times has already afforded us pictures for which we should be warmly grateful (see *Geographical Journal*, 1903). On p. 33, Mr. Fox-Strangways refers to an interesting puzzle as to the origin of certain Foraminifera once stated to be from the Keuper Marl. The suggestion is made that similar forms occur, as derived Liassic material, in the drift, and thence became erroneously recorded from the Keuper. With so many good geologists in the neighbourhood, this question ought not to be left long in uncertainty. The point suggests itself, moreover, that the local Boulder-clay, like that of the low ground of Lancashire, may possibly contain Foraminifera of its own, imported from some neighbouring sea. On this matter, by the by, a paper has reached us from Mr. Mellard Reade (Proc. Liverpool Geological Society, vol. x., part i., 1905), who believes that the abundance of Foraminifera in the Lancashire Boulder-clay points strongly to the probability of the whole of the low-level deposit having been laid down in marine waters under fairly quiet conditions. Mr. W. Edwards, on the other hand (*ibid.*), in a paper on the glacial geology of Anglesey, urges that the island was not submerged beneath the sea at the epoch of the formation of the well-known shell-bearing beds at Moel-y-Tryfan in Caernarvonshire.

A pleasant addition to the publications of the Geological Survey of Great Britain is the "Guide to the Geological Model of the Isle of Purbeck," by Mr. A. Strahan, F.R.S. (1906, price 6*d*.). The model, on the horizontal scale of six inches to one mile, was made by Mr. J. B. Jordan, and is accessible in the museum of the survey in Jermyn Street, London. Copies have also been acquired by the Government museums in Edinburgh and Dublin. The purpose of the model is educational, and the guide, by marginal notes, points out how it illustrates an "escarpment," an "anticline," a "trough-fault," and so forth, so that it serves as a companion to the ordinary text-book. For those unable to consult one of the copies of the model, the photograph and coloured geological map included in the guide will give a clear impression of its features.

Signor Luigi de Marchi has published, through the Reale Istituto Veneto (1905), a folio memoir on "L'Idrografia dei Colli Euganei," in which much attention is paid to the question of the change of slope in the bed of a stream according to the grouping of the rocks successively encountered by it. An interesting result (p. 46), borne out by other evidence, is that the trachytic masses round the central tuff-cone of the Venda are found, not to lie, as Suess and Reyer have supposed, upon fragmental deposits as relics of great viscid lava-flows, but represent independent volcanic necks rising through a mantle of softer rocks. Observations are added on the limitation of human activity on the mountain-sides by the progress of denudation.

In the *Verhandlungen der k.k geologischen Reichsanstalt* for 1905 Dr. Kerner (p. 127) gives the results of five weeks' study of the Neogene deposits of Sinj, in central Dalmatia, and (p. 593) describes the fossil plants collected. Dr. Franz Baron Nopcsa (*Jahrbuch*, *ibid.*, 1905, p. 85) leads us farther south, having been able, with the aid of the Turkish authorities, to study the geology of Albania. He gives a pleasant account of the country that should attract other travellers. Not every geologist can be an artist, and we feel that some of the drawings, made by the author from his photographs, might have been well entrusted to other hands. The author believes that the so-called Flysch of Albania and Bosnia is at latest of Middle Mesozoic age, and has nothing to do with the Flysch of the Dalmatian coast-ranges and of the Wiener Wald. Baron Nopcsa writes very modestly of his results; but he has clearly felt the fascination of working, within the bounds of Europe, in a virgin field. The bibliography provided should help explorers of various tastes.

In the same *Jahrbuch* (p. 349) Mr. W. A. Humphrey, "aus York, England," reports on the ore-deposits of the Stangalp. His remarks on the so-called Urgebirge of Styria and Carinthia are of general interest, since he finds that the gneiss and the mica-schist vary inversely in importance on the margin of a mass of alpine granite. This granite has affected even the interstitial material of the Carboniferous conglomerate, while tourmaline has been formed among the sediments far beyond the zone where they are injected with actual granite-veins. Mr. Humphrey therefore (pp. 363–5) regards the whole sedimentary and schistose mass as a continuous series, which became highly metamorphosed in its lower portions. Here we once more recognise the change of opinion, forced upon field-observers in very diverse areas, with regard to the alleged antiquity of schists in mountain-cores.

Dr. Ampferer's extensive paper (*ibid.*, pp. 451–562) on the Wettersteingebirge, among his favourite limestone Alps, introduces questions of torsional movement combined with thrust-planes. In *Spelunca*, Nos. 42 and 43 (1905), M. Martel deals with the subterranean aspects of limestones, in continuing his immensely valuable abstracts of recent papers upon caves. These two numbers, which are issued as one, cover the whole area outside France, and even contain references to Kerguelen Island and the Fijis.

G. A. J. C.

METEOROLOGICAL REPORTS.

IN the Journal of the Meteorological Society of Japan for February, Mr. H. Mukasa gives a summary of the temperature conditions at Chemulpo (Korea) for the years 1893–1903, from four observations daily. The mean of the daily maxima in summer is 80°·6, in winter 37°·9, and the mean of the minima 67°·3 and 22°·8 respectively. The absolute maximum was 99°·5, in August, 1901, and the minimum −1°·3, in February, 1895; the greatest daily range, 40°·3, also occurred in the latter month. The Journal for April contains an interesting contribution on the management of the wet-bulb thermometer, by Mr. T. Okada. It was pointed out by Dr. Edelmann in the *Meteorologische Zeitschrift* for 1896, p. 334, that the kind of covering used for conveying moisture to the bulb had considerable influence on the readings of the thermometer. Prof. Tanakadate has recently found that a Japanese paper called "Yoshinogami," made from fibres of a species of mulberry tree, was most suited for a cover for the wet-bulb both for temperatures above and below freezing point, and, being quite easy in manipulation, can be changed even daily without the slightest trouble. Mr. Okada's experiments show that the bulb covered with paper is more sensitive than one with the usual muslin covering, and that in frosty weather its indications give the humidity more in accordance with that shown by the hair-hygrometer. The paper is said to be suitable for all climates.

The Proceedings of the Rhodesia Scientific Association (vol. v., part ii.) contains monthly and annual means of meteorological observations made at Bulawayo (altitude about 4469 feet) from 1897 to 1904 by the Jesuit Fathers Barthélemy and Nicot. As the observations mostly refer to 9h. a.m., the results can only be taken as approximate, but the discussion by the Rev. E. Goetz, S.J., is nevertheless very useful. The absolute highest reading of the barometer was 26·171 inches (in July), and the lowest 25·397 inches (in January); the daily range rarely exceeds 0·1 inch. The temperature shows one minimum, in June, and two maxima, in October and January; the means of maximum and minimum readings for these months are 57°·5, 73°·7, and 72°·6 respectively. The absolute extremes were 105° in November and 33° in June (in June, 1905, not included in the tables, the temperature in the screen fell to 30°). The rainfall has two maxima, one in the beginning of December, followed by a serious break, and a second in the middle of January. Mr. Goetz states that this break in the rainfall is a very disastrous feature of the climate, as the crops are either destroyed or stunted by the burning sun. The annual rainfall averages 22·2 inches, and the rainy days seventy-four. Very little rain falls between May and September; it is very heavy during thunderstorms, and for some minutes falls at the rate of from 2 inches to 6 inches an hour.

Sir Charles Todd has recently published the meteorological observations made at the Adelaide Observatory and other places in South Australia during 1902 and 1903. He states that the year 1902 must be classed as one of the driest on record, particularly during the winter season (April to October). The returns for 1903 show a general improvement; on the average, the agricultural areas had about 3 inches above the normal rainfall. A marked feature of this year was that during every month, except September to November, the mean temperature at Adelaide was below the average; the lowest air temperature on record at that place, 32°·2, was observed on July 11. The highest shade-temperature was 105°·6, in February.

The report of the Government astronomer of Natal for the year 1905 has been condensed; in the case of the subsidiary stations, meteorological summaries only are given, and the daily results are only published for the observatory at Durban. The rainfall for the year at that place was 44·95 inches, which is 5·6 inches above the average of the previous twenty-one years. This result was owing to one of the most remarkable hurricanes that have occurred in Natal during the last thirty years, which swept over the entire colony with extraordinary severity on May 31 and June 1. The rainfall on these two days amounted to nearly 11 inches at Durban and to 17 inches at Umzinto. The mean temperature of the year was exceptionally low; the mean of the maxima was 78°·1 and of the minima 61°·4, and the extremes were 90°·7 and 45°·4 respectively. The only year of lower mean temperature was 1887.

Captain H. G. Lyons, director-general of the Survey Department, Egypt, has published his report on the rain of the Nile basin in 1905. The Egyptian and Soudan stations at which rainfall is measured only number thirty-one, but a good many other returns showing the days on which rain fell are received, and are to some extent useful in supplementing the information supplied by the recording stations; observations are also given for neighbouring territories. On the whole, the rainfall is said to have been everywhere deficient; the volume of the Nile flood considered as the volume passing Aswan between July 1 and October 31, was only 0·65 of the average for thirty four years (1869–1903), making the ninth successive year of low floods. The mean rainfall, and the oscillation of the rain-belt with the apparent motion of the sun, are very clearly shown by coloured maps, drawn for each month.

The report of the Falmouth Observatory committee of the Royal Cornwall Polytechnic Society for the year 1905 (one of the principal observatories subsidised by the Meteorological Office) shows that a record reading of the barometer for that part of the British Islands occurred on January 28, viz. 31·097 inches (corrected and reduced to sea-level). The next highest reading at Falmouth during the last thirty years was 30·981 inches, on January 18, 1882. Another interesting point is the mean temperature of the sea-surface, taken one mile outside the harbour, viz. 53°·3, being 2°·3 above the mean temperature of the air. The mean monthly sea-temperature was only below that of the air in June, July, and August. Much attention is given to magnetic observations, and the instruments are not affected by electric tramways. During a display of aurora borealis on the night of November 15, an easterly movement in the declination took place at 8h. 53m. p.m. which in twelve minutes reduced it about 33′, while in the subsequent twenty minutes the declination increased about 41′, which was 8′ west of its position before the movement occurred.

The *Jahrbuch* of the Norwegian Meteorological Institute for 1905 contains hourly observations for Christiania, with tri-daily readings and summaries for other stations. The results are given according to the international scheme, as before, the only change being that mid-European time has been introduced (one hour earlier than Greenwich), so that the observations at telegraphic reporting stations, which were previously taken by Christiania time, are now made seventeen minutes earlier than in previous years, while at the ordinary stations the time of taking observations has not been altered. Accompanying the *Jahrbuch* is part xiv. of the valuable series of climatological tables for Norway, containing the average monthly amount of cloud for the various directions of wind ("cloud wind-roses"); at most of the stations the averages are for a period of twenty years (1876–95).

The trigonometrical branch office at Dehra Dun has published a valuable series of daily rainfall observations for each of the thirty-six years 1868–1903. The mean annual fall is 84·72 inches, of which 65 per cent. falls in July and August. The maximum yearly amount was 122·47 inches, in 1894, and the minimum 41·69 inches, in 1877. The greatest fall in one day was 12·47 inches, on August 10, 1896. From a summary of the highest and lowest temperatures in the shade, for the same years, we observe that the mean of the annual extremes was 104°·3, the absolute maximum being 108°·4, on May 19, 1892 (108°·3 on June 5, 1890), and the minimum 31°·8, on January 13, 1874, the next lowest being 33°·9, on February 5, 1876.

COLOURING OF GUEREZA MONKEYS.

IN vol. ii. of the Proceedings of the Zoological Society of the current year, Mr. Lydekker contributes a paper on colour-evolution in the black or black and white tropical African monkeys of the genus Colobus commonly known as guerezas. Starting with a wholly black monkey, like the West African *C. satanas*, in which, although there is a fringe of long hair round the face, the body is comparatively short-haired and the tail not tufted, the author shows how a gradation can be traced through species like *C. palliatus* and *C. sharpei* of East Central Africa, in which tufts of long white hair (larger in the second than in the first of the two species named) make their appearance on the sides of the face and shoulders, as well as on the terminal third of the tail, to the Abyssinian *C. guereza*, in which the white shoulder-tufts extend backwards to form a mantle on each side of the body, and unite on the lower part of the back. The culmination of this type is formed by the white-tailed guereza (*C. caudatus*) of the Kilimanjaro district, in which the pendent white mantle is still longer, and the tail, which is wholly white except for a small length at the root, is clothed with long pendent hair; the cheek- and throat-tufts, however, have been lost, so that the head is short-haired, with the face and throat white.

The West African white-thighed guereza (*C. vellerosus*) appears to exhibit a kind of retrograde development in these respects, the body having lost the mantle of long white hair and the tail its white "flag," while the white of the perineal patch has spread on to the hinder and outer sides of the thighs. In this case we find practical reversion to the type of the black guereza, with the exception that the band on the forehead, the sides of the face and throat, the thighs, and almost the whole tail have become white, while the long hair has disappeared from the face. In the opinion of the author the colouring and special development of the long hair in the white-tailed guereza form a protective modification, but the purport of the colouring of the intermediate forms between this and the black guereza is left undecided.

FIG. 1.—White-tailed Guereza (*Cololus caudatus*). From the Proceedings of th Zoological Society.

ELECTRICITY IN MINES.

A VERY great development has taken place during the past two years in electrical machinery and apparatus for working colliery plant. Manufacturers seem at last to have realised that machines and accessories must be adapted and made to suit the conditions existing in collieries, and that the collieries cannot be adapted to suit their standard machines. Consequently, in the colliery exhibition which has just taken place, the result of experience in colliery work was clearly put before us in entirely new designs of motors and switchgear specially adapted for this work.

The details of colliery requirements have been most carefully studied and gone into, and the designs prove the tremendous development that has taken place. Whereas a few years ago contractors simply attached their standard machine to a haulage-gear or coal-cutter, and supplied the ordinary switch-gear as for everyday use, to-day we find that it is the general rule for motors to be designed and built for the particular work for which they are intended, and to be made part and parcel of the machine they have to drive. The same applies to the switch-gear, and a large supply of different forms of specially enclosed switches for use in very fiery mines proves how thoroughly the manufacturers have interested themselves in the matter.

The automatic and electrical devices for regulating and signalling in connection with electrically driven winding engines were quite the most interesting and valuable introduction in this year's exhibition, and the fact that by far the greater number of coal-cutters and drills which were exhibited were fitted with electric motors should go far to prove that electricity is fighting its way successfully against the older established methods of colliery procedure.

Other arrangements of colliery machinery showing the adaptability of electric motors were well represented by motor-driven pumps, fans, hoists, heading machines, and elevators, and among interesting signs of the times were the electrically driven air compressors.

This development in colliery work is quite in keeping with the expansion of the use of electricity for power purposes which is taking place at the present time. The many power schemes now in hand or being brought before Parliament also show that, although it has been a long time coming, electricity as a motive power for general use may now be said to have "arrived."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

The annual meeting of the Midland Agricultural and Dairy College will be held on Monday next, July 30, when the certificates gained during last session will be distributed, and the report on the year's work presented.

Mr. P. Fraser has been appointed lecturer in mathematics at University College, Bristol, in succession to Mr. S. B. McLaren, who has resigned to take up an appointment in the University of Birmingham. The University of Liverpool has conferred the degree of Doctor of Engineering on Mr. J. Morrow, lecturer in engineering in University College, Bristol.

Dr. James Stewart, of Rickmansworth, who died on June 2 last, left more than 25,000*l.* to the University of Melbourne, Victoria, to found and endow in perpetuity three scholarships, each of an annual value of not more than 50*l.*, and tenable for two or three years, to be called the "Stewart Scholarships," one to be awarded for anatomy, one for medicine, and one for surgery. In addition to this, more than 3000*l.* is left to the Ballarat School of Mines for a "Stewart Fund" to be applied to the augmentation for ever of the salary of a teacher of mineralogy, and about 1500*l.* to the Ballarat Mechanics' Institute for replenishing the library.

The new regulations of the Board of Education for the training of teachers and for the examination of students in training colleges have been published. No very substantial alterations have been made in the present issue. It is satisfactory to find that no single detailed syllabus of elementary science is included in the schemes of work regulating the instruction in the compulsory subjects of the examination to be conducted by the Board in 1908. After a consideration of the needs of the students and of the facilities which the training college offers for science teaching, the authorities are to draw up a scheme of instruction in science and to submit it to the approval of the Board. This instruction will in the main be tested by inspection, and the students will be expected to be able to carry out experiments selected from that portion of the approved syllabus which has been worked through up to the date of the inspector's visit, or to perform such experiments of similar character as the inspector may consider suitable. Encouragement is to be given to students proposing to teach in country schools to take up what is called "rural science," which includes nature-study and the broad principles of agriculture. The whole tendency of these regulations is to discountenance a mere text-book acquaintance with the facts of science; the Board is to be congratulated upon its recognition of the value to teachers of a practical training in the methods of science.

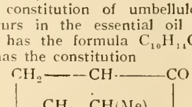
On Wednesday, July 18, the new buildings of the South-Eastern Agricultural College, Wye, were opened by Lady Carrington in the unavoidable absence of the Minister of Agriculture. At the same time the diplomas, certificates, and prizes were presented by her to the students before a large assembly of persons interested in agriculture, including Lord Ashcombe, Mr. Laurence Hardy, M.P., and Mrs. Laurence Hardy, Mr. Henniker-Heaton, M.P., Mr. Marsham (chairman Kent County Council), Major Craigie, C.B. (Board of Agriculture), the Poet Laureate, Lady Theobald Butler, Dr. Clowes, and others. The new buildings have increased the size of the college by about one-third its present extent. The additions include a veterinary and bacteriological laboratory, a large new drawing school, a new zoological research laboratory, a chemical research room connected with a greenhouse, new offices and students' common room, and a large detached gymnasium, the latter and the drawing school both anonymous gifts. The additions have permitted the enlargement of the biological laboratory and one of the lecture rooms to nearly double their former size, and the formation of a mycological research room. Electric light has been installed throughout. The college may now be said to be the most completely equipped agricultural institution in the country. The principal, in addressing the meeting, and also Mr. Laurence Hardy, in seconding the vote of thanks to Lady Carrington, both spoke of the importance of research work and urged strongly that national financial aid should be given to the college, which has opportunities for such work as cannot be found elsewhere.

Higher education will benefit greatly by the handsome bequests detailed in the will of the late Mr. Alfred Beit. The college of technology (including mining and metallurgy) in connection with the University of London receives 50,000*l.* and 5000 preferred shares of 2*l.* 10*s.* each in De Beers Consolidated Mines (Limited). The sum of 200,000*l.* is left to the University of Johannesburg to be applied in or towards building and equipping university buildings on the site of the property recently given by Mr. Beit to Johannesburg (including the construction of a tramway connecting the property with Johannesburg), the income of such 200,000*l.* to be applied meanwhile for educational projects as the Board of Education at Johannesburg may determine; but if at the expiration of ten years the 200,000*l.* shall not have been applied in such building and equipment, then the legacy is to lapse. 200,000*l.* is to be distributed within two years after Mr. Beit's death by a board of trustees, of whom the present Bishop of Mashonaland is to be one, for educational, public, and other charitable purposes in Rhodesia. Mr. Beit also bequeathed 25,000*l.* to the Institute of Medical Sciences Fund, University of London, and 25,000*l.* to the Rhodes University, Grahamstown, Cape Colony; 20,000*l.* to his firm of Eckstein and Co., of Johannesburg, to be applied for educational, public, and other charitable purposes in the Transvaal Colony; 15,000*l.* to his firm at Kimberley, to be applied for educational, public, and other charitable purposes in or near Kimberley; and 15,000*l.* to Dr. Jameson, Prime Minister of Cape Colony, and Sir Lewis L. Michell, to be applied for educational, public, and other charitable purposes in Cape Colony (excluding Kimberley).

SOCIETIES AND ACADEMIES.

London.

Chemical Society, July 5.—Prof. R. Meldola, F.R.S., president, in the chair.—Saponarin, a new glucoside coloured blue with iodine: G. **Barger.** This substance has been isolated from *Saponaria officinalis.* It crystallises in microscopic needles and is hydrolysed by acids yielding glucose, vitexin, and a colouring matter, apparently isomeric with vitexin, for which the name saponaretin is suggested.—The constitution of umbellulone: F. **Tutin.** Umbellulone occurs in the essential oil of *Umbellularia Californica*, and has the formula $C_{10}H_{14}O$. Its reactions indicate that it has the constitution



—The action of ethyl iodide and of propyl iodide on the disodium derivative of diacetylacetone: A. W. **Bain.**—A possible source of error in Stas's nitrogen ratios: R. W. **Gray.** The researches of Rayleigh, Leduc, D. Berthelot, Guye, and the author confirm Stas's lower value for the atomic weight of nitrogen, and an indirect comparison of the atomic weights of nitrogen and silver from the results of Marignac, Scott, and Richards leads to the same result.—Electrolytic oxidation: H. D. **Law.** On oxidising benzoin by the electrolytic method, benzil, benzaldehyde, and benzoic acid are formed. In addition, a certain amount of tarry matter is always obtained, the formation of which is a property of high potential discharge at the anode, and always takes place in the case of unsaturated compounds.—The ethyl esters of acetonyloxalic and acetophenyloxalic acids and the action of ethyl oxalate on acetanilide and its homologues: S. **Ruhemann.**—An oxidation product of indigotin: A. G. **Perkin.** On sublimation with limited access of air, pure indigotin gives a small quantity of a yellow sublimate, which crystallises in needles and has the formula $C_{15}H_8O_2N_2$.—Indigo-yellow: A. G. **Perkin.** In 1904 it was shown that the yellow colouring matter present in Java indigo is kampherol. Examination has now shown that it is derived from a glucoside (kampheritrin) present in the leaves of *Indigofera arrecta*. It is hydrolysed by acids into kampherol (1 mol.) and rhamnose (2 mols.).—1:3-Diphenylbarbituric acid and some coloured derivatives. Synthesis of 1:3-diphenyluric acid: Miss M. A. **Whiteley.**—The alkylation of rhamnose: T. **Purdie** and C. R. **Young.** Dimethyl acetone-rhamnoside, trimethyl methylrhamnoside, di- and tri-methylrhamnose, and a number of their derivatives are described.—The alkylation of *l*-arabinose: T. **Purdie** and R. E. **Rose.** By methylating Fischer's α-methylarabinoside with silver oxide and methyl iodide, trimethyl α-methylarabinoside is obtained in large, well-formed crystals, and by hydrolysing this with dilute hydrochloric acid, trimethyl arabinose is produced. Descriptions of these substances are given.—The esters of triacetic lactone and triacetic acid: F. **Sproxton.** The methyl and ethyl esters are described.—Optically active reduced naphthoic acids, part ii., the resolution of the tetrahydronaphthoic acids: R. H. **Pickard** and J. **Yates.**—The velocity of chemical change in the pentamethylene series: N. **Menschutkin**, sen. A *résumé* of the results obtained in the study of the velocity of chemical change in polymethylene derivatives is given.—Hydrolysis of ammonium salts by water: E. G. **Hill.** The constants obtained in the case of the salts of monobasic acids are inversely proportional to the molecular conductivities of the acids, and agree well with the values obtained for the strength of the acids by the various dynamical methods. In the case of dibasic acids, the constants are irregular.—The addition of alkyl halides to alkylated sugars and glucosides: J. C. **Irvine** and Miss A. M. **Moodie.** The results point to the formation, during cooling, of oxonium compounds of the sugar with alkyl halides, and the α-form of the aldose appears to be more reactive than the β-isomeride.—The following notes have been received since the meeting: Note on the preparation of ethyl acetonedicarboxylate: E. **Ormerod.**—The interaction of nitroformazyl, carbon disulphide, and potassium hydroxide. A contribution to the chemistry of the thiobiazalones and the xanthates: E. **Ormerod.**—Aldehydrol and the hydrates of compounds containing a carbonyl group: W. M. **Colles.** Concentrated aqueous solutions of aldehyde acetone, formic, acetic, monochloroacetic, and trichloroacetic acids were cooled to low temperatures in a special apparatus. The following compounds of special interest were obtained:—aldehydrol, $CH_3CH(OH)_2$; a hydrol of formic acid, possibly *o*-formic acid, $HC(OH)_3$; *o*-acetic acid, $CH_3C(OH)_3$; and *o*-monochloroacetic acid, $CH_2ClC(OH)_3$.

Challenger Society, June 27.—Capt. Wilson-Barker in the chair.—A series of deep-water fish from the N.E. Atlantic slope: Messrs. **Holt** and **Byrne.** The series included *Chimaera mirabilis*, Collett, *Macrurus labiatus*, Koehler, and *Scorpaena echinata*, Koehler. Several of the rarer species filled gaps in the known area of distribution.—A photograph of so-called oily patches at sea, supposed to be rich in plankton: Captain **Wilson-Barker.**—New charts published by the society. Six of these, prepared by Dr. **Schott,** showed the mean annual isotherms of the ocean, and the seventh was a small blank chart of the world for plotting distributions, &c.—A destructive test of Hensen's theory of the uniformity of plankton over large areas: Dr. **Fowler.** It was shown that great variations in the plankton occurred on successive days at stations close together in a district apparently unappreciably affected by currents.—The scientific cruise of his yacht, *Silver Belle*, in 1906: Dr. **Wolfenden.** The vessel was chiefly occupied with trawling and hydrographic work, from Dublin to Funchal, and from Gibraltar to the Josephine Bank and N. coast of Morocco. Mr. Byrne exhibited and commented on some of the fish obtained during the cruise, of which the most interesting was a fine specimen of the little-known *Himantolophus reinhardi*, Lütken, said to have been taken in shallow water near Gibraltar.

Faraday Society, July 2.—Prof. S. P. Thompson, F.R.S., in the chair.—The oxidation of atmospheric nitrogen in electric arcs: Prof. Kr. **Birkeland.** This will be dealt with in a later number.—Preliminary report on the experiments made at Sault Ste. Marie, under Government auspices, on the smelting of Canadian iron ores by the electrothermic process: Dr. E. **Haanel.** The results obtained are summarised as follows:—(1) Magnetite (which is the chief Canadian ore) can be as economically smelted by the electrothermic process as hematite. (2) Ores of high sulphur content not containing manganese can be made into pig-iron containing only a few thousandths of 1 per cent. of sulphur. (3) The silicon content can be varied as required for the class of pig to be produced. (4) Charcoal, which can be cheaply produced from mill refuse or wood which could not otherwise be utilised, can be substituted for coke as a reducing agent, without being briquetted with the ore. (5) A ferro-nickel pig can be produced practically free from sulphur and of fine quality from roasted nickeliferous pyrrhotite. (6) The experiment made with a titaniferous iron ore containing 17·82 per cent. of titanic acid permits the conclusion that titaniferous iron ores up to perhaps 5 per cent. titanic acid can be successfully treated by the electric process.—Electrolysis of dilute solutions of acids and alkalis at low potentials: dissolving of platinum at the anode by a direct current: Dr. G. **Senter.** When dilute solutions of sulphuric acid and of sodium hydroxide are submitted to electrolysis at a potential below that at which oxygen is evolved in the gaseous form, an oxidising agent is formed in a very small amount at the anode. The substance is very stable, and is not destroyed by boiling; it is not hydrogen peroxide. In the course of the experiments with dilute sulphuric acid, it was observed that traces of platinum went into solution from the anode, although the average current density was only about $1·5 \times 10^{-7}$ amperes per sq. cm.

Dublin.

Royal Dublin Society, June 19.—Prof. J. A. McClelland in the chair.—The absorption of β radiation by matter: Prof. J. A. **McClelland** and F. E. **Hackett.** As pointed out in a previous paper, the coefficient of absorption of β radium rays as usually measured gives little information as to the stopping power of different types of atoms. This arises from the fact that the secondary radiation of β particles is important, and must be allowed for before a true coefficient is obtained. The measurements in the present paper are made in such a way that this necessary correction can be applied. The results show that the quotient of this true coefficient of absorption by the density is not constant, but depends on the atomic weight of the absorbing substance. The main feature is that the quotient increases as the atomic weight increases; the rate of increase is not, however, uniform, and there is evidence that the elements fall into divisions with respect to this quotient corresponding to the chemical periods. This may be compared with the previous work by one of the present authors, showing that the emission of secondary β radiation is determined by the atomic weight of the substance acted upon.

Paris.

Academy of Sciences, July 9.—M. H. Poincaré in the chair.—Remarks by M. Berthelot on his work "Archéologie et Histoire des Sciences."—Trypanosomiasis of the

Upper Niger: a new pathogenic trypanosome: A. **Laveran.** The new species was obtained from a ram, inoculated from the blood of a horse infected in the Bari region, and is named *Trypan. cazalboui.* This trypanosome is clearly distinguished from neighbouring species by its pathogenic action upon animals. The chlorides and sulphates of rubidium and cæsium: M. **de Forcrand.** A thermochemical paper.—The secondary alcohols of the octane $(CH_3)_2.CH.(CH_2)_4.CH_3$: Louis **Henry.** A discussion on the relations existing between the boiling points of the secondary alcohols and the position of the hydroxyl group in the chain.—The effect of breathing air containing from 5 per cent. to 10 per cent. of carbon: N. **Gréhant.** The effect of increasing the carbonic acid content of the air from the normal amount to 5 per cent. is to set up more rapid breathing, but the composition of the gases of the blood remains nearly constant. When the proportion of carbonic acid was increased to 10 per cent., the respiratory movements were three times as fast as with pure air; the oxygen in the blood gases was still constant, but the carbonic acid was increased from 38·4 per cent. to 42·8 per cent.—A reflection heliometer: Milan **Stefánik.**—A preliminary measurement of the lines of the solar spectrum in the infra-red: G. **Millochau.** The results of the application of a method indicated in a previous note. Measurements of 106 lines are given for wave-lengths λ 8025·5 to λ 9325·2.—The theory of ensembles: Jules **König.**—The measurement of the capacity and self-induction of telegraph lines: M. **Devaux-Charbonnel.** Details are given of the methods used to prevent the interference of parasitic currents. It was found that the capacity of air lines is higher than their theoretical value, and varies with the hygrometric state of the atmosphere.—The determination, in wave-lengths, of the photographed absorption bands of the colouring matters of the blood: Louis **Lewin,** A. **Miethe,** and E. **Stenger.**—The action of the silent discharge on cyanogen: H. **Gaudechon.** Nitrogen is set free and a solid body deposited, the latter not being merely a polymeride of cyanogen, since the values of n in the formula C_nN_1 varied from 4·4 to 5·0 in different experiments.—Amido-acids derived from the albumens: Albert **Morel.** An account of the preparation of some substituted ureas of glycocoll, including glycocoll-urea, a mixed urea of glycocoll and leucine, and of glycocoll and tyrosin. None of these compounds was capable of hydrolysis with digestive ferments.—Condensations with anthranol: R. **Padova.**—The reduction of the primary unsaturated alcohols of the fatty series by the metal-ammoniums: E. **Chablay.** With allyl alcohol, one molecule is converted into sodium allylate and a second into propylene. The reaction is quantitative, and forms a good method for the preparation of pure propylene.—The transformation of some secondary-tertiary α-glycols into ketones, and the transposition of hydrobenzoin: MM. **Tiffeneau** and **Dorlencourt.**—The isomorphism of potassium chlorate and nitrate: Jean **Herbette.** It is shown in the case of these two salts that the properties of mixed crystals in a series of isomorphous mixtures are not necessarily intermediate between those of the extreme terms of the series, the pure salts.—The influence of the absorption of sugar on the phenomena of germination of young plants: W. **Lubimenko.** When fermentable sugars are absorbed by the plant, the latter behaves physiologically like a yeast placed under aërobic conditions.—Variations in the nutritive exchanges under the influence of muscular work developed during mountain climbing: H. **Guillemard** and R. **Moog.**—The temporary disappearance of the trypanosomes of nagana in infected dogs: Gabriel **Roux** and Léon **Lacomme.**—The geology of the Djebel Ouenza district, on the borders of Tunis and Algeria: Pierre **Termier.**—The terrestrial magnetic inclination in prehistoric times: Paul L. **Mercanton.**—The trajectories of electric corpuscles in space under the influence of terrestrial magnetism, with applications to the aurora borealis and magnetic disturbances: Carl **Störmer.**—The aurora borealis: P. **Villard.**—The supposed law of monthly distribution of earthquakes: F. de Montessus **de Ballore.** The author concludes that earthquakes occur at any time of the year, and that there is no ground for supposing a maximum earthquake frequency in any special month.

NEW SOUTH WALES.

Linnean Society, May 30.—Mr. Thos. Steel, president, in the chair.—The genus Cardiothorax, with descriptions of new species of Australian Coleoptera, part ii.: H. J. **Carter.** All workers in Australian entomology who are precluded from an examination of types in European museums find their difficulties increased by the want of information on many of the commoner species. The present paper is an attempt to clear up much of the confusion that has existed as to the nomenclature, identification, and geographical distribution in one of the larger genera of the family Tenebrionidæ, subfamily Helopides, viz. the genus Cardiothorax.—Preliminary note on the geological history of the Warrumbungle Mountains district: H. I. **Jensen.** It is shown in this note that the Warrumbungle Mountains are the remnants of a dome-shaped mass of volcanic rocks dissected by arid agencies. The erosion has produced a land form similar to that described by Ida H. Ogilvie under the new name of "conoplain" (*American Geologist*, July, 1905). It is also shown that this conoplain is surrounded by a peneplain dissected by arid agencies and base-levelled to the level of the Western Plains.—Descriptions of new species of Australian Coleoptera, part viii.: A. M. **Lea.** The paper contains descriptions of twenty-two new species and one new genera (a blind one) of Staphylinidæ, a new genus of Paussidæ, a remarkable new genus of Ptinidæ, the only known species of which occurs in ants' nests, an Inopeplus, a Pelonium (a genus of Cleridæ not hitherto recorded from Australia), four species of Lathridius, and a beautiful Lemodes.—New Australian species of the family Agrionidæ (Neuroptera: Odonata): R. J. **Tillyard.** Eleven new species are added to the Australian list, bringing the total for this family up from twenty-eight to thirty-nine. Seven genera are represented, of which two have not before been recorded for Australia. Of the species described, ten are new to science, and the eleventh has only been recorded before from Central Africa, where it is common.

CONTENTS.

THURSDAY, AUGUST 2, 1906.

THE RAND THROUGH FRENCH SPECTACLES.

Étude sur l'État actuel des Mines du Transvaal. Les Gites—leur Valeur. Étude industrielle et financière. By George Moreau. Pp. iv+218. (Paris: Librairie polytechnique, Ch. Béranger, Editeur, 1906.)

THIS, the latest description of the Witwatersrand, is a curious medley of history, physiography, geology, mining, and finance, in which the author endeavours, and not without success, to picture to his readers the present condition of the gold-mining industry.

The geological portion of the book consists of a *résumé*, fairly accurate and complete, of recent publications of the Geological Society of South Africa, while the mining and economic statistics are derived chiefly from the excellent compilations of the Witwatersrand Chamber of Mines and the Government Mines Department of the Transvaal. The description of the methods employed in the exploitation of the mines, and of the processes in vogue for the recovery of the gold from the ore during its progress from the rock-crushers, through the stamp-mill and the cyanide works, to the residue dumps, is well done and up to date, such recent innovations on the Rand as tube-mills and filter-presses being described.

The use of the old chemical symbols (in which water is represented by HO) in giving the reactions of the cyanide process seems a strange reversion to the past. The author's reason for this procedure is found in a footnote on p. 165. It runs:—

"Nous avons hésité pour choisir les notations des formules chimiques et avons fini par adopter les vieilles formules des équivalents. Les nouvelles vues relatives à la constitution des corps ont provoqué bien des attaques contre les théories dites atomiques et beaucoup de bons esprits regardent cette notation comme insuffisante. Nous ne prenons nullement position dans le débat et choisissons simplement les formules pondérales comme commode pour les praticiens."

A curious commentary on the chemistry of the day!

Not the least interesting part of the book is that which contains the author's views on the labour supply for the mines—the burning question of the hour in the Transvaal. Speaking of Kafir labour, he says, "whereas among the white working classes continuous work is necessitated by the fact that a day's pay scarcely suffices to meet a day's requirements, the Kafir has no wants (his food and lodging being found), and he works only for six or eight months, during which time he accumulates sufficient capital to enable him to return to his kraal, where he invests his savings in women and cattle. The work of his wives then provides the wherewithal for an idle life. Formerly, war furnished forth slaves for the conquerors; now the males consent to a little temporary fatigue in order to assure a life of complete tranquillity and repose. The constant succession of fresh hands, inexperienced in mine work, depresses the standard of efficiency for Kafir labour. The best workers are, of course, the few who spend their earnings (unfortunately largely in the consumption of alcohol), and consequently remain on the mining field."

The author calculates that in the territories in which recruiting for native labour is permitted a supply of not more than 250,000 can be reckoned on. The labour requirements of South Africa (for mines, agriculture, and public works) amount at present to 380,000, and if the developments that are hoped for are realised, the demand for labour will have increased in five years' time to 600,000. It is evident that the importation of Chinese labour relieved a very pressing necessity.

The introduction of the Chinese receives the commendation of the author. It has, on the whole, he says, been a success.

"Very industrious and most desirous of gain, the Chinese make first-class miners. They take to underground work, and the results are excellent when they know that they are being paid in proportion to the work done. While they exert themselves as little as possible when on salary, they show great activity when put on piece-work."

There is no doubt that if they are employed on piece-work excellent results will be obtained. Moreover, the introduction of the Celestials has, according to the author, had a particularly favourable influence on the recruiting of the Kafirs, who now feel that they are no longer masters of the situation.

The white miners come in for some severe handling at the hands of the author. He ridicules their antagonism which forced the Transvaal administration, in admitting the Chinese, to impose restrictions which prevent their best qualities being utilised. The employment of a Celestial on anything approaching skilled labour is strictly prohibited. Yet, as the author points out, the machine-drills are often actually manipulated by a Chinese or Kafir assistant (whose pay does not amount to more than three or four shillings a day), while the white miner in charge (who draws one pound or more a day) looks on and smokes his pipe.

In concluding a chapter on the future of the Witwatersrand mining industry, the author says:—

"The Transvaal is a fine country, where Nature has been pleased to concentrate enormous mineral wealth, and where there is still a fertile field to exploit. Gold and coal have been found in abundance. The diamond occurs in an eminently favourable condition for exploitation, and a recent notable discovery has added tin to the metals—lead, silver, and copper—which were already known to exist. The *possibilities* of the Transvaal are considerable, and those who interest themselves in a good venture from the start are almost certain to net a profit. The reverse of the medal is that the European markets do not get the chance of participating in South African ventures until they have passed through the hands of a number of intermediaries, all of whom have exacted a profit, and the price at which they are finally offered to the investing public is more in harmony with the illusions of the purchasers than the reality of the facts."

F. H. H.

A NEW FLORA OF GREECE.

Conspectus Florae Graecae. Auctore E. de Halácsy. 3 vols. Vol. i., pp. 825; vol. ii., pp. 612; vol. iii., pp. 520. (Leipzig: W. Engelmann, 1900–1904.)

SINCE the publication of Sibthorp and Smith's great work, "Prodromus Floræ Graecæ," more than a century ago, a large number of individual workers have published floras of certain parts of Greece, and have described a very considerable number of new species. But no work dealing with the Grecian flora as a whole has—since Sibthorp and Smith—been attempted until now. The author of the present work is to be congratulated upon the success he has achieved. His book is most useful to every systematist who has to deal with European plants. He himself had travelled and collected in Greece, and had written on the botany of Greece. To the results of his own observations he has utilised the data furnished by previous authors, whose names and works are duly tabulated at the end of the third volume. The area treated in the "Conspectus" is Greece (as politically understood), as well as Epirus and Crete. The three volumes contain 825, 612, and 520 pages respectively. The species are accurately described, except in the case of the more well-known plants, of which bibliographical references and synonyms, as well as habitats, only are given. The larger genera have a key at the commencement of each to facilitate the "running down" of the species.

Practically the sequence of the genera is that of Bentham and Hooker's "Genera Plantarum," although some of the suborders of those botanists are given independent rank. For instance, Fumariaceæ is separated from Papaveraceæ, Oxalidaceæ from Geraniaceæ, Rosaceæ (as understood by Bentham and Hooker) is split up into Amygdalaceæ, Rosaceæ, and Pomaceæ. Silenaceæ (Caryophyllaceæ of most systematists) has Alsinaceæ separated from it.

It may be of interest to note the relative space occupied by some of the larger natural orders. Compositæ heads the list with 245 pages, Papilionaceæ comes next with 125, Gramineæ and Labiatæ have 120 each, Umbelliferæ 88, and Scrophulariaceæ 74. The largest genera in point of number of species are as follow. To show at a glance the relative proportions of the Greek to the general European flora as given in Nyman's "Conspectus Floræ Europææ," the number given by Halácsy is quoted first, and then the total number for the whole of Europe from Nyman. Of Centaurea, Greece boasts 71 species, the whole of Europe 171; Trifolium 61 species against 108, Euphorbia 44 against 107, Campanula 43 against 94; Allium has more than half the total number of species possessed by the whole of Europe, 41 against 78; in Verbascum Greece claims a still larger proportion, 39 species against 54. In Carex Greece has 36 species, the European flora altogether 163. Vicia has 35 species; Nyman enumerates 61 for Europe. Astragalus has 33 Greek species against 120 for the whole of Europe, and Hieracium has only 20 species against 185.

It is worthy of mention that the origin of the horse-chestnut is here definitely settled. In most books Asia is given as the native country of *Æsculus hippocastanum*; in others it is stated with equal certainty that its native country is uncertain or unknown. Sibthorp records it as occurring in a wild state near Pindus. Nyman, in a note in his "Conspectus Floræ Europææ," says, "Indicatur a Sibthorpio in Pindo, monte illo Graec. bor. sed post eum a nullo alio ibi inventa est." Halácsy, however, quotes Haussknecht as having found it truly wild in this and other localities (see *Mitth. thür. bot. Ver.* 1886, p. 71). It was, however, Heldreich (in *Sitzungsb. bot. Ver. Brandenb.*, 1879, p. 139, and 1882, p. 20) who first brought forward sufficient evidence to prove that the real home of the horse-chestnut was in the mountains of Northern Greece. N.

SUBTERRANEAN GEOGRAPHY.

Höhlenkunde, mit Berucksichtigung der Karstphänomene. By Dr. W. von Knebel. Pp. xvi+222. (Brunswick: Vieweg und Sohn, 1906.) Price 5.50 marks.

THIS book is one of the handy monographs in the collection styled "Die Wissenschaft," which corresponds well in range with the English "International Scientific Series." It may be described as a clear introduction to the study of caves; but it is not so inspiring as the subject deserves. We cannot think, for instance, that it would enable anyone to realise the attraction that the hidden depths have had for certain specialists. There is a tendency in the book to classify phenomena, which may be of service to those who fully grasp their meaning; and perhaps we expect too much from an author who is so eminently exact. Somehow we do not quite see before us the great *gouffres* leading vertically down to unknown waterways; nor, on the surface, the real desolation of the Karstland, the white dust of waterless days, the fantastic rocks standing up in moonlight like ghosts upon the slabs of enormous tombs, the sudden edge of the ravine, and the clear green river sunk half-a-mile below. Well, if we are to study "Höhlenkunde," the emotions are for other moments. Yet what an emotional subject it all is!

Dr. von Knebel's account (p. 57) of the subterranean connection between the Danube at Immendingen and a tributary of the Rhine in the Hegau leaves, let us admit, nothing to be desired; and there are plenty of local touches here. Of equal interest is the description (p. 107) of the flow of sea-water into the limestone near Argostoli in Kephalonia, whereby two mills are kept going in the stream. A diagram shows us how this may be accounted for by the outflow of lighter brackish water into the sea at another point, this water being the result of the mingling of a fresh-water spring with the marine flow underground. We learn also how a fresh-water spring emerging under the sea may draw in sea-water from some point above it, through a cavity partly filled with air.

Among many useful discussions, we note (p. 26) that dolomite is stated to be equally soluble with calcite in water, and that hence dolomite-masses are capable of giving rise to typical karst-phenomena. It is observed (p. 195) that the air of caves is a remarkable conductor of electricity. The relation of typical karst-surfaces to the removal of forests is pointed out, and French areas, cleared after the Revolution, are cited as examples. The French *causses*, by-the bye, deserve rather longer mention, considering how accessible they now are from Millau, and how finely they illustrate the author's thesis. But we welcome the use made of the "dolinas" and "poljes," names that recall the fascination of the Slavonic east. The author's classificatory instinct introduces us also to marine erosion and to Fingal's Cave; to a glimpse of the fauna of caves; and to caves as the haunt of early man. But it is the treatment of the karst-phenomena that will probably give this book a place among works of reference, although precise references to original papers are rare in it, and although it has, strange to say, no index.

G. A. J. C.

OUR BOOK SHELF.

The Outlook to Nature. By L. H. Bailey. Pp. ix+296. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1905.) Price 5*s*. net.

Prof. Bailey is well known as one of the most fertile and inspiring of teachers of science as applied to agriculture and particularly to horticulture, who has built up a great school at Cornell and has also been the source of a wave of teaching from nature among the schools of the United States.

In all Prof. Bailey's work may be seen the qualities of the enthusiast, who is moved, and gets his power to move his followers, by considerations other than those which are the ostensible object of his work. The life of the country-side, farming and gardening, then, are to Prof. Bailey something more than a scientific study or a means of earning a livelihood—they are the great regenerating influences of modern life. He sees civilised existence getting every day more complex, more noisy, more hurried, more exacting; nor in the interests of efficiency does he expect or desire any wholesale return to a more primitive mode of living. But what he does plead for is the "return to nature" in "our personal and private hours" as a "means of restoring the proper balance and proportion in our lives." The book consists of four lectures, delivered in Boston, on such topics as the relation of country to city, the part that nature-teaching should play in school life and the organisation of rural teaching generally, with a final essay on the position of evolutionary conceptions with regard to religion.

We get a vivid and interesting presentment of the opinions and convictions which have made Prof. Bailey a living force in American education; we see that the writer is a passionate lover of nature with a strain of the poet in him, but we do not always find his treatment convincing. The book must be judged as literature, and in literature neither the best of intentions nor the finest of emotions count unless you can express them with something of the freshness and inevitability of a living thing; here we often find the thoughts and arguments of Thoreau, but without his clear-cut and startling intensity of expression. Prof. Bailey is rhetorical, and that means he is sometimes more concerned with the decorative value of his periods than with their absolute truth; for instance, he makes a point that we go to a gallery to see a picture of a sunrise when we might see the sunrise itself! forgetting that it is only the awakened eyes which can see at all. "I never see a sunset like that," objected the critic to Turner; "Don't you wish you could," answered the artist.

However, putting aside the question of these "airs and graces," Prof. Bailey's thesis is sound enough; civilisation is dying and will die of its own self-produced poisons; it is only by the *improbus labor* on the land that the human race seems able to persist.

A. D. H.

Lecture Notes on Chemistry for Dental Students. By Dr. H. Carlton Smith. Pp. viii+273. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1906.) Price 10*s*. 6*d*. net.

The connection between dentistry and chemistry is a two-fold one. The practical dental surgeon is a worker in metals; he has to prepare amalgams for stoppings and carry out a multitude of similar operations; hence his need for a knowledge of inorganic chemistry. No less important is the second link; he must know the composition of the teeth, the action upon them of the reagents and drugs he employs; he must understand the action of ferments, whether they are contained within the micro-organisms of the mouth or in the secretions, like saliva, which come in contact with the teeth; hence his need for a knowledge of organic, and especially of physiological, chemistry. Dr. Smith has produced a work which supplies such needs, and one is glad to see he has provided an over-supply; for instance, the sections on physiological chemistry do not deal exclusively with saliva, though naturally this subject is treated with special fulness. This is as it should be; the less specialised and narrow a dentist's education, the more is he likely to benefit those under his care.

In the analyses given of the different parts of the teeth, Dr. Smith states that enamel contains 3 per cent. of organic matter. He does not allude to the work of Tomes, in which it was shown that enamel contains no organic matter at all, and what was formerly given as organic matter (by difference) is really due to water. It is not a very important point, and possibly the author was not aware of Tomes's research on the question.

A Study of the Sky. By Prof. Herbert A. Howe. Pp. xii+340. (London: Macmillan and Co., Ltd., 1906.) Price 2*s*. 6*d*.

This is a cheap edition of a book that appeared originally several years ago. Written in attractive, simple language, Prof. Howe's volume is just the work for those readers who, knowing little or nothing of the oldest of sciences, wish to become personally acquainted with the wonders of the sky.

A very pleasing feature of this book is the way in which the reader is forced to observe and experiment for himself. Chapter i. gives a brief historical sketch of astronomy, and is followed by five chapters dealing with the constellations observable at various seasons, and their apparent diurnal and annual motions. Then come three chapters dealing with astronomers in general and particular, and their tools. A chapter on time and the method of keeping it is followed by five (xi.–xv.) chapters dealing *seriatim* with the members of the solar system. The concluding chapters discuss in a simple but instructive fashion comets and meteors, the fixed stars, and the nebulæ.

LETTERS TO THE EDITOR.

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

The Positive Charge carried by the α Particle.

SOME time ago I made the suggestion in NATURE (March 9, 1905) that the α particle was initially uncharged on expulsion, and that it gained its charge subsequently by collision with atoms in its path. I need only now repeat that the suggestion was based on the brilliant work o Bragg in Australia, who showed that the α particle passes *through*, rather than collides with, the atoms of solid or gaseous matter in its path, and that whether uncharged or not initially, it must, equally with the atom struck, become charged positively after the encounter by the detachment of a negative electron.

Recently P. Ewers (*Physikalische Zeitschrift*, March 1), using the α particles from polonium, attempted to put the view to an experimental test with negative results, and concluded against the probability of the hypothesis. Bragg (*Phys. Zeit.*, July 1) has pointed out that Ewers's experiments by no means settle the question, and, indeed, he evidently considers it a question which cannot be settled experimentally. Certainly the requisite conditions to be fulfilled for a positive result are so rigorous that no one could be certain they had been fulfilled, and it is impossible to disprove the view by a negative result. But it is obvious that a positive result, that is, the actual isolation of the α particle in an uncharged state, would settle the question. This I have been fortunate enough to do, although only after a long experience of negative results where it might reasonably have been concluded the requisite conditions had been realised. "The best laid schemes of mice and men gang aft a-gley." A determining factor in the problem conditioning whether a positive or negative result is obtained could not possibly have been foreseen, and it was only when all hope of getting anything but a negative result had been abandoned, and what was intended to be a final experiment was being performed, that a slight change in one of the factors happened to eliminate the disturbing cause, and I obtained the coveted positive result. The precise nature of this disturbing influence is, perhaps, not yet fully demonstrated, although personally I think I now hold the clue. But there is not the slightest doubt that the α particle initially expelled is not charged as the experiments given prove.

The essential conditions are two. In the first place, the α particle must be examined in a vacuum such that during its path it does not encounter a single gas molecule. Secondly, the layer of radio-active matter from which it is expelled must not be more than one molecule thick, and must not be mixed with or overlaid by inactive matter. These conditions being fulfilled, the α particle will not traverse a single atom after expulsion, and if uncharged initially must remain so. As a third condition, it is desirable that the test for the charge shall be made on the particle during its flight. It is at least conceivable that an uncharged α particle striking a plate will convey to it a positive charge if the electron detached from the uncharged α particle on impact has sufficient energy to escape the plate.

The second condition is, as may be imagined, the difficult one to make sure of. I hoped to secure it by using radium C as the source of the rays. The rate of its disintegration is so rapid that there is only just the necessary time for an experiment to be carried out. Hence the actual number of atoms of the radio-active substance is for radium C the minimum it is possible to employ. Moreover, this number can readily be calculated, and since it is deposited from a gas uniformly on the exposed surface, not only can an experiment be devised so that the thickness of the deposited layer fulfils the monomolecular condition, but, what is equally important, it can be assumed with reasonable certainty that the radio-active layer is not overlaid or mixed with inactive matter.

With regard to the first condition, all the factors are known, and the necessary conditions can readily be calculated by two independent methods, which, as it proved, are strikingly verified by the actual results obtained. The only pitfall is in the altogether exaggerated impression which is abroad as to the ease with which a high degree of vacuum can be obtained by modern methods.

The third condition was realised by using the magnetic deviation of the α rays as a test for their charge. The rays passed out of the capillary tube from a deposit of radium C at the far end. This was obtained by the use of the emanation from 30 mg. of radium. Conditions were arranged so that the rays were completely deviated under ordinary conditions, and with the magnetic field on did not succeed in escaping from the tube, and the experiment consisted simply in re-examining the deviation in the highest vacuum that could be produced.

Long series of negative results led to the refinement of each essential condition until it seemed no further improvement was possible, and a wide margin of probability that the essential conditions had been realised had been secured. A most unmistakable negative result was obtained. But the next experiment intended to confirm this finally was as unmistakable a positive result as the other had been a negative one. In a partial vacuum the rays were completely deviated. In the highest vacuum the field made no perceptible difference. Between the two experiments there were two slight differences of conditions: (1) In the second experiment the radio-active deposit had been heated *in vacuo* after removal of the emanation and disappearance of radium A in order to remove a possible overlying film of condensed gas. (2) In the first experiment the emanation had been left in the capillary 2 hours 25 minutes, in the second 1 hour 30 minutes, the volume occupied by the emanation being less in the latter case.

In a third experiment the heating of the radio-active surface was omitted, and the emanation was allowed to act for only 45 minutes. The result was unequivocally positive.

In a fourth experiment the film was heated, and the emanation left in 1 hour 20 minutes, reproducing practically the conditions of the second experiment. Again the result was positive, and the magnetic field produced no appreciable effect in a high vacuum. But this experiment was continued for nearly two hours after the start, and at the end of the time the radiation, although, of course, much enfeebled, was quite intense enough for the purpose. As time elapsed a change came over the experiment. Little by little, the rays began to be affected by the field. This change was hastened by heating the active film in place in the high vacuum. At the end the result was as unequivocally negative, all the rays being deviated by the field in the highest vacua, as at the start it had been positive.

The clue, I think, is the change of the glass surface of the capillary, which it experiences under the excessive bombardment to which it is exposed, and which is indicated by the blackening of the glass. In the lead glass used it was remarked independently that the darkening appeared to commence somewhat suddenly. At the conclusion of the experiment it was always marked. But on cutting down the capillary before the commencement in the three final experiments with relatively short exposure to the emanation the darkening had not commenced, whereas in the last experiment, when the pole pieces were removed to allow the deposit to be heated in place it was noted that the darkening had begun. It can be imagined that the slightest roughening of the surface is all that is necessary to cause a negative result. The whole series of experiments from start to finish is explained if accompanying the darkening of the glass there is also a slight roughening. Whether this will prove sufficient to be within the range of the microscope remains to be seen.

I hope to examine the hypothesis that the blackening of the glass is accompanied by the roughening of the surface more in detail later. But whether this or some other explanation proves correct there can, I think, be no doubt about the conclusion that the α particle has been isolated under conditions in which it is not deviated by a magnetic field, and, therefore, is not charged. The theoretical consequences of the discovery need not here be dealt with. Certainly it looks as if the influence of electricity in radioactive change, and its importance generally in its relation to matter, could be overestimated.

FREDERICK SODDY.

The University, Glasgow, July 29.

Stress in Magnetised Iron.

THE important question whether there is any mechanical stress in an iron rod or ring when magnetised, and, if so, whether the stress is compressive or tensile, was discussed in NATURE ten years ago (vol. liii., pp. 269, 316, 365, 462, 533), but has not yet, so far as I know, received any generally accepted answer. That a magnetised rod must necessarily be in the same condition as if under a mechanically applied compressive stress tending to shorten the iron, was, I believe, first suggested by myself (Phil. Trans., vol. clxxix., p. 216, 1888). Those who support this view generally speak of the stress as "Maxwell's stress," and assume its value to be $B^2/8\pi$. The stress in question seems, however, to be quite unconnected with the "stress in the medium" proposed by Maxwell, and its value is not in general exactly $B^2/8\pi$, but $(B^2-H^2)/8\pi$. I have lately had occasion to consider the problem again, and perhaps I may be allowed to re-state my argument in a slightly altered form, and illustrate it by means of an imaginary model.

If a uniformly magnetised rod is divided transversely, and the cut faces are brought close together, the magnetic force inside the narrow gap will be $B=H+4\pi I$. The force acting on the magnetism of one of the faces, and urging this face towards the other, will be less than B by $2\pi I$, the part of the total force due to the first face itself; hence the force per unit of area with which the faces would press against each other if in contact is $P=(B-2\pi I)I=2\pi I^2+HI=(B^2-H^2)/8\pi$. (In the case of an endless permanent magnet, $H=0$, and $P=B^2/8\pi$.) The width of the gap may be diminished until it is no greater than the distance between two neighbouring molecules, when it will cease to be distinguishable; but, assuming the molecular theory of magnetism to be true, the above statement will still hold good for the intermolecular gap. The same pressure P will be exerted across any imaginary section of a magnetised rod, the stress being sustained by the intermolecular springs, whatever their physical nature may be, to which the elasticity of the metal is due. The whole of the rod, therefore, will be subject to a compressive longitudinal stress P, the resulting contraction, expressed as a fraction of the original length, being P/M, where M is Young's modulus for the metal.

Let a magnetic molecule of iron be represented by a rigid steel sphere, uniformly magnetised and covered with a closely fitting shell of india-rubber, to play the part of the "intermolecular springs." Imagine a straight row of these spheres in contact with one another, and kept in place by a force analogous to cohesion, which, while binding the spheres together, leaves them free to turn on their centres. This arrangement would, for present purposes, serve as a model of a filament of iron one molecule in diameter. If the magnetic axes of the spheres pointed indifferently in all directions, the attractions would be balanced by the repulsions, and the length of the filament would be the same as if the spheres were unmagnetised. If, however, the magnetic axis of every sphere pointed in the same direction along the filament, as would be the case when the filament was magnetised, the india-rubber between all the pairs of unlike poles would be compressed and the filament would be shortened. Let F be the compressive stress across the rubber between a single pair of poles, and s the amount, expressed as a fraction of a centimetre, by which the rubber is contracted; then, if there are n spheres, the total contraction will be ns (n being assumed so great that it is sensibly equal to $n\pm 1$), which is the same as would be caused by an equal compressive stress F applied at the two ends of the unmagnetised filament. The whole filament when magnetised may therefore be regarded as under compressive stress due to the magnetic forces, and since Young's modulus $M=Fl/ns$, where l is the length of the unmagnetised filament, the contraction expressed as a fraction of the length is, as originally stated, F/M, the value of F in an actual piece of iron being $2\pi I^2+HI$.

Sometimes there may presumably also be a longitudinal tension, as in the case of an iron rod placed along the lines of force in a uniform field, when the tension would be HI. In a ring electromagnet this would not exist.

As to what effect would be produced in magnetised iron by Maxwell's distribution of stress in the ether, I cannot venture an opinion. But if there is a tension, it can hardly have the familiar value $B^2/8\pi$, which is possible only when B is equal to H, and there is no magnetisation ("Electricity and Magnetism," § 643). My point is that an important component of the stress in magnetised iron is a compression which can be calculated and allowed for. The question whether or not this view is tenable is of the highest interest in connection with the possible correlation of magnetic phenomena, and urgently needs an answer.

SHELFORD BIDWELL.

The Mixed Transformation of Lagrange's Equations.

I SHOULD fancy from the review by "G. H. B." in NATURE of July 19 (p. 265) that the papers of Prof. Levi Civita relate largely to the *mixed* transformation of Lagrange's equations, the complete theory (Proc. Camb. Phil. Soc., vol. vi., p. 117; "Hydrodynamics," vol. i., p. 171) of which was first given by myself so far back as 1887. But what I wish to point out is this, that this theory depends no more on any so-called theory of "ignored" coordinates (or *kinosthenic* coordinates as Prof. J. J. Thomson [Phil. Trans., 1885, part ii.] calls them) than it does on the existence of the hypothetical personage known as the Man in the Moon.

The theory is merely the result of a piece of elimination, and is as follows:—Let the coordinates of a dynamical system be divided into two groups θ and χ; let Θ and κ be the momenta of types θ and χ; and let T be the Lagrangean expression for the kinetic energy. Then it can be shown that

$$T=\mathfrak{T}+\mathfrak{R} \quad \ldots \quad (1)$$

$$\frac{\partial T}{\partial \dot{\chi}}=\kappa \quad \ldots \quad (2)$$

$$\frac{\partial T}{\partial \dot{\theta}}=\Theta=\frac{\partial \mathfrak{T}}{\partial \dot{\theta}}+\bar{\Theta} \quad \ldots \quad (3)$$

where $\mathfrak{T}$ is a homogeneous quadratic function of the velocities $\dot{\theta}$, $\mathfrak{R}$ is a similar function of the momenta κ, and $\bar{\Theta}$ is a linear function of the κ's.

By means of (2) all the velocities and accelerations of type $\dot{\chi}$ can be eliminated from Lagrange's equations, and the result is expressed by means of the modified Lagrangean function

$$L=\mathfrak{T}+\Sigma(\bar{\Theta}\dot{\theta})-\mathfrak{R}-V \quad \ldots \quad (5)$$

and

$$\dot{\chi}=\frac{\partial \mathfrak{R}}{\partial \kappa}-\Sigma\left(\dot{\theta}\frac{\partial \bar{\Theta}}{\partial \kappa}\right) \quad \ldots \quad (6)$$

Equations (5) and (6) constitute the mixed transformation of Lagrange's equations, and include the equations of Hamilton as well as those of Lagrange.

When the coordinates χ are *kinosthenic* coordinates, that is to say, coordinates which enter into expression for the energy of the system only through their differential coefficients with respect to the time, all the κ's are constants, and (5) is sufficient to determine the motion.

In § 173 of my "Hydrodynamics," the words "the latter of which does not enter into the expression for the energy of the system" should be omitted.

A. B. BASSET.

Two Modifications of the Quartz Wedge.

SOME little time ago I wished to make a quartz wedge for producing interference colours with the polarising microscope. The usual wedge supplied by optical instrument makers seldom gives colours lower than "clearer gray" of Newton's colour-scale according to Quincke, while the lower colours are often particularly valuable in petrological work. The quartz wedge is described in the text-books on the subject (*e.g.* Rosenbusch's "Microscopical Physiography") as being cut "so that one of its faces is exactly parallel to the principal axis (optic axis, axis of least elasticity)." The difficulty in getting, say, iron-grey of the first order depends on the extreme thinness of the quartz required at the thin end of the wedge.

Now the interference colour given by plates of equal thickness of the same mineral depends on the direction in which they are cut, varying from a maximum when the plate is parallel to the optic axis to zero when the plate is perpendicular to that direction (assuming the mineral to be uniaxial). If, then, a wedge be made having one face parallel to some such direction as, say, an r or z face of the quartz crystal and its length in the direction of the trace of the vertical plane of symmetry through that face, it will give the same results as the ordinary quartz wedge, but, for the same thickness, will give a lower colour, so that the colours at its thin end may be got very low. On trial a wedge made in this way gave very satisfactory results.

The compound wedge described below, which, so far as I know, is also new, was found to be still better. Suppose a sheet of muscovite be taken, its axes of elasticity determined, and a strip cut of the same size and shape as the quartz wedge with the axis of greatest elasticity parallel to its greatest length. If the wedge is covered with the mica plate and examined between crossed Nicols, there will, of course, be a black compensation band in some position, and by cleaving the mica thinner this band can be made to move towards the thin end of the wedge, and finally to coincide with it. The mica is now cemented to the quartz, and a wedge is produced which gives *all* the colours of the first order. By the use of this compensation mica plate a very poor wedge may be converted into a first-class instrument, or one broken at its thin end restored to usefulness.

Daniel James Mahony.

The Grand Hotel, Melbourne, Victoria, June 25.

Colour Phenomena in "Boletus cœrulescens."

One day recently in the woods at Lynton (where the soil is red) I found and gathered two very beautiful toadstools, with vermilion stem and bright, sulphur-coloured hymenium. In these individuals the striking colour phenomena peculiar to their family were remarkably in evidence; *in the brilliant sunlight* on the bright yellow under-surface of the pileus I found my name when traced in the most gentle way shine out almost immediately in the most magnificent of blues.

Will any of your readers kindly refer me to any recent papers concerning the chemical or physical processes which underlie this fascinating demonstration? From my own superficial observations it is evident, I think, that light plays an important part. The energy liberated by the very gentlest friction appears to be a sufficient initiative.

Parts that have been rendered blue, when left at rest, after a short time return to yellowness, but these same parts are capable under fresh stimulus, so long as the fungus is still alive, of again assuming temporary blueness.

The juice expressed from blue areas is itself bright blue, and imparts a bright blue stain to linen. Upon my handkerchief this colour remained so long (at least five hours) that I thought I had fixed it; but in the morning the *dry* blue patch of the night before was no longer blue, but yellow.

On cutting the stem its upper two-thirds was found endowed with the property of cœrulescence; but this was not in any degree possessed by its lower third, in which the cut surfaces remained of a reddish-brown colour. With the exception of the lower part of the stem and the cuticle, all the tissues of the fungus exhibited cœrulescence.

I take special interest in these observations on account of certain phenomena noticeable in human tissues in the course of a somewhat rarely met with pathological condition which has been described under the name chloroma.

Without entering into details, I may remark that along with the colour development which characterises this pathological condition hæmoglobin is probably being extensively set free from red blood cells, and presumably this body or its derivatives are abnormally abundant in the body fluids. Is there any known organic iron-containing body capable of being responsible for these quick-change effects?

Edgar Trevithick.

Strength of a Beetle.

Last night a small beetle (*Aphodius fossor*), the length of which is ½ inch, flew in at my window and alighted on a table next to me. As it buzzed about I put a lid of a tin box over it, but to my surprise the beetle walked about bearing the lid on its back. I then put the tin box on the top of the lid, and was absolutely amazed to find that the insect tilted up a corner of the combined box and lid, and nearly escaped. The weight of the beetle when dead was ½ grain, alive I suppose it was a little more; but the box and lid weighed 1758 grains! Assuming that the living insect weighed 1 grain, it must have tilted up 1758 times its own weight! Of course, the strength required to tilt up a box on edge is nothing like so great as that required actually to lift the weight, but nevertheless the feat seems to me sufficiently astounding. The dimensions of the box are $3\frac{1}{8} \times 2\frac{1}{8} \times 1\frac{1}{2}$ inches.

Charles R. Keyser.

The Gables, Hayward's Heath, July 26.

THE INTERNATIONAL CELEBRATION OF THE JUBILEE OF THE COAL-TAR INDUSTRY.

During the last century no discovery, perhaps, has led to such far-reaching and important developments as that of mauve, the first aniline dye, by William Henry Perkin. Not only was the door thrown open to the never-ending procession of artificial colouring matters, but the raw materials necessary for their production were also the raw materials for the synthesis of whole series of entirely different substances, which have now assumed most important positions in the world's daily requirements.

It cannot be too often repeated that Perkin's discovery was the result of true scientific devotion to pure research. The synthetic preparation of quinine was the goal aimed at—a sufficiently ambitious one for a lad of seventeen, for the problem is yet unsolved. Perkin did not state, as is perhaps too often done nowadays, that "only a black mass was obtained." His persevering and scientific habit of mind led him to investigate the "black mass," with the result that by extraction with alcohol was isolated the violet dye which is so closely associated with his name.

Great though Perkin's discovery was, yet greater still were the zeal, industry, and genius of the boy of eighteen which enabled him to make the dyestuff on the large scale and place it on the market successfully. Only those who have had experience in large-scale preparations can realise what this must have meant. New plant, new materials, new conditions: all had to be undertaken, and in the introduction of iron vessels for the manufacture of his raw material, aniline, Perkin laid the vast aniline oil industry under lasting obligation.

The start thus given, many entered the field; by a slight variation of Perkin's process Renard and Franc introduced the splendid crimson dye "magenta" in France, whilst shortly afterwards Simpson, Maule, and Nicholson started the manufacture of this colour in London. The happy collaboration of A. W. Hofmann, the college professor, with the splendid technical chemist and business man, E. C. Nicholson, soon not only placed the London firm in a commanding position, but gave to the world those researches on rosaniline for which Hofmann became so famous.

In the meantime, Perkin not only manufactured mauve, but was steadily working at the artificial products of alizarine, which he was able to obtain in 1868, and immediately produced it on the large scale. In 1873, recognising that a very largely increased manufacturing scale was necessary for the highest degree of success (a principle since so thoroughly carried out by the large German firms), Perkin decided to retire from business, and his works were sold. After some vicissitudes the business was transferred to Silvertown, where the British Alizarine Company carries on a large and successful manufacture of alizarine dyes.

From the beginning the development of the industry steadily continued, both in England and on the Continent. In 1859 Griess, a chemist employed at Allsopp's Brewery, discovered the first azo dye, which was manufactured in 1863 by Simpson, Maule, and Nicholson. This was the starting point of one of the most important branches of the colour industry, and was rapidly followed by many brilliant discoveries by Hofmann, Nicholson, Caro, Martius, and Witt in England, Girard and De Laire and Poirrier in France, and Baeyer, Böttiger, Duisberg, and many others in Germany.

The outcome of this has been that the colour industry has progressed to one of enormous importance. The combination of scientific research and business skill so strikingly exampled by Perkin and Nicholson has been applied in Germany with marvellous success, and has resulted in the development of several great firms, each employing several thousands of workmen and hundreds of chemists and engineers.

The example set by Englishmen has not been followed to the same extent in this country, and the industry, affected by the fall of one or two historic houses, has progressed but slowly.

In failing to synthesise what is perhaps the most important aid known to medicine, Perkin gave to medicine its most potent drugs; for the separation of hundreds of products from coal-tar has enabled chemists to prepare phenacetin, antipyrin, antifebrin (the latter actually produced on the large scale as a bye-product by Perkin), and many others. Extensive manufactories of saccharin, photographic developers, and pharmaceutical products have been erected, and, indeed, it is difficult to say where the far-reaching influence of Perkin's discovery may end.

One thing is sure, it is not to be measured by mere statistics; in the words of Hofmann, "the moral of Mauve. . . . is transparent enough. Whenever one of your chemical friends, full of enthusiasm, exhibits and explains to you his newly-discovered compound, you will not cool his noble ardour by asking him that most terrible of all questions, 'What is its use? Will your compound bleach or dye? Will it shave? May it be used as a substitute for leather?' Let him quietly go on with his work. The dye, the leather, will make their appearance in due time. Let him, I repeat, perform *his* task. Let him indulge in the pursuit of truth,—of truth pure and simple,—of truth not for the sake of Mauve,—let him pursue truth for the sake of truth!"

It was a peculiarly happy circumstance that the meeting to honour Sir William Henry Perkin should have been held in the Royal Institution. The most elementary constituent of coal-tar, viz. benzene, was discovered here by Faraday in 1825, and this was followed by Perkin's own discovery of mauve in his home laboratory. "Let me tell you then," said Hofmann in the lecture room in 1862, "that Mauve and Magenta are essentially Royal Institution colours: the foundation of this new industry was laid in Albemarle Street."

The whole of the chemical world was represented at the meeting on July 26, which was presided over by Prof. R. Meldola, F.R.S. It is only necessary to mention such names as Emil Fischer, H. Caro, Albin Haller, P. Friedländer, C. Duisberg, G. Schultz, A. Bernthsen, C. Liebermann, R. Möhlau, in order to indicate that the very foremost of foreign chemists were present, and all the representative English men of science and technology were to be seen at this historic gathering. The presentation of the Hofmann and Lavoisier gold medals, the foreign university degrees, and the great number of congratulatory addresses gave ample proof, were it needed, of the admiration with which all chemists regard the founder of this great industry.

At the dinner in the Whitehall Rooms in the evening (Prof. Meldola in the chair), tributes were paid by an even wider circle of appreciative admirers. Mr. Haldane, His Majesty's Secretary of State for War (who proposed the toast of the evening), the Earl of Halsbury, Lord Alverstone, Sir William Broadbent, Sir Henry Roscoe, Profs. E. Fischer and A. Haller, Sir Robert Pullar, and the chairman pointed out the benefits accruing, not merely to the colour industry, the dyeing trade, the medical profession, and science at large, but also to the whole world.

On the following day Sir William and Lady Perkin entertained a large number of guests at The Chestnuts, Sudbury, near Harrow. The old Greenford works and Sir William's private laboratory were visited, whilst in the beautiful garden one saw the madder plants which came from the late Dr. Schunck's garden in Manchester.

Sir William and Lady Perkin's reception in the Hall of the Leathersellers' Company concluded the festivities, which will never be forgotten by those who were privileged to take part in them.

J. C. Cain.

THE SPORADIC PUBLICATION OF SCIENTIFIC PAPERS.

In these latter days the development of science has led to an inverted fulfilment of the old prophecy, "Men shall run to and fro and knowledge shall be increased." Nowadays men have to run to and fro because knowledge is increased. A very considerable portion of the time of a man of science is taken up in "running to and fro" seeking for the papers which he wishes, which, indeed, he is bound to consult. There are various ways in which much of the time thus spent might be saved, and some of these ways are being more or less successfully made use of. One cause, however, of this "running to and fro" deserves special attention, because it seems really unnecessary, and the time spent through its continuance may be said to be time wholly wasted.

It has been my lot to receive almost at the same time a number of the Journal of the Marine Biological Association, a volume of the Scientific Memoirs of the Officers of the Medical and Sanitary Departments of the Government of India, a volume of the Thompson-Yates and Johnston Laboratories Reports, and the annual Report of the Medical Officer of Health to the Local Government Board.

All these contained papers of great scientific value, and I feel sure that many besides myself are continually having brought before them similar instances of the abundance of what I venture to call the sporadic publication of scientific papers. This has been very strikingly brought home to those who have had to do with the Royal Society's Catalogue of Scientific Papers or the International Catalogue of Scientific Literature.

Now two channels for the publication of scientific papers must be accepted without cavil.

In each country (for international publications, however desirable, present almost insurmountable mechanical difficulties) it is well that there should be a periodical devoted to each "branch" of science, and as time goes on each "branch" will naturally become more and more subdivided. This may be regarded as the natural, and, putting on one side historical considerations, the first channel.

But the publications of established academies and of the older special societies must be accepted also. The newer special societies would do well to make use of the special journals, in some such way as the Physiological Society makes use of the *Journal of Physiology*, and perhaps even some of the older ones might adopt the same methods.

In any case, there is no reason for special comment on these two channels. But things are different when we come to consider the kind of publication of which I have given examples above.

Let me take, for instance, the Journal of the Marine Biological Association, and the Thompson-Yates and Johnston Laboratories Reports. The number of the former is almost wholly occupied by a memoir of systematic zoology, the number of the latter by papers on trypanosomiasis. Why should the student in systematic zoology, who has possibly at some expense taken steps to secure ready access to the publications of the Zoological and Linnean Societies, have also to run after the Journal of the Marine Biological Association?

Why should the student in tropical diseases have to run hither and thither, seeking in this and that report what he ought to find ready at hand either in the *Journal of Comparative Pathology* or *Journal of Hygiene*, or some still more special periodical?

Now there can be no doubt that the *causa causans* of the two periodicals in question is advertisement. One cannot but sympathise with the efforts of the Marine Biological Association to make its worth known; one has also sympathy with the University of Liverpool, but less acute since its great merits are in everyone's mouth. But I venture to put the question, Is it desirable that, for the mere sake of advertisement, the progress of science should be hindered? For anything which puts obstacles in the way of the student getting ready access to a knowledge of what has been done is a distinct hindrance to progress. Why should not the Marine Biological Association spend the money which it has spent in printing the Hon. C. Eliot's valuable memoir on British nudibranchs in subsidising some acknowledged channel of zoological publication. It is well that the association should have a journal, but that journal ought to be occupied exclusively by business matters; all scientific papers of permanent value produced by help of the association ought to be published elsewhere.

In the same way, why should not the Liverpool University spend some of the ample funds at its disposal in subsidising periodicals, many at least of which are in urgent need of support? This would in the end be even a better advertisement.

The Lister Institute sets in this respect a very good example. It too has need of advertisement, but the results of the varied work carried on there are published each in an appropriate acknowledged channel. It limits its direct advertisement to issuing in a collected form reprints of the various papers scattered over many periodicals.

The scientific papers in Government publications stand on a somewhat different footing from those just spoken of. The Annual Report of the medical officer of the Local Government Board referred to above contains, besides several papers of direct administrative value, under the term "report" a number of valuable papers of a purely scientific character, papers to which every inquirer in pathology ought to have ready access. But why should a scientific library, and why especially should the limited library of a pathological institute or laboratory, for the sake of a mouthful of pure science, burden its shelves with an intolerable mass of administrative details? The publications of the medical officer of the Local Government Board do not stand alone in this respect. In the enormous mass of printed matter which H.M. Government puts out every year there are hidden, buried, lost to view, records of scientific research of varying but not unfrequently of great value, records to which the scientific inquirer ought to have ready access. This official burial of scientific work does a double harm; it harms him who did the work, it harms all those who, through the burial, miss knowing what has been done.

Of course it must be recognised that H.M. Government, having ordered and supplied the funds for a scientific inquiry, has a right of possession in the records of that inquiry, so that by the official publication of that record it may justify before Parliament and the public the order for the inquiry. The matter is further complicated by the fact that when the order for inquiry is part of the work of a Royal Commission, the results of such an inquiry cannot be made known until the report of the commission on its work as a whole is laid before Parliament and published.

But these difficulties are not such as cannot be overcome. A small Commission of the nature of what is known as a Departmental Committee, appointed some little time back to investigate plague in India, has, with the approval of the authorities, adopted the following plan. While making the usual arrangements for the reports on administrative matters, it proposes to publish from time to time the scientific results of the work of the commission in an appropriate scientific journal, securing, by the purchase of extra copies of the records thus published, the means for the complete publication of the whole work of the commission at some future period.

Such a plan might be extended to all scientific inquiries carried out by order of H.M. Government; it needs nothing more than frank negotiations between persons responsible to H.M. Government and editors of scientific periodicals. Such a plan would bring many blessings. It would enable the man of science who is putting his best into the work which he is doing for Government to feel that the record of his work will not be hopelessly lost sight of. It would save other men of science the labour of hunting for scientific needles in Government bottles of hay, or the chagrin of finding out, when too late, that by shrinking from such uncongenial labour they had missed something of great price. It would save the nation a not inconsiderable sum of money, and yet furnish the editors of scientific journals with money, which many of them need for the conduct of their journals, and which most of them at least would use in helping the poor author to a more complete publication of the records of his work. Lastly, it would relieve the bibliographer from much wearisome labour. In every way, in fact, it would tend to advance natural knowledge.

X.

THE YORK MEETING OF THE BRITISH ASSOCIATION.

THE York meeting of the British Association, which was opened as we went to press last night, promises to be a very large one. The local arrangements and the programmes of the various sections have already been described in these columns. Among the representatives from abroad who are expected at the meeting are the following:—Section A, Prof. H. Rubens, the University, Berlin; Prof. C. G. Rockwood, Prof. F. P. Whitman. Section B, Prof. Paul Pelseneer, Ghent; M. G. Grandidier, Paris; Dr. and Mrs. Yves Delage, Paris; Prof. Looss, Cairo; Prof. Gary N. Calkins, New York; Prof. H. F. E. Jungerson, Copenhagen; Dr. Gustave Loisel, Utrecht. Section C, Prof. Edgworth David, Sydney. Section E, Prof. Loezy, Budapest. Section F, Prof. K. Wicksell, Lund. Section K, Prof. W. Johannsen, Copenhagen; Prof. C. H. Ostenfeld, Copenhagen; Dr. C. Rosenberg, Stockholm; Prof. E. Pfitzer, Heidelberg; Prof. and Mrs. Jeffrey, Harvard University; Prof. Ligrier, Caen; Prof. H. Potonie, Berlin. Corresponding member, Prof. C. Julin, Liége.

The Court of the University of Leeds has resolved to confer the honorary degree of D.Sc. upon the following in connection with this meeting of the Association:—Prof. E. Ray Lankester, F.R.S.; Prof. A. Grandidier, of Paris; Prof. P. Pelseneer, of Ghent; and Prof. H. Rubens, of Berlin. The degree of D.Sc. will be conferred upon the following in connection with the meeting of the Association and also with the coal-tar colour jubilee:—Sir W. H. Perkin, Dr. Heinrich Caro, of Mannheim; Prof. Albin Haller, of Paris; Prof. C. Liebermann, of Berlin; and Dr. C. A. von Martins, of Berlin.

INAUGURAL ADDRESS BY PROF. E. RAY LANKESTER, M.A., LL.D., D.Sc., F.R.S., F.L.S., DIRECTOR OF THE NATURAL HISTORY DEPARTMENTS OF THE BRITISH MUSEUM, PRESIDENT OF THE ASSOCIATION.

MY LORDS, LADIES AND GENTLEMEN,—It is, first of all, my privilege to thank you for the distinguished honour you have done me in electing me President of this great scientific Association—an honour which is enhanced by the fact that our meeting this year is once more held in the venerable city of York, in which seventy-five years ago the British Association for the Advancement of Science held its first meeting.

It is a great pleasure to me to convey to the Lord Mayor and the dignitaries and citizens of York your hearty thanks for the invitation to meet this year in their city. It seems to have become a custom that the Association should be invited at regular intervals to assemble in the city where it took birth and to note the progress made in the objects for the furtherance of which it was founded. A quarter of a century ago we met here under the presidency of that versatile leader in public affairs—Sir John Lubbock, now Lord Avebury. That occasion was the jubilee—the fiftieth anniversary—of the Association.

Lord Avebury on that occasion gave as his presidential address a survey of the progress of science during the fifty years of the Association's existence. He had a wonderful story to tell, and told it with a fulness which was only possible to one of his wide range of knowledge and keen interest in the various branches of science. If I venture on the present occasion to say a few words as to the great features in the progress of our knowledge of Nature during the last twenty-five years, it will be readily understood that the mere volume of new knowledge to be surveyed has become so vast that a full and detailed statement such as that which Lord Avebury placed before the Association at its jubilee is no longer possible in a single address delivered from the President's chair.

Let me ask you before we go further to take for a few moments a more personal retrospect and to think of the founders of this Association, then of the great workers in science who were still alive in 1881 when last we met here and have since gone from among us, leaving their great deeds and their noble enthusiasm to inspire now and for all future time those who have vowed themselves to the advancement of science in this realm of Britain.

There must be some here who had the privilege of personal acquaintance with several of the men who founded this Association in York seventy-five years ago. I myself knew Prof. John Phillips, Sir Charles Lyell, Sir Roderick Murchison, Sir David Brewster, Dr. Whewell, and Mr. Harcourt of Nuneham. All these fathers of our Association had passed away before our last meeting in York. And now, in the quarter of a century which has rolled by and brought us here again, we have lost many who took an active part in its annual meetings and were familiar figures in the scientific world of the later Victorian period. Huxley and Tyndall, Spottiswoode and Cayley, Owen and Flower, Williamson and Frankland, Falconer and Busk, Prestwich and Godwin Austen, Rolleston and Henry Smith, Stokes and Tait, and many others are in that list, including one whose name was, and is, more often heard in our discussions than any other, though he himself never was able to join us—I mean Charles Darwin. Happily some of the scientific veterans of the nineteenth century are still living, if not with us in York. Sir Joseph Hooker, who visited the Antarctic with Ross in 1839, is still hale and hearty, and so are Alfred Russel Wallace, Lord Kelvin, Sir William Huggins, and many others who were already veteran leaders in scientific investigation when last we visited York: they are still active in thought, observation, and experiment.

In attempting to give an outline of the advancement of science in the past twenty-five years I think it is necessary to distinguish two main kinds of advancement, both of which our founders had in view. Francis Bacon gave the title "Advancement of Learning" to that book in which he explained not merely the methods by which the increase of knowledge was possible, but advocated the promotion of knowledge to a new and influential position in the organisation of human society. His purpose, says Dean Church, was "to make knowledge really and intelligently the interest, not of the school or the study or the laboratory only, but of society at large." This is what our founders also intended by their use of the word "advancement." So that in surveying the advancement of science in the past quarter of a century we of the British Association must ask not only what are the new facts discovered, the new ideas and conceptions which have come into activity, but what progress has science made in becoming really and intelligently the interest of society at large. Is there evidence that there is an increase in the influence of science on the lives of our fellow-citizens and in the great affairs of the State? Is there an increased provision for securing the progress of scientific investigation in proportion to the urgency of its need or an increased disposition to secure the employment of really competent men trained in scientific investigation for the public service?

I. THE INCREASE OF KNOWLEDGE IN THE SEVERAL BRANCHES OF SCIENCE.

The boundaries of my own understanding and the practical consideration of what is appropriate to a brief address must limit my attempt to give to the general public who follow with friendly interest our proceedings some presentation of what has been going on in the workshops of science in this last quarter of a century. My point of view is essentially that of the naturalist, and in my endeavour to speak of some of the new things and new properties of things discovered in recent years I find it is impossible to give any systematic or detailed account of what has been done in each division of science. All that I can attempt is to mention some of the discoveries which have aroused my own interest and admiration. I feel, indeed, that it is necessary to ask your forbearance for my presumption in daring to speak of so many subjects in which I cannot claim to speak as an authority, but only as a younger brother full of fraternal pride and sympathy in the glorious achievements of the great experimentalists and discoverers of our day. The duty of attempting some indication of their work is placed upon me as your President, and it is for my effort to discharge that duty that I ask your generous consideration.

As one might expect, the progress of the knowledge of nature (for it is to that rather than to the historical, moral and mental sciences that English-speaking people refer when they use the word "science") has consisted, in the last twenty-five years, in the amplification and fuller verification of principles and theories already accepted, and in the discovery of hitherto unknown things which either have fallen into place in the existing scheme of each science or have necessitated new views, some not very disturbing to existing general conceptions, others of a more startling and, at first sight, disconcerting character. Nevertheless I think I am justified in saying that, exciting and of entrancing interest as have been some of the discoveries of the past few years, there has been nothing to lead us to conclude that we have been on the wrong path—nothing which is really revolutionary; that is to say, nothing which cannot be accepted by an intelligible modification of previous conceptions. There is, in fact, continuity and healthy evolution in the realm of science. Whilst some onlookers have declared to the public that science is at an end, its possibilities exhausted, and but little of the hopes it raised realised, others have asserted, on the contrary, that the new discoveries—such as those relating to the X-rays and to radium—are so inconsistent with previous knowledge as to shake the foundations of science, and to justify a belief in any and every absurdity of an unrestrained fancy. These two reciprocally destructive accusations are due to a class of persons who must be described as the enemies of science. Whether their attitude is due to ignorance or traditions of self-interest, such persons exist; and it is one of the objects of this Association to combat their assertions and to demonstrate, by the discoveries announced at its meetings and the consequent orderly building up of the great fabric of "natural knowledge," that Science has not come to the end of her work—has, indeed, only as yet given mankind a foretaste of what she has in store for it—that her methods and her accomplished results are sound and trustworthy, serving with perfect adaptability for the increase of true discovery and the expansion and development of those general conceptions of the processes of nature at which she aims.

New Chemical Elements.—There can be no doubt that the past quarter of a century will stand out for ever in human history as that in which new chemical elements, not of an ordinary type, but possessed of truly astounding properties, were made known with extraordinary rapidity and sureness of demonstration. Interesting as the others are, it is the discovery of radio-activity and of the element radium which so far exceeds all others in importance that we may well account it a supreme privilege that it has fallen to our lot to live in the days of this discovery. No single discovery ever made by the searchers of nature even approaches that of radio-activity in respect of the novelty of the properties of matter suddenly revealed by it. A new conception of the structure of matter is necessitated and demonstrated by it, and yet, so far from being destructive and disconcerting, the new conception fits in with, grows out of, and justifies the older schemes which our previous knowledge has formulated.

Before saying more of radio-activity, which is apt to eclipse in interest every other topic of discourse, I must recall to you the discovery of the five inert gaseous elements by Rayleigh and Ramsay, which belongs to the period on which we are looking back. It was found that nitrogen obtained from the atmosphere invariably differed in weight from nitrogen obtained from one of its chemical combinations; and thus the conclusion was arrived at by Rayleigh that a distinct gas is present in the atmosphere, to the extent of 1 per cent., which had hitherto passed for nitrogen. This gas was separated, and to it the name argon (the lazy one) was given, on account of its incapacity to combine with any other element. Subsequently this argon was found by Ramsay to be itself impure, and from it he obtained three other gaseous elements equally inert: namely neon, krypton, and xenon. These were all distinguished from one another by the spectrum, the sign-manual of an element given by the light emitted in each case by the gas when in an incandescent condition. A fifth inert gaseous element was discovered by Ramsay as a constituent of certain minerals which was proved by its spectrum to be identical with an element discovered twenty-five years ago by Sir Norman Lockyer in the atmosphere of the sun, where it exists in enormous quantities. Lockyer had given the name helium to this new solar element, and Ramsay thus found it locked up in certain rare minerals in the crust of the earth.

But by helium we are led back to radium, for it was found only two years ago by Ramsay and Soddy that helium is actually formed by a gaseous emanation from radium. Astounding as the statement seems, yet that is one of the many unprecedented facts which recent study has brought to light. The alchemist's dream is, if not realised, at any rate justified. One element is actually under our eyes converted into another; the element radium decays into a gas which changes into another element, namely helium.

Radium, this wonder of wonders, was discovered owing to the study of the remarkable phosphorescence, as it is called—the glowing without heat—of glass vacuum-tubes through which electric currents are made to pass. Crookes, Lenard, and Röntgen each played an important part in this study, showing that peculiar rays or linear streams of at least three distinct kinds are set up in such tubes—rays which are themselves invisible, but have the property of making glass or other bodies which they strike glow with phosphorescent light. The celebrated Röntgen rays make ordinary glass give out a bright green light; but they pass through it, and cause phosphorescence outside in various substances, such as barium platino-cyanide, calcium tungstate, and many other such salts; they also act on a photographic plate and discharge an electrified body such as an electroscope. But the most remarkable feature about them is their power of penetrating substances opaque to ordinary light. They will pass through thin metal plates or black paper or wood, but are stopped by more or less dense material. Hence it has been possible to obtain "shadow pictures" or skiagraphs by allowing the invisible Röntgen rays to pass through a limb or even a whole animal, the denser bone stopping the rays, whilst the skin, flesh, and blood let them through. They are allowed to fall (still invisible) on to a photographic plate, when a picture like an ordinary permanent photograph is obtained by their chemical action, or they may be made to exert their phosphorescence-producing power on a glass plate covered with a thin coating of a phosphorescent salt such as barium platino-cyanide, when a temporary picture in light and shade is seen.

The rays discovered by Röntgen were known as the X-rays, because their exact nature was unknown. Other rays studied in the electrified vacuum-tubes are known as kathode rays or radiant corpuscles, and others, again, as the Lenard rays.

It occurred to M. Henri Becquerel, as he himself tells us, to inquire whether other phosphorescent bodies besides the glowing vacuum-tubes of the electrician's laboratory can emit penetrating rays like the X-rays. I say "other phosphorescent bodies," for this power of glowing without heat—of giving out, so to speak, cold light—is known to be possessed by many mineral substances. It has become familiar to the public in the form of "phosphorescent paint," which contains sulphide of calcium, a substance which shines in the dark after exposure to sunlight—that is to say, is phosphorescent. Other sulphides and the minerals fluor-spar, apatite, some gems, and, in fact, a whole list of substances have, under different conditions of treatment, this power of phosphorescence or shining in the dark without combustion or chemical change. All, however, require some special treatment, such as exposure to sunlight or heat or pressure, to elicit the phosphorescence, which is of short duration only. Many of the compounds of a somewhat uncommon metallic element, called uranium, used for giving a fine green colour to glass, are phosphorescent substances, and it was, fortunately, one of them which Henri Becquerel chose for experiment. Henri Becquerel is professor in the Jardin des Plantes of Paris; his laboratory is a delightful old-fashioned building, which had for me a special interest and sanctity when, a few years ago, I visited him there, for, a hundred years before, it was the dwelling-house of the great Cuvier. Here Henri Becquerel's father and grandfather—men renowned throughout the world for their discoveries in mineralogy, electricity, and light—had worked, and here he had himself gone almost daily from his earliest childhood. Many an experiment bringing new knowledge on the relations of light and electricity had Henri Becquerel carried out in that quiet old-world place before the day on which, about twelve years ago, he made the experimental inquiry, Does uranium give off penetrating rays like Röntgen's rays? He wrapped a photographic plate in black paper, and on it placed and left lying there for twenty-four hours some uranium salt. He had placed a cross, cut out in thin metallic copper, under the uranium powder, so as to give some shape to the photographic print should one be produced. It *was* produced. Penetrating rays were given off by the uranium: the black paper was penetrated, and the form of the copper cross was printed on a dark ground. The copper was also penetrated to some extent by the rays from the uranium, so that its image was not left actually white. Only one step more remained before Becquerel made his great discovery. It was known, as I stated just now, that sulphide of calcium and similar substances *become* phosphorescent when exposed to sunlight, and lose this phosphorescence after a few hours. Becquerel thought at first that perhaps the uranium acquired its power similarly by exposure to light; but very soon, by experimenting with uranium long kept in the dark, he found that the emission of penetrating rays, giving photographic effects, was produced spontaneously. The emission of rays by this particular fragment of uranium has shown no sign of diminution since this discovery. The emission of penetrating rays by uranium was soon found to be independent of its phosphorescence. Phosphorescent bodies, as such, do not emit penetrating rays. Uranium compounds, whether phosphorescent or not, emit, and continue to emit, these penetrating rays, capable of passing through black paper and metallic copper. They do not derive this property from the action of light or any other treatment. The emission of these rays discovered by Becquerel is a new property of matter. It is called "radio-activity," and the rays are called Becquerel rays.

From this discovery by Becquerel to the detection and separation of the new element radium is an easy step in thought, though one of enormous labour and difficulty in practice. Prof. Pierre Curie (whose name I cannot mention without expressing the grief with which we all heard in April last of the sad accident by which his life was taken) and his wife, Madame Sklodowski Curie, incited by Becquerel's discovery, examined the ore called pitch-blende which is worked in mines in Bohemia and is found also in Cornwall. It is the ore from which all commercial uranium is extracted. The Curies found that pitch-blende has a radio-activity four times more powerful than that of metallic uranium itself. They at once conceived the idea that the radio-activity of the uranium salts examined by Becquerel is due not to the uranium itself, but to another element present with it in variable quantities. This proved to be in part true. The refuse of the first processes by which in the manufacturer's works the uranium is extracted from its ore, pitch-blende, was found to contain four times more of the radio-active matter than does the pure uranium. By a long series of fusions, solutions, and crystallisations the Curies succeeded in "hunting down," as it were, the radio-active element. The first step gave them a powder mixed with barium chloride, and having 2000 times the activity of the uranium in which Becquerel first proved the existence of the new property—radio-activity. Then step by step they purified it to a condition 10,000 times, then to 100,000 times, and finally to the condition of a crystalline salt having 1,800,000 times the activity of Becquerel's sample of uranium. The purification could go no further, but the extraordinary minuteness of the quantity of the pure radio-active substance obtained and the amount of labour and time expended in preparing it may be judged from the fact that of one ton of the pitch-blende ore submitted to the process of purification only the hundredth of a gram—the one-seventh of a grain—remained.

The amount of radium in pitch-blende is one ten-millionth per cent.; rarer than gold in sea-water. The marvel of this story and of all that follows consists largely in the skill and accuracy with which our chemists and physicists have learnt to deal with such infinitesimal quantities, and the gigantic theoretical results which are securely posed on this pin-point of substantial matter.

The Curies at once determined that the minute quantity of colourless crystals they had obtained was the chloride of a new metallic element with the atomic weight 225, to which they gave the name radium. The proof that radium is an element is given by its "sign-manual"—the spectrum which it shows to the observer when in the incandescent state. It consists of six bright lines and three fainter lines in the visible part of the spectrum, and of three very intense lines in the ultra-violet (invisible) part. A very minute quantity is enough for this observation; the lines given by radium are caused by no other known element in heaven or earth. They prove its title to be entered on the roll-call of elements.

The atomic weight was determined in the usual way by precipitating the chlorine in a solution of radium chloride by means of silver. None of the precious element was lost in the process, but the Curies never had enough of it to venture on any attempt to prepare pure metallic radium. This is a piece of extravagance no one has yet dared to undertake. Altogether the Curies did not have more than some four or five grains of chloride of radium to experiment with, and the total amount prepared and now in the hands of scientific men in various parts of the world probably does not amount to more than sixty grains at most. When Prof. Curie lectured on radium four years ago at the Royal Institution in London he made use of a small tube an inch long and of one-eighth inch bore, containing nearly the whole of his precious store, wrenched by such determined labour and consummate skill from tons of black shapeless pitch-blende. On his return to Paris he was one day demonstrating in his lecture room with this precious tube the properties of radium when it slipped from his hands, broke, and scattered far and wide the most precious and magical powder ever dreamed of by alchemist or artist of romance. Every scrap of dust was immediately and carefully collected, dissolved, and re-crystallised, and the disaster averted with a loss of but a minute fraction of the invaluable product.

Thus, then, we have arrived at the discovery of radium—the new element endowed in an intense form with the new property "radio-activity" discovered by Becquerel. The wonder of this powder, incessantly and without loss, under any and all conditions pouring forth by virtue of its own intrinsic property powerful rays capable of penetrating opaque bodies and of exciting phosphorescence and acting on photographic plates, can perhaps be realised when we reflect that it is as marvellous as though we should dig up a stone which without external influence or change, continually poured forth light or heat, manufacturing both in itself, and not only continuing to do so without appreciable loss or change, but necessarily having always done so for countless ages whilst sunk beyond the ken of man in the bowels of the earth.

Wonderful as the story is, so far it is really simple and commonplace compared with what yet remains to be told. I will only barely and abruptly state the fact that radio-activity has been discovered in other elements, some very rare, such as actinium and polonium; others more abundant and already known, such as thorium and uranium, though their radio-activity was not known until Becquerel's pioneer-discovery. It is a little strange and no doubt significant that, after all, pure uranium is found to have a radio-activity of its own and not to have been altogether usurping the rights of its infinitesimal associate.

The wonders connected with radium really begin when the experimental examination of the properties of a few grains is made. What I am saying here is not a systematic, technical account of radium; so I shall venture to relate some of the story as it impresses me.

Leaving aside for a moment what has been done in regard to the more precise examination of the rays emitted by radium, the following astonishing facts have been found out in regard to it: (1) If a glass tube containing radium is much handled or kept in the waistcoat pocket, it produces a destruction of the skin and flesh over a small area—in fact, a sore place. (2) The smallest trace of radium brought into a room where a charged electroscope is present, causes the discharge of the electroscope. So powerful is this electrical action of radium that a very sensitive electrometer can detect the presence of a quantity of radium five hundred thousand times more minute than that which can be detected by the spectroscope (that is to say, by the spectroscopic examination of a flame in which minute traces of radium are present). (3) Radium actually realises one of the properties of the hypothetical stone to which I compared it, giving out light and heat. For it does give out heat which it makes itself incessantly and without appreciable loss of substance or energy ("appreciable" is here an important qualifying term). It is also faintly self-luminous. Fairly sensitive thermometers show that a few granules of radium salt have always a higher temperature than that of surrounding bodies. Radium has been proved to give out enough heat to melt rather more than its own weight of ice every hour; enough heat in one hour to raise its own weight of water from the freezing-point to the boiling-point. After a year and six weeks a gram of radium has emitted enough heat to raise the temperature of a thousand kilograms of water one degree. And this is always going on. Even a small quantity of radium diffused through the earth will suffice to keep up its temperature against all loss by radiation! If the sun consists of a fraction of one per cent. of radium, this will account for and make good the heat that is annually lost by it.

This is a tremendous fact, upsetting all the calculations of physicists as to the duration in past and future of the sun's heat and the temperature of the earth's surface. The geologists and the biologists have long contended that some thousand million years must have passed during which the earth's surface has presented approximately the same conditions of temperature as at present, in order to allow time for the evolution of living things and the formation of the aqueous deposits of the earth's crust. The physicists, notably Prof. Tait and Lord Kelvin, refused to allow more than ten million years (which they subsequently increased to a hundred million)—basing this estimate on the rate of cooling of a sphere of the size and composition of the earth. They have assumed that its material is self-cooling. But, as Huxley pointed out, mathematics will not give a true result when applied to erroneous data. It has now, within these last five years, become evident that the earth's material is *not* self-cooling, but on the contrary self-heating. And away go the restrictions imposed by physicists on geological time. They now are willing to give us not merely a thousand million years, but as many more as we want.

And now I have to mention the strangest of all the proceedings of radium—a proceeding in which the other radio-active bodies, actinium and thorium, resemble it. This proceeding has been entirely Rutherford's discovery in Canada, and his name must be always associated with it. Radium (he discovered) is continually giving off, apart from and in addition to the rectilinear darting rays of Becquerel—an "emanation"—a gaseous "emanation." This "emanation" is radio-active—that is, gives off Becquerel rays—and deposits "something" upon bodies brought near the radium, so that they become radio-active, and remain so for a time after the radium is itself removed. This emanation is always being formed by a radium salt, and may be most easily collected by dissolving the salt in water, when it comes away with a rush, as a gas. Sixty milligrams of bromide of radium yielded to Ramsay and Soddy 0·124 (or about one-eighth) of a cubic millimetre of this gaseous emanation. What is it? It cannot be destroyed or altered by heat or by chemical agents; it is a heavy gas, having a molecular density of 100, and it can be condensed to a liquid by exposing it to the great cold of liquid air. It gives a peculiar spectrum of its own, and is probably a hitherto unknown inert gas—a new element similar to argon. But this by no means completes its history, even so far as experiments have as yet gone. The radium emanation decays, changes its character altogether, and loses half its radio-activity every four days. Precisely at the same rate as it decays the specimen of radium salt from which it was removed forms a new quantity of emanation, having just the amount of radio-activity which has been lost by the old emanation. All is not known about the decay of the emanation, but one thing is absolutely certain, having first been discovered by Ramsay and Soddy and subsequently confirmed by independent experiment by Madame Curie. It is this: After being kept three or four days the emanation becomes, in part at least, converted into helium—the light gas (second only in the list of elements to hydrogen), the gas found twenty-five years ago by Lockyer in the sun, and since obtained in some quantities from rare radio-active minerals by Ramsay! The proof of the formation of helium from the radium emanation is, of course, obtained by the spectroscope, and its evidence is beyond assail. Here, then, is the partial conversion or decay of one element, radium, through an intermediate stage into another. And not only that, but if, as seems probable, the presence of helium indicates the previous presence of radium, we have the evidence of enormous quantities of radium in the sun, for we know helium is there in vast quantity. Not only that, but inasmuch as helium has been discovered in most hot springs and in various radio-active minerals in the earth, it may be legitimately argued that no inconsiderable quantity of radium is present in the earth. Indeed, it now seems probable that there is enough radium in the sun to keep up its continual output of heat, and enough in the earth to make good its loss of heat by radiation into space, for an almost indefinite period. Other experiments of a similar kind have rendered it practically certain that radium itself is formed by a somewhat similar transformation of uranium, so that our ideas as to the permanence and immutability on this globe of the chemical elements are destroyed, and must give place to new conceptions. It seems not improbable that the final product of the radium emanation after the helium is removed is or becomes the metal lead!

It must be obvious from all the foregoing that radium is very slowly, but none the less surely, destroying itself. There is a definite loss of particles which, in the course of time, must lead to the destruction of the radium, and it would seem that the large new credit on the bank of time given to biologists in consequence of its discovery has a definite, if remote, limit. With the quantities of radium at present available for experiment, the amount of loss of particles is so small, and the rate so slow, that it cannot be weighed by the most delicate balance. Nevertheless it has been calculated that radium will transform half of itself in about fifteen hundred years, and unless it were being produced in some way all the radium now in existence would disappear much too soon to make it an important geological factor in the maintenance of the earth's temperature. As a reply to this depreciatory statement we have the discovery by Rutherford and others that radium is continually being formed afresh, and from that particular element in connection with which it was discovered—namely, uranium. Hypotheses and experiments as to the details of this process are at this moment in full swing, and results of a momentous kind, involving the building-up of an element with high atomic weight by the interaction of elements with a lower atomic weight, are thought by some physicists to be not improbable in the immediate future.

The delicate electric test for radio-activity has been largely applied in the last few years to all sorts and conditions of matter. As a result it appears that the radium emanation is always present in our atmosphere; that the air in caves is especially rich in it, as are underground waters. Tin-foil, glass, silver, zinc, lead, copper, platinum and aluminium are, all of them, slightly radio-active. The question has been raised whether this widespread radio-activity is due to the wide dissemination of infinitesimal quantities of strong radio-active elements, or whether it is the natural intrinsic property of all matter to emit Becquerel rays. This is the immediate subject of research.

Over and above the more simply appreciable facts which I have thus narrated, there comes the necessary and difficult inquiry, What does it all mean? What *are* the Becquerel rays of radio-activity? What must we conceive to be the structure and mechanism of the atoms of radium and allied elements, which can not only pour forth ceaseless streams of intrinsic energy from their own isolated substance, but are perpetually, though in infinitesimal proportions, changing their elemental nature spontaneously, so as to give rise to other atoms which we recognise as other elements?

I cannot venture as an expositor into this field. It belongs to that wonderful group of men, the modern physicists, who with an almost weird power of visual imagination combine the great instrument of exact statement and mental manipulation called mathematics, and possess an ingenuity and delicacy in appropriate experiment which must fill all who even partially follow their triumphant handling of nature with reverence and admiration. Such men now or recently among us are Kelvin, Clerk Maxwell, Crookes, Rayleigh, and J. J. Thomson.

Becquerel showed early in his study of the rays emitted by radium that some of them could be bent out of their straight path by making them pass between the poles of a powerful electromagnet. In this way have finally been distinguished three classes of rays given off by radium: (1) the *alpha* rays, which are only slightly bent, and have little penetrative power; (2) the *beta* rays, easily bent in a direction opposite to that in which the alpha rays bend, and of considerable penetrative power; (3) the *gamma* rays, which are absolutely unbendable by the strongest magnetic force, and have an extraordinary penetrative power, producing a photographic effect through a foot thickness of solid iron.

The *alpha* rays are shown to be streams of tiny bodies positively electrified, such as are given off by gas flames and red-hot metals. The particles have about twice the mass of a hydrogen atom, and they fly off with a velocity of 20,000 miles a second; that is, 40,000 times greater than that of a rifle bullet. The heat produced by radium is ascribed to the impact of these particles of the alpha rays.

The *beta* rays are streams of corpuscles similar to those given off by the kathode in a vacuum tube. They are charged with negative electricity and travel at the velocity of 100,000 miles a second. They are far more minute than the alpha particles. Their mass is equal to the one-thousandth of a hydrogen atom. They produce the major part of the photographic and phosphorescent effects of the radium rays.

The *gamma* rays are apparently the same, or nearly the same, thing as the X-rays of Röntgen. They are probably not particles at all, but pulses or waves in the ether set up during the ejection of the corpuscles which constitute the beta rays. They produce the same effects in a much smaller degree as do the beta rays, but are more penetrating.

The kind of conceptions to which these and like discoveries have led the modern physicist in regard to the character of that supposed unbreakable body—the chemical atom—the simple and unaffected friend of our youth—are truly astounding. But I would have you notice that they are not destructive of our previous conceptions, but rather elaborations and developments of the simpler views, introducing the notion of structure and mechanism, agitated and whirling with tremendous force, into what we formerly conceived of as homogeneous or simply built-up particles, the earlier conception being not so much a positive assertion of simplicity as a non-committal expectant formula awaiting the progress of knowledge and the revelations which are now in our hands.

As I have already said, the attempt to show in detail how the marvellous properties of radium and radio-activity in general are thus capable of a pictorial or structural representation is beyond the limits both of my powers and the time allowed me; but the fact that such speculations furnish a scheme into which the observed phenomena can be fitted is what we may take on the authority of the physicists and chemists of our day.

Intimately connected with all the work which has been done in the past twenty-five years in the nature and possible transformations of atoms is the great series of investigations and speculations on astral chemistry and the development of the chemical elements which we owe to the unremitting labour during this period of Sir Norman Lockyer.

Wireless Telegraphy.—Of great importance has been the whole progress in the theory and practical handling of electrical phenomena of late years. The discovery of the Hertzian waves and their application to wireless telegraphy is a feature of this period, though I may remind some of those who have been impressed by these discoveries that the mere fact of electrical action at a distance is that which hundreds of years ago gave to electricity its name. The power which we have gained of making an instrument oscillate in accordance with a predetermined code of signalling, although detached and a thousand miles distant, does not really lend any new support to the notion that the old-time beliefs of thought-transference and second sight are more than illusions based on incomplete observation and imperfect reasoning. For the important factors in such human intercourse—namely, a signalling-instrument and a code of signals—have not been discovered, as yet, in the structure of the human body, and have to be consciously devised and manufactured by man in the only examples of thought-transference over long distances at present discovered or laid bare to experiment and observation.

High and Low Temperatures.—The past quarter of a century has witnessed a great development and application of the methods of producing both very low and very high temperatures. Sir James Dewar, by improved apparatus, has produced liquid hydrogen and a fall of temperature probably reaching to the absolute zero. A number of applications of extremely low temperatures to research in various directions has been rendered possible by the facility with which they may now be produced. Similarly high temperatures have been employed in continuation of the earlier work of Deville, and others by Moissan, the distinguished French chemist.

Progress in Chemistry.—In chemistry generally the theoretical tendency guiding a great deal of work has been the completion and verification of the "periodic law" of Mendeléeff; and, on the other hand, the search by physical agents such as light and electricity for evidence as to the arrangement of atoms in the molecules of the most diverse chemical compounds. The study of "valency" and its outcome, stereochemistry, have been the special lines in which chemistry has advanced. As a matter of course hundreds, if not thousands, of new chemical bodies have been produced in the laboratory of greater or less theoretical interest. The discovery of the greatest practical and industrial importance in this connection is the production of indigo by synthetical processes, first by laboratory and then by factory methods, so as to compete successfully with the natural product. Von Baeyer and Heumann are the names associated with this remarkable achievement, which has necessarily dislocated a large industry which derived its raw material from British India.[1]

Astronomy.—A biologist may well refuse to offer any remarks on his own authority in regard to this earliest and grandest of all the sciences. I will therefore at once say that my friend the Savilian Professor of Astronomy in Oxford has turned my thoughts in the right direction in regard to this subject. There is no doubt that there has been an immense "revival" in astronomy since 1881; it has developed in every direction. The invention of the "dry plate," which has made it possible to apply photography freely in all astronomical work, is the chief cause of its great expansion. Photography was applied to astronomical work before 1881, but only with difficulty and haltingly. It was the dry-plate which made long exposures possible, and thus enabled astronomers to obtain regular records of faintly luminous objects such as nebulæ and star-spectra. Roughly speaking, the number of stars

[1] I had at first intended to give in this address a more detailed and technical statement of the progress of science than I have found possible when actually engaged in its preparation. The limits of time and space render any such survey on this occasion impossible, and, moreover, the patience of even the general meeting of the British Association cannot be considered as unlimited. With a view to the preparation of a more detailed review, I had asked a number of friends and colleagues to send me notes on the progress and tendency in their own particular branches of science. They responded with the greatest generosity and unselfishness. I must entirely disclaim for them any responsibility for the brief detached statements made in the address. At the same time I should wish to thank them here by name for their most kind and timely help. They are: Sir William Ramsay, Mr. Soddy, Prof. H. H. Turner, Dr. Marr, Dr. Haddon, Dr. Smith Woodward, Prof. Sherrington, Prof. Farmer, Prof. Vines, Dr. D. H. Scott, Prof. Meldola, Dr Macdougal, Prof. Poulton, Mr. C. V. Boys Major MacMahon, and Mr. Mackinder.

visible to the naked eye may be stated as eight thousand; this is raised by the use of our best telescopes to a hundred million. But the number which can be photographed is indefinite and depends on length of exposure: a thousand million can certainly be so recorded.

The serious practical proposal to "chart the sky" by means of photography certainly dates from this side of 1881. The Paris Conference of 1887, which made an international scheme for sharing the sky among eighteen observatories (still busy with the work, and producing excellent results), originated with photographs of the comet of 1882, taken at the Cape Observatory.

Prof. Pickering, of Harvard, did not join this cooperative scheme, but has gradually devised methods of charting the sky very rapidly, so that he has at Harvard records of the whole sky many times over, and when new objects are discovered he can trace their history *backwards* for more than a dozen years by reference to his plates. This is a wonderful new method, a mode of keeping record of present movements and changes which promises much for the future of astronomy. By the photographic method hundreds of new variable stars and other interesting objects have been discovered. New planets have been detected by the hundred. Up to 1881 two hundred and twenty were known. In 1881 only one was found; namely, Stephania, being No. 220, discovered on May 19. Now a score at least are discovered every year. More than five hundred are now known. One of these—Eros (No. 433)—is particularly interesting, since it is nearer to the sun than is Mars, and gives a splendid opportunity for fixing with increased accuracy the sun's distance from the earth. Two new satellites to Saturn and two to Jupiter have been discovered by photography (besides one to Jupiter in 1892 by the visual telescope of the Lick Observatory). One of the new satellites of Saturn goes round that planet the *wrong way*, thus calling for a fundamental revision of our ideas of the origin of the solar system.

The introduction of photography has made an immense difference in spectroscopic work. The spectra of the stars have been readily mapped out and classified, and now the motions in the line of sight of faint stars can be determined. This "motion in the line of sight," which was discernible but scarcely measurable with accuracy before, now provides one of the most refined methods in astronomy for ascertaining the dimensions and motions of the universe. It gives us velocities in miles per second instead of in an angular unit to be interpreted by a very imperfect knowledge of the star's distance. The method was in 1881 a mere curiosity, which Huggins was almost alone in having examined, though visual measures had been begun at Greenwich in 1875, and were continued for many years, only to be ultimately found to be affected by systematic error. The photographic method started by Vogel in 1887 really has made all the difference, and this work is now a vast department of astronomical industry. Among other by-products of the method are the "spectroscopic doubles," stars which we know to be double, and of which we can determine the period of revolution, though we cannot separate them visually by the greatest telescope.

Work on the sun has been entirely revolutionised by the use of photography. The last decade has seen the invention of the spectroheliograph—which simply means that astronomers can now study *in detail* portions of the sun of which they could previously only get a bare indication.

More of the same story could be related, but enough has been said to show how full of life and progress is this most ancient and imposing of all sciences.

A minor though very important influence in the progress of astronomy has been the provision, by the expenditure of great wealth in America, of great telescopes and equipments.

In 1877 my distinguished predecessor in the presidency of the British Association started a line of mathematical research which has been very fruitful and is of great future promise for astronomy. He was able himself last year to give some account of this research to the Association. On the present occasion I may mention that as recently as last April, at the Royal Astronomical Society, two important papers were read—one by Mr. Cowell and the other by Mr. Stratton—which have their roots in Sir George Darwin's work. The former was led to suggest that the day is lengthening ten times as rapidly as had been supposed, and the latter showed that in all probability the planets had all turned upside down since their birth.

And yet M. Brunettière and his friends wish us to believe that science is bankrupt, and has no new things in store for humanity.

Geology.—In the field of geological research the main feature in the past twenty-five years has been the increasing acceptance of the evolutionary as contrasted with the uniformitarian view of geological phenomena. The great work of Suess, "Das Antlitz der Erde," is undoubtedly the most important contribution to physical geology within the period. The first volume appeared in 1885, and the impetus which it has given to the science may be judged by the epithet applied to the views for which Suess is responsible—"the New Geology." Suess attempts to trace the orderly sequence of the principal changes in the earth's crust since it first began to form. He strongly opposes the old theory of elevation, and accounts for the movements as due to differential collapse of the crust, accompanied by folding due to tangential stress. Among special results gained by geologists in the period we survey may be cited new views as to the origin of the crystalline schists, favouring a return to something like the hypogene origin advocated by Lyell; the facts as to deep-sea deposits, now in course of formation, embodied in the "Challenger" reports on that subject; the increasing discrimination and tracking of those minor divisions of strata called "zones"; the assignment of the Olenellus fauna of Cambrian age to a position earlier than that of the Paradoxides fauna; the discovery of Radiolaria in Palæozoic rocks by special methods of examination, and the recognition of Graptolites as indices of geological horizons in lower Palæozoic beds. Glacially eroded rocks in Boulder-clays of Permo-Carboniferous age have been recognised in many parts of the world (*e.g.* Australia and South Africa), and thus the view put forward by W. T. Blanford as to the occurrence of the same phenomena in conglomerates of this age in India is confirmed. Eozoon is finally abandoned as owing its structure to an organism. The oldest fossiliferous beds known to us are still far from the beginning of life. They contain a highly developed and varied animal fauna—and something like the whole of the older moiety of rocks of aqueous origin have failed as yet to present us with any remains of the animals or plants which must have inhabited the seas which deposited them. The boring of a coral reef initiated by Prof. Sollas at the Nottingham meeting of this Association in 1893 was successfully carried out, and a depth of $1114\frac{1}{2}$ feet reached. Information of great value to geologists was thus obtained.

Animal and Vegetable Morphography.—Were I to attempt to give an account of the new kinds of animals and plants discovered since 1881, I should have to read out a bare catalogue, for time would not allow me to explain the interest attaching to each. Explorers have been busy in all parts of the world—in Central Africa, in the Antarctic, in remote parts of China, in Patagonia and Australia, and on the floor of the ocean, as well as in caverns, on mountain tops, and in great lakes and rivers. We have learnt much that is new as to distribution; countless new forms have been discovered, and careful anatomical and microscopical study conducted on specimens sent home to our laboratories. I cannot refrain from calling to mind the discovery of the eggs of the Australian duckmole and hedgehog; the fresh-water jelly-fish of Regent's Park, the African lakes, and the Delaware River; the marsupial mole of Central Australia; the okapi; the young and adult of the mud-fishes of Australia, Africa, and South America; the fishes of the Nile and Congo; the gill-bearing earthworms and mud-worms; the various forms of the caterpillar-like Peripatus; strange deep-sea fishes, polyps and sponges.

The main result of a good deal of such investigation is measured by our increased knowledge of the pedigree of organisms, what used to be called "classification." The anatomical study by the Australian professors, Hill and Wilson, of the teeth and the fœtus of the Australian group of pouched mammals—the marsupials—has entirely upset previous notions, to the effect that these were a primitive group, and has shown that their possession of only one replacing tooth is a retention of one out of many such teeth (the germs of which are present), as in placental mammals; and further that many of these marsupials have the nourishing outgrowth of the fœtus called the placenta fairly well developed, so that they must be regarded as a degenerate side-branch of the placental mammals, and not as primitive forerunners of that dominant series.

Speculations as to the ancestral connection of the great group of vertebrates with other great groups have been varied and ingenious; but most naturalists are now inclined to the view that it is a mistake to assume any such connection in the case of vertebrates of a more definite character than we admit in the case of starfishes, shell-fish, and insects. All these groups are ultimately connected by very simple, remote, and not by proximate ancestors, with one another and with the ancestors of vertebrates.

The origin of the limbs of vertebrates is now generally agreed to be correctly indicated in the Thatcher-Mivart-Balfour theory to the effect that they are derived from a pair of continuous lateral fins, in fish-like ancestors, similar in every way to the continuous median dorsal fin of fishes.

The discovery of the formation of true spermatozoa by simple unicellular animals of the group Protozoa is a startling thing, for it had always been supposed that these peculiar reproductive elements were only formed by multicellular organisms. They have been discovered in some of the gregarina-like animalcules, the Coccidia, and also in the blood-parasites.

Among plants one of the most important discoveries relates to these same reproductive elements, the spermatozoa, which by botanists are called antherozoids. A great difference between the whole higher series of plants, the flowering plants or phanerogams, and the cryptogams or lower plants, including ferns, mosses, and algæ, was held to be that the latter produce vibratile spermatozoa like those of animals which swim in liquid and fertilise the motionless egg-cell of the plant. Two Japanese botanists (and the origin of this discovery from Japan, from the University of Tokio, in itself marks an era in the history of science), Hirase and Ikeno, astonished the botanical world fifteen years ago by showing that motile antherozoids or spermatozoa are produced by two gymnosperms, the ginkgo tree (or Salisburya) and the cycads. The pollen-tube, which is the fertilising agent in all other phanerogams, develops in these cone-bearing trees, beautiful motile spermatozoa, which swim in a cup of liquid provided for them in connection with the ovules. Thus a great distinction between phanerogams and cryptogams was broken down, and the actual nature of the pollen-tube as a potential parent of spermatozoids demonstrated.

When we come to the results of the digging out and study of extinct plants and animals, the most remarkable results of all in regard to the affinities and pedigree of organisms have been obtained. Among plants the transition between cryptogams and phanerogams has been practically bridged over by the discovery that certain fern-like plants of the Coal-measures—the Cycadofilices, supposed to be true ferns, are really seed-bearing plants and not ferns at all, but phanerogams of a primitive type, allied to the cycads and gymnosperms. They have been re-christened Pteridosperms by Scott, who, together with F. Oliver and Seward, has been the chief discoverer in this most interesting field.

By their fossil remains whole series of new genera of extinct mammals have been traced through the Tertiary strata of North America and their genetic connections established; and from yet older strata of the same prolific source we have almost complete knowledge of several genera of huge extinct Dinosauria of great variety of form and habit.

The discoveries by Seeley at the Cape, and by Amalitzky in North Russia of identical genera of Triassic reptiles, which in many respects resemble the Mammalia and constitute the group Theromorpha, is also a prominent feature in the palæontology of the past twenty-five years. Nor must we forget the extraordinary Silurian fishes discovered and described in Scotland by Prof. Traquair. The most important discovery of the kind of late years has been that of the Upper Eocene and Miocene mammals of the Egyptian Fayum, excavated by the Egyptian Geological Survey and by Dr. Andrews of the Natural History Museum, who has described and figured the remains. They include a huge four-horned animal as big as a rhinoceros, but quite peculiar in its characters—the Arsinoitherium—and the ancestors of the elephants, a group which was abundant in Miocene and Pliocene times in Europe and Asia, and in still later times in America, and survives at the present day in its representatives the African and Indian elephants. One of the European extinct elephants—the Tetrabelodon—had, we have long known, an immensely long lower jaw with large chisel-shaped terminal teeth. It had been suggested by me that the modern elephant's trunk must have been derived from the soft upper jaw and nasal area, which rested on this elongated lower jaw, by the shortening (in the course of natural selection and modification by descent) of this long lower jaw, to the present small dimensions of the elephant's lower jaw, and the consequent down-dropping of the unshortened upper jaw and lips, which thus become the proboscis. Dr. Andrews has described from Egypt and placed in the Museum in London specimens of two new genera—one, Palæomastodon, in which there is a long, powerful jaw, an elongated face, and an increased number of molar teeth; the second, Mœritherium, an animal with a hippopotamus-like head, comparatively minute tusks, and a well-developed complement of incisor, canine, and molar teeth, like a typical ungulate mammal. Undoubtedly we have in these two forms the indications of the steps by which the elephants have been evolved from ordinary-looking pig-like creatures of moderate size, devoid of trunk or tusks. Other remains belonging to this great mid-African Eocene fauna indicate that not only the Elephants but the Sirenia took their origin in this area. Amongst them are also gigantic forms of Hyrax, like the little Syrian coney and many other new mammals and reptiles.

Another great area of exploration and source of new things has been the southern part of Argentina and Patagonia, where Ameghino, Moreno, and Scott of Princeton have brought to light a wonderful series of extinct ant-eaters, armadilloes, huge sloths, and strange ungulates, reaching back into early Tertiary times. But most remarkable has been the discovery in this area of remains which indicate a former connection with the Australian land surface. This connection is suggested by the discovery in the Santa Cruz strata, considered to be of early Tertiary date, of remains of a huge horned tortoise which is generically identical with one found fossil in the Australian area of later date, and known as Miolania. In the same wonderful area we have the discovery in a cave of the fresh bones, hairy skin, and dung of animals supposed to be extinct, viz. the giant sloth, Mylodon, and the peculiar horse, Onohippidium. These remains seem to belong to survivors from the last submergence of this strangely mobile land-surface, and it is not improbable that some individuals of this "extinct" fauna are still living in Patagonia. The region is still unexplored, and those who set out to examine it have, by some strange fatality, hitherto failed to carry out the professed purpose of their expeditions.

I cannot quit this immense field of gathered fact and growing generalisation without alluding to the study of animal embryology and the germ-layer theory, which has to some extent been superseded by the study of embryonic cell-lineage, so well pursued by some American microscopists. The great generalisation of the study of the germ-layers and their formation seems to be now firmly established—namely, that the earliest multicellular animals were possessed of one structural cavity, the enteron, surrounded by a double layer of cells, the ectoderm and endoderm. These Enterocœla or Cœlentera gave rise to forms having a second great body-cavity, the cœlom, which originated not as a split between the two layers, as was supposed twenty-five years ago by Haeckel and Gegenbaur and their pupils, but by a pouching of the enteron to form one or more cavities in which the reproductive cells should develop—pouchings which became nipped off from the cavity of their origin, and formed thus the independent cœlom. The animals so provided are the Cœlomocœla (as opposed to the Enterocœla), and comprise all animals above the polyps, jelly-fish, corals, and sea-anemones. It has been established in these twenty-five years that the cœlom is a definite structural unit of the higher groups, and that outgrowths from it to the exterior (cœlomoducts) form the genital passages, and may become renal excretory organs also. The vascular system has not, as it was formerly supposed to have, any connection of origin with the cœlom, but is independent of it, in origin and development, as also are the primitive and superficial renal tubes known as nephridia. These general statements seem to me to cover the most important advance in the general morphology of animals which we owe to embryological research in the past quarter of a century.[1]

Before leaving the subject of animal morphology I must apologise for my inability to give space and time to a consideration of the growing and important science of anthropology, which ranges from the history of human institutions and language to the earliest prehistoric bones and implements. Let me therefore note here the discovery of the cranial dome of Pithecanthropus in a river gravel in Java—undoubtedly the most ape-like of human remains, and of great age; and, further, the Eoliths of Prestwich, in the human authorship of which I am inclined to believe, though I should be sorry to say the same of all the broken flints to which the name "Eolith" has been applied. The systematic investigation and record of savage races have taken on a new and scientific character. Such work as Baldwin Spencer's and Haddon's in Australasia furnish examples of what is being done in this way.

Physiology of Plants and Animals.—Since I have only time to pick the most important advances in each subject for brief mention, I must signalise in regard to the physiology of plants the better understanding of the function of leaf-green or chlorophyll due to Pringsheim and to the Russian Timiriaseff, the new facts as to the activity of stomata in transpiration discovered by Horace Brown, and the fixation of free nitrogen by living organisms in the soil and by organisms (*Bacillus radicola*) parasitic in the rootlets of leguminous plants, which thus benefit by a supply of nitrogenous compounds which they can assimilate.

Great progress in the knowledge of the chemistry of the living cells or protoplasm of both plants and animals has been made by the discovery of the fact that ferments or enzymes are not only secreted externally by cells, but exist in active and preformed *inside* cells. Büchner's final conquest of the secret of the yeast-cell by heroic mechanical methods—the actual grinding to powder of these already very minute bodies—first established this, and now successive discoveries of intracellular ferments have led to the conclusion that it is probable that the cell respires by means of a respiratory "oxydase," builds up new compounds and destroys existing ones, contracts and accomplishes its own internal life by ferments. Life thus (from the chemical point of view) becomes a chain of ferment actions. Another most significant advance in animal physiology has been the sequel (as it were) of Bernard's discovery of the formation of glycogen in the liver, a substance not to be excreted, but to be taken up by the blood and lymph, and in many ways more important than the more obvious formation of bile which is thrown out of the gland into the alimentary canal. It has been discovered that many glands, such as the kidney and pancreas and the ductless glands, the suprarenals, thyroid, and others, secrete indispensable products into the blood and lymph. Hence myxœdema, exophthalmic goitre, Addison's disease, and other disorders have been traced to a deficiency or excess of internal secretions from glands formerly regarded as interesting but unimportant vestigial structures. From these glands have in consequence been extracted remarkable substances on which their peculiar activity depends. From the suprarenals a substance has been extracted which causes activity of all those structures which the sympathetic nerve system can excite to action: the thyroid yields a substance which influences the growth of the skin, hair, bones, &c.; the pituitary gland, an extract which is a specific urinary stimulant. Quite lately the mammalian ovary has been shown by Starling to yield a secretion which influences the state of nutrition of the uterus and mammæ. Had I time, I might say a great deal more on topics such as these—topics of almost infinite importance; but the fact is that the mere enumeration of the most important lines of progress in any one science would occupy us for hours.

[1] See the introduction to part ii. of a "Treatise on Zoology," edited by E. Ray Lankester. (London: A. and C. Black.)

Nerve-physiology has made immensely important advances. There is now good evidence that all excitation of one group of nerve-centres is accompanied by the *concurrent inhibition* of a whole series of groups of other centres, the activity of which might interfere with that of the group excited to action. In a simple reflex flexure of the knee the motor-neurones to the flexor muscles are excited, but concurrently the motor-neurones to the extensor muscles are thrown into a state of inhibition, and so equally with all the varied excitations of the nervous system controlling the movements and activities of the entire body.

The discovery of the continuity of the protoplasm through the walls of the vegetable cell by means of connecting canals and threads is one of the most startling facts discovered in connection with plant-structure, since it was held twenty years ago that a fundamental distinction between animal and vegetable structure consisted in the boxing-up or encasement of each vegetable cell-unit in a case of cellulose, whereas animal cells were not so imprisoned, but freely communicated with one another. It perhaps is on this account the less surprising that lately something like sense-organs have been discovered on the roots, stems, and leaves of plants, which, like the otocysts of some animals, appear to be really "statocytes," and to exert a varying pressure according to the relations of these parts of the plant to gravity. There is apparently something resembling a perception of the incidence of gravity in plants which reacts on irritable tissues, and is the explanation of the phenomena of geotropism. These results have grown out of the observations of Charles Darwin, followed by those of F. Darwin, Haberlandt, and Němec.

A few words must be said here as to the progress of our knowledge of cell-substance, and what used to be called the protoplasm question. We do not now regard protoplasm as a chemical expression, but, in accordance with von Mohl's original use of the word, as a structure which holds in its meshes many and very varied chemical bodies of great complexity. Within these twenty-five years the "centrosome" of the cell-protoplasm has been discovered, and a great deal has been learnt as to the structure of the nucleus and its remarkable stain-taking bands, the chromosomes. We now know that these bands are of definite fixed number, varying in different species of plants and animals, and that they are halved in number in the reproductive elements—the supermatozoid and the ovum—so that on union of these two to form the fertilised ovum (the parent cell of all the tissues), the proper specific number is attained. It has been pretty clearly made out by cutting up large living cells—unicellular animals—that the body of the cell alone, without the nucleus, can do very little but move and maintain for a time its chemical status. But it is the nucleus which directs and determines all definite growth, movement, secretion, and reproduction. The simple protoplasm, deprived of its nucleus, cannot form a new nucleus—in fact, can do very little but exhibit irritability. I am inclined to agree with those who hold that there is not sufficient evidence that any organism exists at the present time which has not both protoplasm and nucleus—in fact, that the simplest form of life at present existing is a highly complicated structure—a nucleated cell. That does not imply that simpler forms of living matter have not preceded those which we know. We must assume that something more simple and homogeneous than the cell, with its differentiated cell-body or protoplasm, and its cell kernel or nucleus, has at one time existed. But the various supposed instances of the survival to the present day of such simple living things—described by Haeckel and others—have one by one yielded to improved methods of microscopic examination and proved to be differentiated into nuclear and extra-nuclear substance.

The question of "spontaneous generation" cannot be said to have been seriously revived within these twenty-five years. Our greater knowledge of minute forms of life, and the conditions under which they can survive, as well as our improved microscopes and methods of experiment and observation, have made an end of the arguments and instances of supposed abiogenesis. The accounts which have been published of "radiobes," minute bodies arising in fluids of organic origin when radium salts have been allowed to mix in minute quantities with such fluids, are wanting in precision and detail, but the microscopic particles which appear in the circumstances described seem to be of a nature identical with the minute bodies well known to microscopists and recognised as crystals modified by a colloid medium. They have been described by Rainey, Harting, and Ord, on different occasions, many years ago. They are not devoid of interest, but cannot be considered as having any new bearing on the origin of living matter.

Psychology.—I have given a special heading to this subject because its emergence as a definite line of experimental research seems to me one of the most important features in the progress of science in the past quarter of a century. Thirty-five years ago we were all delighted by Fechner's psychophysical law, and at Leipzig I, with others of my day, studied it experimentally in the physiological laboratory of that great teacher, Carl Ludwig. The physiological methods of measurement (which are the physical ones) have been more and more widely, and with guiding intelligence and ingenuity, applied since those days to the study of the activities of the complex organs of the nervous system which are concerned with "mind" or psychic phenomena. Whilst some enthusiasts have been eagerly collecting ghost stories and records of human illusion and fancy, the serious experimental investigation of the human mind, and its forerunner the animal mind, has been quietly but steadily proceeding in truly scientific channels. The science is still in an early phase—that of the collection of accurate observations and measurements—awaiting the development of great guiding hypotheses and theories. But much has been done, and it is a matter of gratification to Oxford men that through the liberality of the distinguished electrician, Mr. Henry Wilde, F.R.S., a lectureship of Experimental Psychology has been founded in the University of Oxford, where the older studies of Mental and Moral Philosophy, Logic and Metaphysics have so strong a hold, and have so well prepared the ground for the new experimental development. The German investigators W. Wundt, G. E. Müller, C. Stumpf, Ebbinghaus, and Munsterberg have been prominent in introducing laboratory methods, and have determined such matters as the elementary laws of association and memory, and the perceptions of musical tones and their relations. The work of Goldschneider on "the muscular sense," of von Frey on the cutaneous sensations, are further examples of what is being done.

The difficult and extremely important line of investigation, first scientifically treated by Braid under the name "Hypnotism," has been greatly developed by the French school, especially by Charcot. The experimental investigation of "suggestion," and the pathology of dual consciousness and such exceptional conditions of the mind, has been greatly advanced by French observers.

The older work of Ferrier and Hitzig on the functions of the parts of the brain has been carried further by Goltz and Munk in Germany, and by Schäfer, Horsley, and Sherrington in England.

The most important general advance seems to be the realisation that the mind of the human adult is a social product; that it can only be understood in relation with the special environment in which it develops, and with which it is in perpetual interaction. Prof. Baldwin, of Princeton, has done important work on this subject. Closely allied is the study of what is called "the psychology of groups," the laws of mental action of the individual as modified by his membership of some form of society. French authors have done valuable work here.

These two developments of psychology are destined to provide the indispensable psychological basis for Social Science, and for the anthropological investigation of mental phenomena.

Hereafter, the well-ascertained laws of experimental psychology will undoubtedly furnish the necessary scientific basis of the art of education, and psychology will hold the same relation to that art as physiology does to the art of medicine and hygiene.

There can be little doubt, moreover, of the valuable interaction of the study of physical psychology and the theories of the origin of structural character by natural selection. The relation of the human mind to the mind of animals, and the gradual development of both, is a subject full of rich stores of new material, yielding conclusions of the highest importance, which has not yet been satisfactorily approached.

I am glad to be able to give wider publicity here to some conclusions which I communicated to the Jubilee volume of the "Société de Biologie" of Paris in 1899. I there discussed the significance of the great increase in the size of the cerebral hemispheres in recent, as compared with Eocene Mammals, and in Man as compared with Apes, and came to the conclusion that "the power of building up appropriate cerebral mechanism in response to individual experience," or what may be called "educability," is the quality which characterises the larger cerebrum, and is that which has led to its selection, survival, and further increase in volume. The bearing of this conception upon questions of fundamental importance in what has been called genetic psychology is sketched as follows.

"The character which we describe as 'educability' can be transmitted; it is a congenital character. But the *results* of education can *not* be transmitted. In each generation they have to be acquired afresh. With increased 'educability' they are more readily acquired and a larger variety of them. On the other hand, the nerve-mechanisms of instinct are transmitted, and owe their inferiority as compared with the results of education to the very fact that they are *not* acquired by the individual in relation to his particular needs, but have arisen by selection of congenital variation in a long series of preceding generations."

"To a large extent the two series of brain-mechanisms, the 'instinctive' and the 'individually acquired,' are in opposition to one another. Congenital brain-mechanisms may prevent the education of the brain and the development of new mechanisms specially fitted to the special conditions of life. To the educable animal the less there is of specialised mechanism transmitted by heredity, the better. The loss of instinct is what permits and necessitates the education of the receptive brain."

"We are thus led to the view that it is hardly possible for a theory to be further from the truth than that expressed by George H. Lewes and adopted by George Romanes, namely, that instincts are due to 'lapsed' intelligence. The fact is that there is no community between the mechanisms of instinct and the mechanisms of intelligence, and that the latter are later in the history of the development of the brain than the former, and can only develop in proportion as the former become feeble and defective."[1]

Darwinism.—Under the title "Darwinism" it is convenient to designate the various work of biologists tending to establish, develop, or modify Mr. Darwin's great theory of the origin of species. In looking back over twenty-five years it seems to me that we must say that the conclusions of Darwin as to the origin of species by the survival of selected races in the struggle for existence are more firmly established than ever. And this because there have been many attempts to gravely tamper with essential parts of the fabric as he left it, and even to substitute conceptions for those which he endeavoured to establish, at variance with his conclusions. These attempts must, I think, be considered as having failed. A great deal of valuable work has been done in consequence; for honest criticism, based on observation and experiment, leads to further investigation, and is the legitimate and natural mode of increase of scientific knowledge. Amongst the attempts to seriously modify Darwin's doctrine may be cited that to assign a great and leading importance to Lamarck's theory as to the transmission by inheritance of newly "acquired" characters, due chiefly to American palæontologists and to the venerated defender of such views, who has now closed his long life of great work, Mr. Herbert Spencer; that to attribute leading importance to the action of physiological congruity and incongruity in selective breeding, which was put forward by another able writer and naturalist who has now passed from among us, Dr. George Romanes; further, the views of de Vries as to discontinuity in the origin of new species, supported by the valuable work of Mr. Bateson on discontinuous variation; and lastly, the attempt to assign a great and general importance to the facts ascertained many years ago by the Abbé Mendel as to the cross-breeding of varieties and the frequent production (in regard to certain characters in certain cases) of pure strains rather than of breeds combining the characters of both parents. On the other hand we have the splendid series

[1] From the Jubilee volume of the Soc. de Biol. of Paris, 1899. Reprinted in NATURE, vol. lxi., 1900, pp. 624, 625.

of observations and writings of August Weismann, who has, in the opinion of the majority of those who study this subject, rendered the Lamarckian theory of the origin and transmission of new characters altogether untenable, and has, besides, furnished a most instructive, if not finally conclusive, theory or mechanical scheme of the phenomena of Heredity in his book "The Germ-plasm." Prof. Karl Pearson and the late Prof. Weldon—the latter so early in life and so recently lost to us—have, with the finest courage and enthusiasm in the face of an enormous and difficult task, determined to bring the facts of variation and heredity into the solid form of statistical statement, and have organised, and largely advanced in, this branch of investigation, which they have termed "Biometrics." Many naturalists throughout the world have made it the main object of their collecting and breeding of insects, birds, and plants, to test Darwin's generalisations and to expand the work of Wallace in the same direction. A delightful fact in this survey is that we find Mr. Alfred Russel Wallace (who fifty years ago conceived the same theory as that more fully stated by Darwin) actively working and publishing some of the most convincing and valuable works on Darwinism. He is still alive and not merely well, but pursuing his work with vigour and ability. It was chiefly through his researches on insects in South America and the Malay Islands that Mr. Wallace was led to the Darwinian theory; and there is no doubt that the study of insects, especially of butterflies, is still one of the most prolific fields in which new facts can be gathered in support of Darwin and new views on the subject tested. Prominent amongst naturalists in this line of research has been and is Edward Poulton of Oxford, who has handed on to the study of entomology throughout the world the impetus of the Darwinian theory. I must here also name a writer who, though unknown in our laboratories and museums, seems to me to have rendered very valuable service in later years to the testing of Darwin's doctrines and to the bringing of a great class of organic phenomena within the cognisance of those naturalists who are especially occupied with the problems of Variation and Heredity. I mean Dr. Archdall Reid, who has with keen logic made use of the immense accumulation of material which is in the hands of medical men, and has pointed out the urgent importance of increased use by Darwinian investigators of the facts as to the variation and heredity of that unique animal, man, unique in his abundance, his reproductive activity, and his power of assisting his investigator by his own record. There are more observations about the variation and heredity of man and the conditions attendant upon individual instances than with regard to any other animal. Medical men need only to grasp clearly the questions at present under discussion in order to be able to furnish with ease data absolutely invaluable in quantity and quality. Dr. Archdall Reid has in two original books full of insight and new suggestions, the "Present Evolution of Man" and "Principles of Heredity," shown a new path for investigators to follow.

The attempt to resuscitate Lamarck's views on the inheritance of acquired [1] characters has been met not only by the demand for the production of experimental proof that such inheritance takes place, which has never been produced, but on Weismann's part by a demonstration that the reproductive cells of organisms are developed and set aside from the rest of the tissues at so early a period that it is extremely improbable that changes brought about in those other tissues by unaccustomed incident forces can be communicated to the germ-cells so as to make their appearance in the offspring by heredity. Apart from this, I have drawn attentinn to the fact that Lamarck's first and second laws (as he terms them) of heredity are contradictory the one of the other, and therefore may be dismissed. In 1894 I wrote:

"Normal conditions of environment have for many thousands of generations moulded the individuals of a given species of organism, and determined as each individual developed and grew 'responsive' quantities in its parts (characters); yet, as Lamarck tells us, and as we know, there is in every individual born a potentiality which has *not* been extinguished. Change the normal conditions of the species in the case of a young individual taken today from the site where for thousands of generations its ancestors have responded in a perfectly defined way to the normal and defined conditions of environment; reduce the daily or the seasonal amount of solar radiation to which the individual is exposed; or remove the aqueous vapour from the atmosphere; or alter the chemical composition of the pabulum accessible; or force the individual to previously unaccustomed muscular effort or to new pressures and strains; and (as Lamarck bids us observe), in spite of all the long-continued response to the earlier normal specific conditions, the innate congenital potentiality shows itself. The individual under the new quantities of environing agencies shows *new* responsive quantities in those parts of its structure concerned, new or *acquired* characters.

"So far, so good. What Lamarck next asks us to accept, as his 'second law,' seems not only to lack the support of experimental proof, but to be inconsistent with what has just preceded it. The new character which is *ex hypothesi*, as was the old character (length, breadth, weight of a part) which it has replaced—a response to environment, a particular moulding or manipulation by incident forces of the potential congenital quality of the race—is, according to Lamarck, all of a sudden raised to extraordinary powers. The new or freshly acquired character is declared by Lamarck and his adherents to be capable of transmission by generation; that is to say, it alters the potential character of the species. It is no longer a merely responsive or reactive character, determined quantitatively by quantitative conditions of the environment, but becomes fixed and incorporated in the potential of the race, so as to persist when other quantitative external conditions are substituted for those which originally determined it. In opposition to Lamarck, one must urge, in the first place, that this thing has never been shown experimentally to occur; and in the second place, that there is no ground for holding its occurrence to be probable, but, on the contrary, strong reason for holding it to be improbable. Since the old character (length, breadth, weight) had not become fixed and congenital after many thousands of successive generations of individuals had developed it in response to environment, but gave place to a new character when new conditions operated on an individual (Lamarck's first law), why should we suppose that the new character is likely to become fixed after a much shorter time of responsive existence, or to escape the operation of the first law? Clearly there is no reason (so far as Lamarck's statement goes) for any such supposition, and the two so-called laws of Lamarck are at variance with one another."

In its most condensed form my argument has been stated thus by Prof. Poulton: Lamarck's "first law assumes that a past history of indefinite duration is powerless to create a bias by which the present can be controlled; while the second assumes that the brief history of the present can readily raise a bias to control the future" (NATURE, vol. li., 1894, p. 127).

An important light is thrown on some facts which seem at first sight to favour the Lamarckian hypothesis by the consideration that, though an "acquired" character is not transmitted to offspring as the consequence of the action of external agencies determining the "acquirement," yet the tendency to react exhibited by the parent *is* transmitted, and if the tendency is exceptionally great a false suggestion of a Lamarckian inheritance can readily result. This inheritance of "variation in tendencies to react" has a wide application, and has led me to coin the word "educability" as mentioned in the section of this address on Psychology.

The principle of physiological selection advocated by Dr. Romanes does not seem to have caused much discussion, and has been unduly neglected by subsequent writers. It was ingenious, and was based on some interesting observations, but has failed to gain support.

The observations of de Vries—showing that in cultivated varieties of plants a new form will sometimes assert itself suddenly and attain a certain period of dominance, though not having been gradually brought into existence by a slow process of selection—have been considered by him, and by

[1] I use the term "acquired" without prejudice in the sense given to that word by Lamarck himself.

a good many other naturalists, as indicating the way in which new species arise in Nature. The suggestion is a valuable one if not very novel, but a great deal of observation will have to be made before it can be admitted as really having a wide bearing upon the origin of species. The same is true of those interesting observations which were first made by Mendel, and have been resuscitated and extended with great labour and ingenuity by recent workers, especially in this country by Bateson and his pupils. If it should prove to be true that varieties when crossed do not, in the course of eventual inter-breeding, produce intermediate forms as hybrids, but that characters are either dominant or recessive, and that breeds result having pure unmixed characters—we should, in proportion as the Mendelian law is shown to apply to all tissues and organs and to a majority of organisms, have before us a very important and determining principle in all that relates to heredity and variation. It remains, however, to be shown how far the Mendelian phenomenon is general. And it is, of course, admitted on all sides that, even were the Mendelian phenomenon general and raised to the rank of a law of heredity, it would not be subversive of Mr. Darwin's generalisations, but probably tend to the more ready application of them to the explanation of many difficult cases of the structure and distribution of organisms.

Two general principles which Mr. Darwin fully recognised appear to me to deserve more consideration and more general application to the history of species than he had time to give to them, or than his followers have accorded to them. The first is the great principle of "correlation of variation," from which it follows that, whilst natural selection may be favouring some small and obscure change in an unseen group of cells—such as digestive, pigmentary or nervous cells, and that change a change of selective value—there may be, indeed often is, as we know, a correlated or accompanying change in a physiologically related part of far greater magnitude and prominence to the eye of the human onlooker. This accompanying or correlated character has no selective value, is not an adaptation—is, in fact, a necessary but useless by-product. A list of a few cases of this kind was given by Darwin, but it is most desirable that more should be established. For they enable us to understand how it is that specific characters, those seen and noted on the surface by systematists, are not in most cases adaptations of selective value. They also open a wide vista of incipient and useless developments which may suddenly, in their turn, be seized upon by ever-watchful natural selection and raised to a high pitch of growth and function.

The second, somewhat but by no means altogether neglected, principle is that a good deal of the important variation in both plants and animals is not the variation of a minute part or confined to one organ, but has really an inner physiological basis, and may be a variation of a whole organic system or of a whole tissue expressing itself at several points and in several shapes. In fact, we should perhaps more generally conceive of variation as not so much the accomplishment and presentation of one little mark or difference in weight, length, or colour, as the expression of a *tendency to vary* in a given tissue or organ in a particular way. Thus we are prepared for the rapid extension and dominance of the variation if once it is favoured by selective breeding. It seems to me that such cases as the complete disappearance of scales from the integument of some osseous fishes, or the possible retention of three or four scales out of some hundreds present in nearly allied forms, favour this mode of conceiving of variation. So also does the marked tendency to produce membranous expansions of the integument in the bats, not only between the digits and from the axilla, but from the ears and different regions of the face. Of course, the alternative hairy or smooth condition of the integuments both in plants and animals is a familiar instance in which a tendency extending over a large area is recognised as that which constitutes the variation. In smooth or hairy varieties we do not postulate an individual development of hairs subjected one by one to selection and survival or repression.

Disease.—The study of the physiology of unhealthy, injured, or diseased organisms is called pathology. It necessarily has an immense area of observation and is of transcending interest to mankind, who do not accept their diseases unresistingly and die as animals do, so purifying their race, but incessantly combat and fight disease, producing new and terrible forms of it by their wilful interference with the earlier rule of Nature.

Our knowledge of disease has been enormously advanced in the last quarter of a century, and in an important degree our power of arresting it, by two great lines of study going on side by side and originated, not by medical men nor physiologists in the narrow technical sense, but by naturalists, a botanist, and a zoologist. Ferdinand Cohn, Professor of Botany in Breslau, by his own researches and by personal training in his laboratory, gave to Robert Koch the start on his distinguished career as a bacteriologist. It is to Metschnikoff the zoologist and embryologist that we owe the doctrine of phagocytosis and the consequent theory of immunity now so widely accepted.

We must not forget that in this same period much of the immortal work of Pasteur on hydrophobia, of Behring and Roux on diphtheria, and of Ehrlich and many others to whom the eternal gratitude of mankind is due, has been going on. It is only some fifteen years since Calmette showed that if cobra poison were introduced into the blood of a horse in less quantity than would cause death, the horse would tolerate with little disturbance after ten days a full dose, and then day after day an increasing dose, until the horse without any inconvenience received an injection of cobra poison large enough to kill thirty horses of its size. Some of the horse's blood being now withdrawn was found to contain a very active antidote to cobra poison—what is called an antitoxin. The procedure and preparation of the antitoxin is practically the same as that previously adopted by Behring in the preparation of the antitoxin of diphtheria poison. Animals treated with injections of these antitoxins are immune to the poison itself when subsequently injected with it, or, if already suffering from the poison (as, for instance, by snake-bite), are readily shown by experiment to be rapidly cured by the injection of the appropriate antitoxin. This is, as all will admit, an intensely interesting bit of biology. The explanation of the formation of the antitoxin in the blood and its mode of antagonising the poison is not easy. It seems that the antitoxin is undoubtedly formed from the corresponding toxin or poison, and that the antagonism can be best understood as a chemical reaction by which the complex molecule of the poison is upset, or effectively modified.

The remarkable development of Metschnikoff's doctrine of phagocytosis during the past quarter of a century is certainly one of the characteristic features of the activity of biological science in that period. At first ridiculed as "Metschnikoffism," it has now won the support of its former adversaries.

For a long time the ideal of hygienists has been to preserve man from all contact with the germs of infection, to destroy them and destroy the animals conveying them, such as rats, mosquitoes and other flies. But it has now been borne in upon us that, useful as such attempts are, and great as is the improvement in human conditions which can thus be effected, yet we cannot hope for any really complete or satisfactory realisation of the ideal of escape from contact with infective germs. The task is beyond human powers. The conviction has now been arrived at that, whilst we must take every precaution to diminish infection, yet our ultimate safety must come from within—namely, from the activity, the trained, stimulated, and carefully guarded activity, of those wonderful colourless amœba-like corpuscles whose use was so long unrecognised, but has now been made clear by the patiently continued experiments and arguments of Metschnikoff, who has named them "phagocytes." The doctrine of the activity and immense importance of these corpuscles of the living body which form part of the all-pervading connective tissues and float also in the blood, is in its nature and inception opposed to what are called the "humoral" and "vitalistic" theories of resistance to infection. Of this kind were the beliefs that the *liquids* of the living body have an inherent and somewhat vague power of resisting infective germs, and even that the mere living quality of the tissues was in some unknown way antagonistic to foreign intrusive disease-germs.

The first eighteen years of Metschnikoff's career, after his undergraduate course, were devoted to zoological and embryological investigations. He discovered many important facts, such as the alternation of generations in the parasitic worm of the frog's lung—*Ascaris nigrovenosa*—and the history of the growth from the egg of sponges and medusæ. In these latter researches he came into contact with the wonderfully active cells, or living corpuscles, which in many low forms of life can be seen by transparency in the living animal. He saw that these corpuscles (as was indeed already known) resemble the well-known amœba, and can take into their soft substance (protoplasm) at all parts of their surface any minute particles and digest them, thus destroying them. In a transparent water-flea Metschnikoff saw these amœba-like, colourless, floating blood-corpuscles swallowing and digesting the spores of a parasitic fungus which had attacked the water-fleas and was causing their death. He came to the conclusion that this is the chief, if not the whole value of these corpuscles in higher as well as lower animals, in all of which they are very abundant. It was known that when a wound bringing in foreign matter is inflicted on a vertebrate animal the blood-vessels become gorged in the neighbourhood and the colourless corpuscles escape through the walls of the vessels in crowds. Their business in so doing, Metschnikoff showed, is to eat up the foreign matter, and also to eat up and remove the dead, wounded tissue. He therefore called these white or colourless corpuscles "phagocytes," the eater-cells, and in his beautiful book on Inflammation, published twenty years ago, proved the extreme importance of their activity. At the same time he had shown that they eat up intrusive bacteria and other germs; and his work for the last twenty years has mainly consisted in demonstrating that they are the chief, and probably the only, agents at work in either ridding the human body of an attack of disease-causing germs or in warding off even the commencement of an attack, so that the man or animal in which they are fully efficient is "immune"—that is to say, cannot be effectively attacked by disease-germs.

Disease-germs, bacteria, or protozoa produce poisons which sometimes are too much for the phagocytes, poisoning them and so getting the upper hand. But, as Metschnikoff showed, the training of the phagocytes by weak doses of the poison of the disease-germ, or by weakened cultures of the disease-germ itself, brings about a power of resistance in the phagocytes to the germ's poison, and thus makes them capable of attacking the germs and keeping them at bay. Hence the value of inoculations.

The discussion and experiments arising from Metschnikoff's demonstrations have led to the discovery of the production by the phagocytes of certain exudations from their substance which have a most important effect in weakening the resistance of the intrusive bacteria and rendering them easy prey for the phagocyte. These are called "sensitisers," and have been largely studied. They may be introduced artificially into the blood and tissues so as to facilitate the work of the phagocytes, and no doubt it is a valuable remedial measure to make use of such sensitisers as a treatment. Sir A. E. Wright considers that such sensitisers are formed in the blood and tissues independently of the phagocytes, and has called them "opsonins," under which name he has made most valuable application of the method of injecting them into the body so as to facilitate the work of the phagocytes in devouring the hostile bacteria of various diseases. Each kind of disease-producing microbe has its own sensitiser or opsonin; hence there has been much careful research and experiment required in order to bring the discovery to practical use. Metschnikoff himself holds and quotes experiments to show that the "opsonins" are actually produced by the phagocytes themselves. That this should be so is in accordance with some striking zoological facts, as I pointed out nearly twenty years ago. For the lowest multicellular animals provided with a digestive sac or gut, such as the polyps, have that sac lined by digestive cells which have the same amœboid character as "phagocytes," and actually digest to a large extent by swallowing or taking into their individual protoplasm raw particles of food. Such particles are enclosed in a temporary cavity, or vacuole, into which the cell-protoplasm secretes digestive ferment and other chemical agents. Now there is no doubt that such digestive vacuoles may burst and so pour out into the polyp's stomach a digestive juice which will act on food particles outside the substance of the cells, and thus by the substitution of this process of outpouring of the secretion for that of ingestion of food particles into the cells we get the usual form of digestion by juices secreted into a digestive cavity. Now this being certainly the case in regard to the history of the original phagocytes lining the polyp's gut, it does not seem at all unlikely, but on the contrary in a higher degree probable, that the phagocytes of the blood and tissues should behave in the same way and pour out sensitisers and opsonins to paralyse and prepare their bacterial food. And the experiments of Metschnikoff's pupils and followers show that this is undoubtedly the case. Whether there is any great variety of and difference between "sensitisers" and "opsonins" is a matter which is still the subject of active experiment. Metschnikoff's conclusion, as recently stated in regard to the whole progress of this subject, is that the phagocytes in our bodies should be stimulated in their activity in order successfully to fight the germs of infection. Alcohol, opium, and even quinine, hinder the phagocytic action; they should therefore be entirely eschewed or used only with great caution where their other and valuable properties are urgently needed. It appears that the injection of blood-serum into the tissues of animals causes an increase in the number and activity of the phagocytes, and thus an increase in their resistance towards pathogenic germs. Thus Durham (who was a pioneer in his observations on the curious phenomena of the "agglutination" of blood corpuscles in relation to disease) was led to suggest the injection of sera during surgical operations, and experiments recently quoted by Metschnikoff seem to show that the suggestion was well founded. After years of opposition bravely met in the pure scientific spirit of renewed experiment and demonstration, Metschnikoff is at last able to say that the foundation-stone of the hygiene of the tissues—the thesis that our phagocytes are our arms of defence against infective germs—has been generally accepted.

Another feature of the progress of our knowledge of disease—as a scientific problem—is the recent recognition that minute animal parasites of that low degree of unicellular structure to which the name "Protozoa" is given, are the causes of serious and ravaging diseases, and that the minute algoid plants, the bacteria, are not alone in possession of this field of activity. It was Laveran—a French medical man—who, just about twenty-five years ago, discovered the minute animal organism in the red blood-corpuscles, which is the cause of malaria. Year by year ever since our knowledge of this terrible little parasite has increased. We now know many similar to, but not identical with it, living in the blood of birds, reptiles, and frogs.

It is the great merit of Major Ross, formerly of the Indian Army Medical Staff, to have discovered, by most patient and persevering experiment, that the malaria parasite passes a part of its life in the spot-winged gnat or mosquito (Anopheles), not, as he had at first supposed, in the common gnat or mosquito (Culex), and that if we can get rid of spot-winged mosquitoes or avoid their attentions, or even only prevent them from sucking the blood of malarial patients, we can lessen, or even abolish, malaria.

This great discovery was followed by another as to the production of the deadly "Nagana" horse and cattle disease in South Africa by a screw-like, minute animal parasite, the *Trypanosoma Brucei*. The Tsetze fly, which was already known in some way to produce this disease, was found by Colonel David Bruce to do so by conveying by its bite the Trypanosoma from wild big-game animals, to the domesticated horses and cattle of the colonists. The discovery of the parasite and its relation to the fly and the disease was as beautiful a piece of scientific investigation as biologists have ever seen. A curious and very important fact was discovered by Bruce—namely, that the native big game (zebras, antelopes, and probably buffaloes), are *tolerant* of the parasite. The Trypanosoma grows and multiplies in their blood, but does not kill them or even injure them. It is only the unaccustomed introduced animals from Europe which are poisoned by the chemical excreta of the Trypanosomes and die in consequence. Hence the wild creatures—brought into a condition of tolerance by natural selection and the dying out of those susceptible to the poison—form a sort of "reservoir" of deadly Trypanosomes for the Tsetze flies to carry into the blood of new-comers. The same phenomenon of "reservoir-hosts" (as I have elsewhere called them) has since been observed in the case of malaria; the children of the native blacks in Africa and in other malarious regions are *tolerant* of the malarial parasite, as many as 80 per cent. of children under ten being found to be infected, and yet not suffering from the poison. This is not the same thing as the immunity which consists in *repulsion* or *destruction* of the parasite.

The Trypanosomes have acquired a terrible notoriety within the last four years, since another species, also carried by a Tsetze fly of another species, has been discovered by Castellani in cases of sleeping sickness in Uganda, and demonstrated by Colonel Bruce to be the cause of that awful disease. More than 200,000 natives of Uganda have died from it within the last five years. It is incurable, and, sad to relate, not only a certain number of European employés have succumbed to it in tropical Africa, but a brave young officer of the Army Medical Corps, Lieutenant Tulloch, has died from the disease acquired by him in the course of an investigation of this disease and its possible cure, which he was carrying out, in association with other men of science, on the Victoria Nyanza Lake in Central Africa. Lieutenant Tulloch was sent out to this investigation by the Royal Society of London, and I will venture to ask you to join that body in sympathy for his friends, and admiration for him and the other courageous men who risk their lives in the endeavour to arrest disease.

Trypanosomes are now being recognised in the most diverse regions of the world as the cause of disease—new horse diseases in South America, in North Africa, in the Philippines and East India are all traced to peculiar species of Trypanosome. Other allied forms are responsible for Delhi-sore, and certain peculiar Indian fevers of man. A peculiar and ultra-minute parasite of the blood cells causes Texas fever, and various African fevers deadly to cattle. In all these cases, as also in that of plague, the knowledge of the carrier of the disease, often a mite or acarus—in that of plague the flea of the rat—is extremely important, as well as the knowledge of reservoir-hosts when such exist.

The zoologist thus comes into closer touch than ever with the profession of medicine, and the time has arrived when the professional students of disease fully admit that they must bring to their great and hopeful task of abolishing the diseases of man the fullest aid from every branch of biological science. I need not say how great is the contentment of those who have long worked at apparently useless branches of science, in the belief that all knowledge is good, to find that the science they have cultivated has become suddenly and urgently of the highest practical value.

I have not time to do more than mention here the effort that is being made by combined international research and cooperation to push further our knowledge of phthisis and of cancer, with a view to their destruction. It is only since our last meeting at York that the parasite of Phthisis or Tubercle has been made known; we may hope that it will not be long before we have similar knowledge as to Cancer. Only eighteen months have elapsed since Fritz Schaudinn discovered the long-sought parasitic germ of Syphilis, the *Spirochaeta pallida*. As I write these words the sad news of Schaudinn's death at the age of thirty-five comes to me from his family at Hamburg—an irreparable loss.

Let me finally state, in relation to this study of disease, what is the simple fact—namely, that if the people of Britain wish to make an end of infective and other diseases they must take every possible means to discover capable investigators, and employ them for this purpose. To do this, far more money is required than is at present spent in that direction. It is necessary, if we are to do our utmost, to spend a thousand pounds of public money on this task where we now spend one pound. It would be reasonable and wise to expend ten million pounds a year of our revenues on the investigation and attempt to destroy disease. Actually, what is so spent is a mere nothing, a few thousands a year. Meanwhile our people are dying by thousands of preventable disease.

II. The Advancement of Science as Measured by the Support given to it by Public Funds, and the Respect Accorded to Scientific Work by the British Government and the Community at Large.

Whilst I have been able, though in a very fragmentary and incomplete way, to indicate the satisfactory and, indeed, the wonderful progress of science since this Association last met in York, so far as the making of new knowledge is concerned, I am sorry to say that there is by no means a corresponding "advancement" of Science in that signification of the word which implies the increase of the influence of science in the life of the community, the increase of the support given to it, and of the desire to aid in its progress, to discover and then to encourage and reward those who are specially fitted to increase scientific knowledge, and to bring it to bear so as to promote the welfare of the community. I am speaking on a privileged occasion to a body of men who are met together for the Advancement of Science, and I claim the right to say to them, without offence to the representatives of institutions which I criticise, what is in my mind.

It is, unfortunately, true that the successive political administrators of the affairs of this country, as well as the permanent officials, are altogether unaware to-day, as they were twenty-five years ago, of the vital importance of that knowledge which we call science, and of the urgent need for making use of it in a variety of public affairs. Whole departments of Government in which scientific knowledge is the one thing needful are carried on by ministers, permanent secretaries, assistant secretaries, and clerks who are wholly ignorant of science, and naturally enough dislike it since it cannot be used by them, and is in many instances the condemnation of their official employment. Such officials are, of course, not to be blamed, but rather the general indifference of the public to the unreasonable way in which its interests are neglected.

A difficult feature in treating of this subject is that when one mentions the fact that ministers of State and the officials of the public service are not acquainted with science, and do not even profess to understand its results or their importance, one's statement of this very obvious and notorious fact is apt to be regarded as a personal offence. It is difficult to see wherein the offence lies, for no one seeks to blame these officials for a condition of things which is traditional and frankly admitted.

This is really a very serious matter for the British Association for the Advancement of Science to consider and deal with. We represent a line of activity, a group of professions which are in our opinion of vital importance to the well-being of the nation. We know that those interests which we value so highly are not merely ignored and neglected, but are actually treated as of no account or as non-existent by the old-established class of politicians and administrators. It is not too much to say that there is a natural fear and dislike of scientific knowledge on the part of a large proportion of the persons who are devoid of it, and who would cease to hold, or never have held, the positions of authority or emolument which they now occupy, were scientific knowledge of the matters with which they undertake to deal required of them. This is a thorny subject, and one in which, however much one may endeavour to speak in general terms, it is difficult to avoid causing personal annoyance. Yet it seems to me one which, believing as I do that it is of most urgent importance, it is my duty as your President to press upon the attention of the members of the British Association. Probably an inquiry into and discussion of the neglect of science and the questionable treatment of scientific men by the administrative departments of Government would be more appropriate to a committee appointed by the Council of the Association for this purpose than to the Presidential Address.

At the same time, I think the present occasion is one on which attention should be drawn in general terms to the fact that science is not gaining "advancement" in public and official consideration and support. The reason is, I think, to be found in the defective education, both at school and university, of our governing class, as well as in a racial dislike among all classes to the establishment and support by public funds of posts which the average man may not expect to succeed by popular clamour or class privilege in gaining for himself—posts which must be held by men of special training and mental gifts. Whatever the reason for the neglect, the only remedy which we can possibly apply is that of improved education for the upper classes, and the continued effort to spread a knowledge of the results of science and a love for it amongst all members of the community. If members of the British Association took this matter seriously to heart they might do a great deal by insisting that their sons, and their daughters too, should have reasonable instruction in science both at school and college. They could, by their own initiative and example, do a good deal to put an end to the trifling with classical literature and the absorption in athletics which is considered by too many schoolmasters as that which the British parent desires as the education of his children.

Within the past year a letter has been published by a well-known nobleman, who is one of the Trustees of the British Museum, holding up to public condemnation the method in which the system laid down by the officials of the Treasury and sanctioned by successive Governments, as to the remuneration of scientific men, was applied in an individual case. I desire to place on record here the Earl of Crawford's letter to the *Times* of October 31, 1905, for the careful consideration of the members of the British Association and their friends. When such things are done, science cannot be said to have advanced much in public consideration or Governmental support.

To the Editor of the "Times.

Sir,—The death, noted by you to-day, of my dear friend and colleague, Dr. Copeland, His Majesty's Astronomer for Scotland, creates a vacancy in the scientific staff of Great Britain.

Will you permit me, Sir, to offer a word of warning to any who may be asked to succeed him?

Students or masters of astronomy are not, in the selfish sense, business men, nor are they as a general rule overburdened with this world's goods. It behoves them henceforth to take more care as to their future in case of illness or physical infirmity, and not to trust to the gratitude or generous impulse of the Treasury Department.

In old days it was the custom when a man distinguished in science was brought into a high position in the Civil Service that he was credited with a certain number of years service ranking for pension This practice has been done away with and a bargain system substituted. A short while ago the growing agonies of heart disease caused Dr Copeland to feel that he was less able to carry on the duties of his post, and he determined to resign; but he learnt that under the scale, and in the absence of any special bargain, the pension he would receive would not suffice for the necessities of life. The only increase his friends could get from the Treasury was an offer to allow him about half-a-crown a week extra by way of a house.

Indignant and ashamed of my Government, I persuaded Dr. Copeland to withdraw his resignation and to retain the official position which he has honoured till his death.

I trust, Sir, that this memorandum of mine may cause eminent men of science who are asked to enter the service of the State when already of middle age to take heed for their future welfare.

I am, Sir, your obedient servant,

2 Cavendish Square, October 28. CRAWFORD.

It is more agreeable to me not to dwell further on the comparative failure of science to gain increased influence and support in this country, but to mention to you some instances on the other side of the account. As long ago as 1842 the British Association took over and developed an observatory in the Deer Park at Kew, which was placed at the disposal of the Association by Her Majesty the Queen. Until 1871 the Association spent annually a large part of its income—as much in later years as 600*l.* a year—in carrying on the work of the Kew Observatory, consisting of magnetic, meteorological and physical observations. In 1871 the Association handed over the Observatory to the Royal Society, which had received an endowment of 10,000*l.* from Mr. Gassiot for its maintenance, and had further devoted to that purpose considerable sums from its own Donation Fund and Government grant. Further aid for it was also received from private sources. From this Observatory at last has sprung, in the beginning of the present century, the National Physical Laboratory in Bushey Park, a fine and efficient scientific institution, built and supported by grants from the State, and managed by a committee of really devoted men of science who are largely representatives of the Royal Society. In addition to the value of the site and buildings occupied by the National Physical Laboratory, the Government has contributed altogether 34,000*l.* to the capital expenditure on new buildings, fittings, and apparatus, and has further assigned a grant of 6000*l.* a year to the working of the laboratory. This institution all men of science are truly glad to have gained from the State, and they will remember with gratitude the statesmen—the late Marquis of Salisbury, the Right Hon. Arthur J. Balfour, Mr. Haldane, and others—as well as their own leaders—Lord Rayleigh, Sir William Huggins, and the active body of physicists in the Royal Society—who have carried this enterprise to completion. The British Association has every reason to be proud of its share in early days in nursing the germ at Kew which has at length expanded into this splendid national institution.

I may mention also another institution which, during the past quarter of a century, has come into existence and received, originally through the influence of the late Lord Playfair (one of the few men of science who have ever occupied the position of a Minister of the Crown), and later by the influence of the Right Hon. Joseph Chamberlain, a subsidy of 1000*l.* a year from the Government and a contribution of 5000*l.* towards its initial expenses. This is the Marine Biological Association, which has a laboratory at Plymouth, and has lately expended a special annual grant, at the spontaneous invitation of His Majesty's Treasury, in conducting an investigation of the North Sea in accordance with an international scheme devised by a central committee of scientific experts. This scheme has for its purpose the gaining such knowledge of the North Sea and its inhabitants as shall be useful in dealing practically and by legislation with the great fisheries of that area. You will, perhaps, not be surprised to hear that there are persons in high positions who, though admittedly unacquainted with the scientific questions at issue or the proper manner of solving them, are discontented with the action of the Government in entrusting the expenditure of public money to a body of scientific men who give their services, without reward or thanks, to carrying out the purposes of the international inquiry. Strange criticisms are offered by these malcontents in regard to the work done in the international exploration of the North Sea, and a desire is expressed to secure the money for expenditure by a less scientific agency. I do not hesitate to say here that the results obtained by the Marine Biological Association are of great value and interest, and, if properly continued and put to practical application, are likely to benefit very greatly the fishery industry; on the other hand, if the work is cut short or entrusted to incompetent hands it will no doubt be the case that what has already been done will lose its value—that is to say, will have been wasted. There is imminent danger of this perversion of the funds assigned to this scientific investigation taking place. There is no guarantee for the continuance of any funds or offices assigned to science in one generation by the officials of the next. The Mastership of the Mint held by Isaac Newton, and finally by Thomas Graham, has been abolished and its salary appropriated by non-scientific officials. Only a few years ago it was with great difficulty that the Government of the day was prevented from assigning the Directorship of Kew Gardens to a young man of influence devoid of all knowledge of botany!

One of the most solid tests of the esteem and value attached to scientific progress by the community is the dedication of large sums of money to scientific purposes by its wealthier members. We know that in the United States such gifts are not infrequent; they are rare in this country. It is, therefore, with especial pleasure that I call your attention to a great gift to science in this country made only a few years ago. Lord Iveagh has endowed the Lister Institute, for researches in connection with the prevention of disease, with no less a sum than a quarter of a million pounds sterling. This is the largest gift ever made to science in this country, and will be productive of great benefit to humanity. The Lister Institute took its origin in the surplus of a fund raised by Sir James Whitehead when Lord Mayor, some sixteen years ago, for the purpose of making a gift to the Pasteur Institute in Paris, where many English patients had been treated, without charge, after being bitten by rabid dogs. Three thousand pounds was sent to M. Pasteur, and the surplus of a few hundred pounds was made the starting-point of a fund which grew, by one generous gift and another, until the Lister Institute on the Thames Embankment at Chelsea was set up on a site presented by that good and high-minded man, the late Duke of Westminster.

Many other noble gifts to scientific research have been made in this country during the period on which we are looking back. Let us be thankful for them, and admire the wise munificence of the donors. But none the less we must refuse to rely entirely on such liberality for the development of the army of science, which has to do battle for mankind against the obvious disabilities and sufferings which afflict us and can be removed by knowledge. The organisation and finance of this army should be the care of the State.

It is a fact which many of us who have observed it regret very keenly, that there is to-day a less widespread interest than formerly in natural history and general science, outside the strictly professional arena of the school and university. The field naturalists among the squires and the country parsons seem nowadays not to be so numerous and active in their delightful pursuits as formerly, and the Mechanics' Institutes and Lecture Societies of the days of Lord Brougham have given place, to a very large extent, to musical performances, bioscopes, and other entertainments, more diverting, but not really more capable of giving pleasure than those in which science was popularised. No doubt the organisation and professional character of scientific work are to a large extent the cause of this falling-off in its attraction for amateurs. But perhaps that decadence is also due in some measure to the increased general demand for a kind of manufactured gaiety, readily sent out in these days of easy transport from the great centres of fashionable amusement to the provinces and rural districts.

In conclusion, I would say a word in reference to the associations of our place of meeting, the birthplace of our Society. It seems to me not inappropriate that a Society for the Advancement of Science should have taken its origin under the walls of York Minster, and that the clergy of the great cathedral should have stood by its cradle. It is not true that there is an essential antagonism between the scientific spirit and what is called the religious sentiment. "Religion," said Bishop Creighton, "means the knowledge of our destiny and of the means of fulfilling it." We can say no more and no less of Science. Men of Science seek, in all reverence, to discover the Almighty, the Everlasting. They claim sympathy and friendship with those who, like themselves, have turned away from the more material struggles of human life, and have set their hearts and minds on the knowledge of the Eternal.

NOTES.

Sir William Crookes, Prof. Eduard Suess, Prof. Luigi Palazzo, and Prof. Orazio Marucchi were elected honorary members of the Royal Academy of Acireale (Sicily) at a meeting on July 24.

The Highways Committee of the London County Council has taken the necessary steps in connection with the appointment of the committee suggested by the Admiralty to inquire whether the working of the Greenwich electricity generating station will have any injurious effect upon the Royal Observatory, Greenwich. Sir Benjamin Baker will act as the Council's representative on the committee, and Prof. C. V. Boys will act in an advisory capacity from the astronomical and scientific point of view. The representatives appointed by the Admiralty on the committee are Prof. J. A. Ewing and Lord Rosse.

The seventy-fourth annual meeting of the British Medical Association will be held at Toronto, Canada, on August 21. The president-elect is Dr. Richard A. Reeve, of the University of Toronto. Addresses will be delivered in medicine by Sir James Barr, in surgery by Sir Victor Horsley, F.R.S., and in obstetrics by Dr. Walter S. A. Griffith. The business of the meeting will be carried on in thirteen sections, dealing respectively with anatomy, dermatology, laryngology, medicine, obstetrics and gynæcology, ophthalmology, pædiatrics, pathology and bacteriology, physiology, psychology, State medicine, surgery, and therapeutics. Several receptions and soirées have been arranged, and the last day of the meeting is to be devoted to outings.

On Tuesday the Natural History Museum received, from Mr. Rowland Ward's establishment, a mounted specimen of a wild male African elephant, standing 11 feet 4 inches at the shoulder. The animal was shot in Rhodesia. The specimen could only be brought into the museum by taking down the doors, and, after considerable difficulty, was duly installed in the central hall, facing the entrance. This is the first wild African elephant's skin that has ever been mounted. The architect should be congratulated upon his clever achievement in one of the largest buildings in London with really one of the largest doors until he had artistically obliterated it.

The contents of Nos. 7 and 8 of *Naturen* include articles on the habits of humble-bees, Chilian nitre, squirrels' nests, and "animalcules."

In a paper on the development of the cusps on mammalian cheek-teeth, published in the Proceedings of the Washington Academy (vol. vii., pp. 91–110), Mr. J. W. Gidley points out that, in his opinion, the tritubercular theory cannot be maintained in its original form. It appears that the three main cusps of the upper tritubercular molar are by no means always homologous. Despite the want of homology in the cusps, the author deprecates any change in Prof. Osborn's nomenclature for tritubercular molars, which is found to be exceedingly convenient in practice.

A collection of skulls of Californian Indians forms the subject of an elaborate paper by Mr. A. Hrdlicka constituting No. 2 of vol. iv. of the Archæological and Ethnological Publications of the University of California. These ancient Californian Indians, like those of Santa Barbara Island, show no affinity to the aborigines of Arizona and Sonora, but appear akin to the Otomi of the States of Hidalgo and Mexico. "A large group of peoples in the States of Puebla, Michoacan, and further south, even including the Aztecs, and finally the Tarahumare, in Chihuahua, are all physically related to the Otomi as well as to the Californians."

Corals from California and Brazil form the subject of No. 1477 of the Proceedings of the U.S. National Museum, a Californian Cœnocyathus being described by Mr. T. W. Vaughan, the author of the paper, as new. In No. 1478 of the same serial Messrs. Evermann and Clark describe certain new fishes from a small river in the centre of Santo Domingo. Six specimens were obtained, referable to four species, three of which are regarded as new, two being assigned to the genus Platypœcilus and the third to Sicydium.

A NUMBER of new South African Palæozoic fossils—both vegetable and animal—are described by Mr. E. H. L. Schwarz in the sixth part of the first volume of the Records of the Albany Museum. It is noteworthy that the plants, which appear to be either of Upper Devonian or Lower Carboniferous age, are referable to the "Lepidodendron flora." In the same issue Mr. J. E. Duerden reviews the South African tortoises of the genus Homopus, and describes and figures, under the name of *H. boulengeri*, a species regarded as new to science. In regard to the tortoises of the *Testudo geometrica* group, the author points out that some of the named species appear to intergrade, thus suggesting that in this group we may have species in course of evolution. A fourth contribution, by Mr. P. Cameron, on the Hymenoptera in the Albany Museum, completes this issue.

THE first issue of the Memoirs of the National Museum, Melbourne, consists of a paper by Dr. A. Smith Woodward on a Carboniferous fish-fauna from the Mansfield district, Victoria. It appears that the fish-remains described were discovered so long ago as 1888, and that a brief notice of them was published by the late Sir F. McCoy in the following year. Coloured plates were, moreover, prepared under that palæontologist's direction, and these have been utilised in the present issue. Of the six generic types recognised, one is too imperfectly known for its affinities to be exactly defined, four others, Acanthodes, Ctenodus, Strepsodus, and Elonichthys, occur in the Permian and Carboniferous of Europe and the Carboniferous of North America, but the sixth, Gyracanthides, although related to a northern Carboniferous type, is altogether peculiar and of exceptional interest. It appears, indeed, to be an acanthodian referable either to the Diplacanthidæ or a kindred family group, but of a highly specialised nature, the specialisation displaying itself in the enlargement of the pectoral fins, the reduction and forward displacement of the pelvics, and the absence or modification of the intermediate spines. A restored figure of this remarkable shark is given.

IN the annual report of the U.S. National Museum, 1904, Mr. G. P. Merrill, whose writings on geology are always acceptable, has produced a treatise entitled "Contributions to the History of American Geology." Sir Archibald Geikie and the late Prof. Zittel have already provided geologists with historical accounts of the growth of their subject, mainly from the European standpoint. In these "Contributions" Mr. Merrill takes up the story from the American point of view, thereby filling a serious gap in a manner that will earn the gratitude of everyone interested in the science. The mode of presentation of the subject is the chronological one, but several topics that were at one time of outstanding prominence are treated separately; such are the Laramie question, the Taconic succession, and the Eozoon problem. Not the least interesting feature in this extremely interesting work is the assemblage of portraits of American geologists, including many early workers whose names must be almost unknown in this country.

THE latest addition to the publications of the Geological Survey of Western Australia is an exhaustive report (Bulletin No. 21) on the geology and mineral resources of the Norseman district, Dundas goldfield, by Mr. W. D. Campbell. The mining plans and sections, of which five accompany the report, mark an advance on any of the official mining plans yet issued in that their most prominent features are the lodes, faults, and dykes, rather than the underground roads. These data, together with the descriptions given in the report, form a permanent record of the Norseman mines up to the date of publication. The area dealt with in the report up to the end of 1904 has yielded 266.054 ounces of gold, or 1·019 ounces for every ton of ore treated.

IN the *Engineering Magazine* (July) Mr. Clarence Heller gives some interesting personal observations on the effect of earthquake and fire on steel buildings at San Francisco. His photographs give a graphic record of the failure of structural materials and systems under various conditions. Riveted connections showed their superiority over bolts when called upon to resist twist by earthquake. The great losses by fire were due to poor material, bad mortar, and miserable workmanship.

IN his presidential address to the Norfolk and Norwich Naturalists' Society at the meeting held on March 27, which is published in the second part of vol. viii. of the Transactions of that body, Mr. Eustace Gurney, after surveying recent progress in "limnology," directed attention to the opportunities for research presented by the Norfolk Broads. He pointed out that after the compilation of complete lists of the fauna, much might be done in regard to a knowledge of the life-history of many species by keeping them in tanks. In addition to this, we ought to be acquainted with the physical and chemical characteristics of each sheet of water, the nature of the bottom-deposits, and so on. The papers in the same issue include one by Mr. T. Southwell on the share taken in former times by Lynn and Yarmouth in the Greenland whale-fishery, one by Mr. T. J. Wigg on last year's herring-fishery, and a third, by Mr. W. G. Clarke, on the classification of Norfolk flint-implements.

IN the Annual Report and Proceedings of the Belfast Naturalists' Field Club for 1905–6, the secretary announces a small excess of expenditure over receipts. The two most important papers in this issue are a *résumé* of the club's recent work with regard to local glaciation, by Madame Christen, and an account of the Carnmoney chalcedony, by Mr. J. Strachan. As the results of his investigations on the latter subject, the author is disposed to reject the theory that deposits in lava of chalcedony of the nature of the one in question are due to decomposition changes in favour of the idea that they are contemporaneous products of the rock, and that they were formed during the final stages of cooling and drying. He is also of opinion that the associated zeolitic or calcitic layer, as well as the siliceous contents of the veins or cavities, owes its origin, not to the decomposition of the parent rock, but to the last stages in its formation.

ACCORDING to the observations of Mr. A. Toyama, of the College of Agriculture, Tokyo University, published in the June issue of *Biologisches Centralblatt*, Mendel's law of heredity is strictly applicable, in a very large number of cases, to cross-bred silkworms. The colours of the cocoons and the larval markings are, for instance, strictly Mendelian, while other features appear to conform to certain laws not yet formulated. No single instance was observed in which an irregular development of Mendelian phenomena took place. In another article issued in the same number Dr. H. Simroth urges that the sporadic development of a black phase of the hamster affords an instance of undoubted mutation among mammals. In giving *Cricetus vulgaris niger* as the equivalent of Schreber's "Mus cricetus Linné niger," the author is unwittingly founding a new subspecies, as no *C. v. niger* occurs in any of the published lists.

The Department of Agriculture in India has commenced the issue of a chemical series of memoirs. Part i. contains an article by Dr. J. W. Leather, agricultural chemist to the Government of India, on the composition of Indian rain and dew. The author points out that the amount of ammonia and nitric or nitrous acid found in the annual rainfall by observers in different parts of the world has varied within wide limits. The observations at Rothamsted during fifteen years, 1889–1903, show mean quantities of 2·78 lb. of "ammonia" nitrogen and 1·19 lb. of "nitric" nitrogen per acre per annum, the total being 3·97 lb.; but there has been a tendency among observers in the East to attribute to tropical rainfall much greater amounts. A record of these compounds was kept recently for twelve months at Dehra Dun and Cawnpore, both stations being nearly within the tropics, and is of interest as additional evidence upon the subject. The results obtained were, approximately, in lb. per acre:—Dehra Dun, ammonia 2·04, nitrate and nitrite 1·37, total 3·41; Cawnpore, 2·48 and 0·77 respectively, total 3·25, the amount of ammonia being less at both stations than at Rothamsted; of nitric acid, the Dehra Dun rain contained somewhat more, the Cawnpore rain a good deal less, than at the English station. Information regarding the quantity and composition of dew is but limited. Observations were made at Cawnpore between September, 1904, and March, 1905; the amount of dew was only 0·17 inch, and contained approximately 0·055 lb. of "ammonia" nitrogen and 0·056 lb. of "nitric" nitrogen per acre. Dr. Leather thinks it probable that the method adopted at Cawnpore for registering the amount of dew gave a low result.

The value of statistical researches in the subject of heredity and variation is well illustrated by a paper lately published in the Proceedings of the American Academy of Arts and Sciences, under the joint names of W. E. Castle, F. W. Carpenter, A. H. Clark, S. O. Mast, and W. M. Barrows, on the effects of inbreeding, cross-breeding and selection upon the fertility and variability of Drosophila, a genus of Diptera which feeds in the larval stage on over-ripe fruit. The experiments were conducted with great care, and their results recorded with minuteness, the outcome being a valuable set of conclusions on various moot points connected with the subject. The authors consider that their experiments prove that, although long-continued inbreeding (extending in one case to fourteen generations) may possibly cause a decline in fertility, this effect may be more than counterbalanced by selection of the most productive among closely inbred pairs. No falling-off was observed in either strength, size, or variability in the inbred generations. Different degrees of fertility are characteristic of different stocks; inheritance of such differences does actually take place, and gives material for selection. Indications were found of a cyclical change in fertility. This appeared to be due to external conditions, *e.g.* temperature. The quality of low productiveness was found to conform imperfectly with Mendel's law, but the alternative character of high and low fertility is not sharply defined. Sexual maturity was shown to be reached at some time between twenty-four and thirty-nine hours after emergence from the pupa, and a single male was proved to be capable of fertilising at least four females.

Dr. Shadworth H. Hodgson's paper on the inter-relation of the academical sciences, read to the British Academy on March 14, has been published by Mr. Henry Frowde. Dr. Hodgson asks what is the common ulterior end of the four sections of the British Academy, dealing as they do with the different sciences of history, philology, philosophy, and law. These four branches of inquiry, he discovers, have to do with man, and his conscious activities in every direction, and the relations of men with men and with other conscious beings; and the whole group has as its differentia from the positive physical sciences the fact that it takes consciousness as the point of view. So the ulterior aim of all the sections is the harmonising and organising into a system of the knowledge obtained in each section and subsection of those conscious activities which are its special province, with the further purpose of harmonising those conscious activities themselves into a concerted life of mankind on earth. The lecturer further claims that internal organisation of the academical sciences can only be effected by connecting the sciences of history, philology, and law with philosophy, "which alone possesses in its metaphysical department a secure foundation for any science whatever, being itself founded, alone among all, upon the analysis of consciousness, or experience, without initial assumptions of any kind."

The "Year-book of Agriculture" for the State of Victoria for the year 1905, recently issued under the supervision of its new director of agriculture, Dr. Cherry, contains a series of valuable articles on economic biology. It supplies an interesting case of the rapid spread of a European plant in Australia, which is of value from the exact information available as to its rate of movement. Some seeds of a species of St. John's wort (*Hypericum perforatum*) were planted at Bright twenty-five years ago by a lady who wanted the plant for medicinal purposes. From her garden it spread to the Bright racecourse, where it grew so luxuriantly that it gained the popular name of the "racecourse weed." Thence it has been carried by cattle, as shown by a map of the present distribution of the plant in Victoria, along all the main stock routes from Bright. Among other directions it has crossed the main water-shed of Victoria into Gippsland, and now occupies more than 10,000 acres of good land. Methods proposed for its eradication are engaging the attention of the Agricultural Department of Victoria, which has tried an extensive series of experiments. Treatment of the ground with pyrites, at the cost of more than 5*l*. an acre, has been the most successful. The cost of some of the methods tested is prohibitive, ranging up to 47*l*. an acre. Amongst other valuable articles in the volume are those on the soils of Victoria, by Dr. Cherry; on farm irrigation from small dams, by Mr. A. S. Kenyon; and on various branches of dairy farming

The report of the committee on ancient earthworks and fortified enclosures, presented to the seventeenth congress of archæological societies held at Burlington House on July 4, is now available. The committee regrets that the archæological societies have not yet been able to undertake the systematic scheduling of the ancient earthworks and defensive enclosures in their respective districts. The report contains a list of the additions to the literature of the subject of the committee's inquiries, a list of recent cases of the destruction or mutilation of defensive outworks, tumuli, and barrows, and some account of the excavations during the year.

A valuable memoir of the Geological Survey on "Soils and Subsoils from a Sanitary Point of View, with especial Reference to London and its Neighbourhood," was issued nine years ago. The second edition of this memoir has just been published by the Board of Agriculture and

Fisheries. Questions of water-supply, of ground-water, and of drainage are dealt with in their sanitary aspects; the geology of the district is described according to the nature of the subsoil, whether clayey, sandy, gravelly, or chalky. A small colour-printed map accompanies the letterpress, and the memoir is further illustrated by twenty-two sections and drawings. Copies may be obtained from any agents for the sale of Ordnance Survey maps, or directly or through any bookseller, from the Ordnance Survey Office, Southampton. The price is 1*s*. 6*d*.

THE first mention of petroleum in North America is due to Father de la Roche d'Allion, the Franciscan, in 1629. Mr. Alfred Sang, of Pittsburg, U.S.A., suggests, in a note to us, that the first mention of oil in South America may be that by Albaro Alonso Barba, of Potosi, eleven years later, in 1640, in "The Art of Metals," translated by the Earl of Sandwich in 1669. The part referring to petroleum is contained in the following extract sent by Mr. Sang:—"*La Naphte* is a sulphurous liquor, sometimes white, and sometimes black also, and is that which is called Oyl of *Peter*, of admirable vertue to cure old pains, proceeding from cold causes. It will draw fire to it (as the Loadstone does Iron) with that force, that it will take fire at a great distance from the flame, as hath been confirmed by the miserable experience of the *Conde de Hercules de Icontrarii*, of the Country of Ferara, who having a well in his ground, the water whereof was mixed with *Petreol*; and by some breaches or cracks in the well, much of this water ran to waste; commanded it to be repaired; the Laborer that was let down into the bottom of the Well desired a Candle, the better to see his work, which was furnished him in a Lanthorn, and immediately through the holes of the Lanthorn the *Naphte* suckt the flame into it self and set fire on the whole Well, which discharged it self instantly like a great piece of Cannon, and blew the poor man into pieces, and took off an arm of a Tree that hung over the Well."

IN the "Ethnography of the Macedonian Slavs" (London: Horace Cox), translated from the second edition of Dr. Cvijić's well-known booklet, we have a useful criticism of many wild statements which have been made with regard to racial relations in Macedonia. After treating of the sense of nationality and showing its connection with religion in the area in question, the author discusses the value of ethnographical maps published in the peninsula and elsewhere; he has little difficulty in showing that the majority are quite untrustworthy. Most of them are dominated by erroneous conceptions as to the term Bulgarian, adopted by Macedonian Slavs, and often used by the peasant to denote simply one who speaks the Slav tongue; an additional complication is introduced by the attribution of the same name by the Macedonian peasants to the Serbs, so that Russian, Serb, and Bulgarian all bear the same name. The maps published in the peninsula reflect only the political aims of the cartographer. In such circumstances Dr. Cvijić's impartial evidence is of the highest value. A comparative table at the end of the booklet shows the variations of the statistical tables. The translation would have gained if an anthropologist had revised the terminology.

AN article on pure food legislation, by Mr. Robert McD. Allen, in the *Popular Science Monthly* for July has a special interest at the present moment. Its object is to show the difficulties which have retarded legislation with regard to the adulteration of food in the United States in the past, and the proposals by which the Hepburn Pure Food Bill, which has passed the House of Representatives, suggests a remedy. The Bill aims at the correct labelling of foods, drugs, and liquors in such a way as to show the source of the material, its treatment, and whether colouring matters or preservatives have been added. It is pointed out that not only has the chief of the Bureau of Chemistry, assisted by the medical staff of the Army, reported against the use of salicylic, benzoic, and boric acids as preservatives, but that preservatives are used in many cases as a substitute for cleanliness and careful handling, thus discouraging better methods, such as chilling, sterilising, and curing. The use of artificial colouring matters, if not actually injurious, is at the best a fraud; genuine colour is one of the best indications of quality, and with artificial colour to depend upon there is less need for the selection of the best materials. With regard to tinned meats, the "Government inspection," which is supposed to be a guarantee, refers only to the state of the original carcass, and antiseptics, colouring matters, filling materials, and other adulterants may be freely added. The extreme difficulty of the problem of pure food legislation is owing to the fact that adulteration has become "so strongly entrenched in business systems that a proposition to put truthful labels on foods and drugs intended for interstate commerce has met continuous defeat for more than fifteen years at the national capital."

IN the *Atti dei Lincei*, xv., 10, Dr. G. Almansi discusses how far the principle of virtual work is applicable to systems in which friction exists.

AN interesting note on "Americanism" is contributed to the *Rendiconti* of the Lombardy Institution, xxxix., 10–11, by Dr. Bassano Gabba. It deals largely with religious thought in America, with special reference to Catholicism.

A SIMPLE machine for compounding sine-curves is described by Prof. W. G. Cady in *Science*, xxiii., 597. While not possessing the same capabilities as Michelson's harmonic analyser, the instrument is convenient for demonstration purposes, and gives the resultant of a fundamental sine-curve and either its second, third, or fifth harmonic with any desired amplitude and phase-relation.

A COMMEMORATION of Christopher Columbus, read on the 400th anniversary of his death by Dr. Dalla Vedona, is published in the *Atti dei Lincei*, xv., 11. It is pointed out that the work of Columbus initiated a new method of research by applying to navigation the theory of the sphericity of the earth. As the author remarks, the fundamental conception of Columbus was absolutely rational and absolutely scientific.

STEREOPHOTOMICROGRAPHY forms the subject of two papers in the Journal of the Royal Microscopical Society for June. One, by Mr. W. P. Dollman, of Adelaide, is illustrated by a photograph of polyzoa (*Idmonea radians*), the other, by Mr. H. Taverner, by groups of Foraminifera and the water mite (*Ecpolus papillosus*, Soar). In both cases the photographs were taken by successive exposures on the same plate with a screen cutting off half the objective.

MOST teachers of geometrical optics have, at one time or another, devised arrangements for showing the paths of rays reflected at a mirror or transmitted through a lens; in general, however, such arrangements require time to be spent in their adjustment, and the results obtained are often very poor when the trouble taken in attaining them is considered. Prof. Hartl has laid all teachers of experimental optics under an obligation by designing a piece of apparatus which he calls the "optical disc"; this, at a moment's notice, can be adjusted so as to show the path of the rays in any one of the important cases usually dealt with in elementary lectures on geometrical optics. The reflection of a single ray, or a number of rays (parallel or divergent) from a plane, concave, or convex mirror; the refraction of a ray at a plane surface, including the case where total internal reflection occurs; the path of a single ray or a number of rays through a convergent or a divergent lens; the nature of spherical and chromatic aberration; the theory of the rainbow, these are a few of the experiments which can be performed by its aid. The apparatus, which is sold by Messrs. A. Gallenkamp and Co., Ltd., is very compact, and its general arrangement is so good that one experiment may be changed for another in about half a minute. The same firm supplies an appliance comprising bent glass rods, which show the total reflection phenomena generally demonstrated by the aid of the illuminated fountain; a simple polarising apparatus, consisting of a pile of plates and a black glass reflector, which may be attached to the optical disc described above; and a simple form of polariscope, together with specimens of strained glass showing the characteristic coloured figures associated with double refraction.

AN interesting light is thrown on the difficult problem of the behaviour of manures in soils by some recent observations, made under the auspices of the Bureau of Soils of the United States Department of Agriculture, by Messrs. Oswald Schreiner and George H. Failyer, and published in the form of two communications in the *Journal of Physical Chemistry* (Nos. 4 and 5). One of these deals with the absorption by different soils of the phosphates of calcium and sodium from dilute solutions, whilst in the other the removal by a soil of potassium from an aqueous solution of potassium chloride is studied. It is shown that the soils dealt with take up the phosphates and potassium from aqueous solution according to the law of a monomolecular reaction, and that the action is strictly reversible. Water washes out the absorbed material according to a similar law. Each soil is characterised by a definite limiting capacity of absorption, which differs with different soils. It is remarkable that for certain clay soils and clay loams this capacity is the same for sodium phosphate as for calcium phosphate, pointing to the occurrence of definite reversible chemical actions. It is particularly noteworthy that when water percolates through a soil the amounts of phosphate or of potassium in the transmitted liquid give no clue to the quantities of these materials present in the soil itself. The results are determined, not by solubility alone, but by a special law governing the removal of the absorbed substances.

THE Institute of Chemistry has published a "List of Official Chemical Appointments held in Great Britain and Ireland, in India and the Colonies." The list has been compiled under the supervision of the proceedings committee of the institute by Mr. R. B. Pilcher, the secretary of the institute, and its price is 2*s*. net. The list is arranged in two main divisions; the first contains appointments under the departments of State and professorial appointments in the British Isles; the second section deals similarly with India and the colonies. The information provided indicates the steadily increasing demand for professional chemical services in connection with State and municipal administration, and it should prove of service to chemists everywhere.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN AUGUST:—

Aug. 4. 1h. 0m. Eclipse of the Moon invisible at Greenwich.
,, 9h. 3m. to 10h. 13m. Moon occults ι Capricorni (mag. 4·3).
6. 10h. Saturn in conjunction with Moon (Saturn 0° 49′ N.).
,, 12h. 21m. to 12h. 54m. Moon occults ψ' Aquarii (mag. 4·5).
7. Saturn. Major axis of rings = 43″·82, Minor = 3″·02.
10. 13h. 18m. to 14h. 13m. Moon occults ξ^2 Ceti (mag. 4·3).
10–12. Epoch of the Perseid meteoric shower. Radiant 45° + 57°.
15. Venus. Illuminated portion of disc = 0·650; of Mars = 0 997.
18. 12h. 15m. Minimum of Algol (β Persei).
19. 13h. 13m. Eclipse of the Sun invisible at Greenwich.
21. 9h. 4m. Minimum of Algol (β Persei).
24. 11h. 47m. to 14h. 37m. Transit of Jupiter's Sat. III. (Ganymede).
29. 6h. 29m. to 7h. 43m. Moon occults ξ^2 Sagittarii (mag. 3·5).
,, 11h. Mercury at greatest elongation (18° 11′ W.).
31. 16h. 2m. to 18h. 54m. Transit of Jupiter's Sat. III. (Ganymede).

FINLAY'S COMET (1906*d*).—The following approximate elements, corrected for planetary perturbations, are published in No. 4106 of the *Astronomische Nachrichten* by M. L. Schulhof for Finlay's comet at the present epoch:—

Epoch 1906 *August* 1·0 *M.T. Paris.*

$$M = 354^\circ\ 22'\ 45''\!\cdot 7 \qquad \phi = 46^\circ\ 23'\ 22''\!\cdot 9$$
$$\left.\begin{aligned} \pi &= 8\ 10\ 55\cdot 2 \\ \Omega &= 52\ 22\ 37\cdot 7 \\ i &= 3\ 3\ 5\cdot 5 \end{aligned}\right\} 1906\cdot 0 \qquad \begin{aligned} \mu &= 542''\cdot 557 \\ \log a &= 0\cdot 815560 \\ T &= \text{Sept. } 7\ 3\ \text{(Paris)} \end{aligned}$$

A daily ephemeris, from which the following has been extracted, has been calculated by M. Fayet:—

1906	α (true) h. m. s.	δ (true) ° ′	log *r*	log Δ	Brightness
Aug. 1	1 55 25	−1 27	0·04347	9·43680	23·4
3	2 13 6	+0 15	0·03807	9·43308	
5	2 30 47	+1 58	0·03288	9·43202	25·1
7	2 48 21	+3 39	0·02780	9·43350	
9	3 5 38	+5 17	0·02292	9·43742	25·7
11	3 22 31	+6 50	0·01823	9·44356	

The brightness of the comet when discovered in 1886 is taken as 1·0.

The observation of this comet at Heidelberg on July 16 gave corrections of −12m. 11s. and −1° 37′·5 to this ephemeris, and thereby brought the calculated time of perihelion to about September 8·35, 1906 (Paris M.T.). Applying these corrections to the above ephemeris, it will be seen that the comet will be about 3° north of Mira Ceti on August 4.

AN UNEXPLAINED OBSERVATION.—In No. 4106 of the *Astronomische Nachrichten* Prof. Barnard places on record the following observation, which he made so far back as August 13, 1892, and for which he has not yet been able to find any explanation. While examining Venus with the 36-inch Lick refractor at 0h. 50m. (G.M.T.) on August 13, 1892, he saw a star of about the seventh magnitude in the same field as the planet, and about 1′ south and 14s. ± preceding. The position of this object would be, therefore, α = 6h. 52m. 30s., δ = +17° 11′·0; this position reduced to 1855 becomes α = 6h. 50m. 21s., δ + 17° 13′·6, and there appears to be no such bright star in this place, neither does it agree with the position of any B.D. star. The actual elongation of Venus would exclude the possibility of the unknown object being an intra-Mercurial planet, although it does not preclude an improbable planetary body interior to Venus.

Although fourteen years have elapsed since the observation was made, Prof. Barnard has hitherto hesitated about publishing the results, but now thinks that they should be placed on record, especially as his notes are very definite, and there could have been no known possibility of mistake.

Unless the unknown body was one of the brighter asteroids—and Ceres, Pallas, Juno, and Vesta were known to be elsewhere—the result is, as yet, entirely incomprehensible.

The Rio de Janeiro Observatory.—We have just received the "Annuario" of the Rio de Janeiro Observatory for 1906, a useful volume which is published by the observatory, under the direction of the Minister of Industry and of Public Works, and which is the twenty-second of the series.

In addition to the usual calendars and tables of astronomical events, this volume contains numerous tables employed in astronomical reductions and conversions, tables for the reduction of meteorological observations, data employed in physical and chemical operations, and a *résumé* of the meteorological observations made in the Rio de Janeiro area during the year 1904.

IRON AND STEEL INSTITUTE.

In place of the usual autumn meeting, the Iron and Steel Institute held a largely attended meeting in London on July 24 and following days jointly with the American Institute of Mining Engineers. At the opening meeting the president of the Iron and Steel Institute, Mr. R. A. Hadfield, gave an address of welcome to the American guests, expressing satisfaction that so many American engineers had been able to be present at this important international meeting. Sir James Kitson, who was president when the society first visited America in 1890, followed with a similar address of cordial welcome. Mr. Robert Hunt, president of the American society, in acknowledgment, said they felt as though they were part of the Iron and Steel Institute in that their society was formed on the same lines, and was equally comprehensive in its character and membership. The president announced that the King had consented to receive a deputation of the American guests, and also to honour the institute by accepting the Bessemer gold medal. He also announced that Sir Hugh Bell had been unanimously elected as his successor to the presidency in May next. Papers on Continental practice in blast-furnace gas engines were then read in abstract by the secretary, Mr. Bennett H. Brough. The first of these, by Prof. Hubert (Liége), dealt with the design of blast-furnace gas engines in Belgium. It reviewed the history of the direct utilisation of blast-furnace gas in engines since the early attempts in 1895, and gave particulars of detailed tests of a 1400 horse-power two-cylinder double-acting and tandem engine made by the Cockerill Company. Mr. Reinhardt's paper, on the application of large gas engines in the German iron and steel industries, formed an exhaustive treatise on the subject. The author showed that in the German ironworks there are 349 gas engines with a total effective horse-power of 385,000. He reviewed the practical experience gained by working, and with the aid of a large number of illustrations explained the present design of large gas engines in Germany. The old arrangement of the single-acting four-cycle motor, with one or more cylinders, has in recent years not been generally used, and, on the other hand, double-acting four-cycle motors, mostly with tandem cylinders, are in keen competition with two-cycle motors. The author described in detail the cylinder and exhaust-valve chest, valve gear, shifting boxes, cooled pistons and piston rods, ignition and starting, and various engines of the double-acting four-cycle type of the leading German makers, the remainder of the paper being devoted to two-cycle engines on the Oechelhäuser and the Körting systems. Suitable trials concerning the consumption of gas, Mr. Reinhardt remarked, are not available for comparison, and therefore it is not yet known how far the two-cycle engine is at the present time in this respect still inferior to the four-cycle engine. In conclusion, the author stated that the present position of the application of gas engines in German ironworks shows the value the managers of these undertakings attribute to the better and less dangerous utilisation of the waste gases of their furnaces.

Mr. T. Westgarth (Middlesbrough) followed with a paper on large gas engines built in Great Britain. All the British builders were, he said, using the four-cycle system, except the builders of the Körting and Oechelhäuser engines, who worked on the two-cycle system.

In discussion, Mr. Julian Kennedy pointed out that in the United States gas engines were only in their infancy. After further well-sustained discussion, the meeting adjourned. During the afternoon visits were paid to the National Physical Laboratory, to the London County Council's electricity generating station at Greenwich, to the Mercers' Hall, and to the Hall of the Armourers' and Brasiers' Company, and in the evening a reception was given by the Lord Mayor at the Mansion House.

On July 25 a crowded meeting was presided over by Mr. Robert W. Hunt (Chicago), president of the American Institute of Mining Engineers. His presidential address dealt chiefly with American rolling-mill practice, and concluded with the announcement that Mr. J. E. Stead, F.R.S., and Mr. R. A. Hadfield had been elected honorary members of the American society. The first paper read dealt with a comparison of American and foreign rail specifications, with a proposed standard specification to cover American rails rolled for export. The author, Mr. A. L. Colby, read the paper in abstract, and the proposal to admit 0·1 per cent. of phosphorus was adversely criticised by Mr. Windsor Richards and other British members, the 0·07 per cent. recommended by the Engineering Standards Committee being considered safest for British practice. A paper by Mr. R. H. Lee, on producers in blast-furnace work, was briefly discussed, and the meeting adjourned. In the afternoon visits were paid to the works of Messrs. John I. Thornycroft at Chiswick, to the works of Messrs. J. and E. Hall at Dartford, to the halls of the Inner and Middle Temples, to Kensington Palace, the Imperial Institute, and the museums at South Kensington. In the evening there was a *fête* at the Imperial Royal Austrian Exhibition at Earl's Court.

On July 26 Mr. Hunt occupied the chair, but upon his proposal Mr. Hadfield presided. The first paper taken was by Mr. James P. Roe, on the development of the puddling process, and this was followed by a paper by Mr. James E. York on improvements in rolling iron and steel. These two papers, which are of extreme importance from a practical point of view, elicited an excellent discussion. The remaining papers on the British and American lists were taken as read. Many of these are of great interest and value, and we hope to publish abstracts of them in a subsequent issue. During the afternoon, visits were paid to the works of Messrs. Fraser and Chalmers at Erith, to the works of the Associated Portland Cement Manufacturers at Northfleet, to the Chelsea Power Station, and to the hall of the Ironmongers' Company. In the evening there was a banquet and special firework display at the Crystal Palace.

On July 27 the King received at Buckingham Palace a deputation of the councils of the Iron and Steel Institute and of the American Institute of Mining Engineers, and accepted from the president, Mr. Hadfield, the Bessemer gold medal and a suitable illuminated address. The general body of members visited Windsor Castle, where special facilities were given them for seeing the palace and gardens. In the evening there was a banquet at the Guildhall; Mr. Hadfield presided, and the company numbered 600 and included many distinguished guests. The American ladies, numbering 100, were entertained at dinner in two of the committee rooms, with Mrs. Hadfield and Lady Lloyd-Wise presiding.

On July 28 there were alternative excursions to Messrs. Butlin's blast furnaces at Wellingborough and to the Dover harbour works. These two successful visits brought the Iron and Steel Institute meeting to a close. For the American guests visits were arranged, on Sunday, July 29, to St. Paul's Cathedral, the Roman Catholic Cathedral at Westminster, the Zoological Society's Gardens, the Botanic Society's Gardens, and to Hurlingham and Ranelagh Clubs, and on July 30 they started on a provincial tour, organised by the Iron and Steel Institute, to York, Ripon, Middlesbrough, Durham, Newcastle-on-Tyne, Glasgow, and Edinburgh.

SOME RECENT ASTRONOMICAL WORKS.[1]

THE appearance of another star catalogue from the Radcliffe Observatory shows how loyal that institution has remained to the traditions that Main and Stone received from Johnson and the earlier observers. The result is in every way worthy of those traditions. Other duties may have divided the attention of the director. The maintenance of the observatory in the first rank has demanded within the last few years that new and larger instruments should be erected, and the adjustment of these has necessarily taxed the energies of the small staff at the observers' disposal. But these imperative tasks have only had the effect of diminishing somewhat the number of stars observed. The accuracy and the independence of the observations, which have ever been a feature in the Radcliffe meridian measures, have in no whit suffered. In these respects the tradition of the observatory has been unflinchingly upheld.

The introduction to the volume shows that the stability of the instrument has been increased by structural alterations. The examination of the division errors, that tedious and laborious work, involving in this case more than ten thousand readings of the circle, has been manfully tackled with apparently greater care than Stone bestowed upon this fundamental work. The pivots have been tested by an apparatus that Dr. Rambaut himself has perfected. The results are apparently quite satisfactory. Finally, we are brought face to face with that troublesome R-D correction, the origin of which defies satisfactory explanation, as its treatment taxes ingenious applications. The method employed at Oxford is not the same as that which recommends itself to the authorities at Greenwich. At the former observatory no correction for this discordance has been made to the direct measures, the whole difference being applied as a correction to the reflexion observations in order to render the two series homogeneous. In the Greenwich observations of zenith distance, a correction is applied which has practically the effect of making the final result a mean between the direct and reflected observations. One may not say that it is a consequence of these different methods of reduction that the declinations obtained at Oxford and Greenwich show systematic differences. But when a comparison between the star-places common to the two catalogues (Radcliffe, 1900, and Greenwich, 1890) is instituted, a systematic discordance is disclosed, the greater portion of which can be removed by reducing the Greenwich and Radcliffe observations in substantially the same manner. The zone catalogue of Albany also includes a large number of stars that have been observed at Oxford. A comparison between these two catalogues is most satisfactory. The difference between the two is practically the same as between Albany and Romberg's Pulkova catalogue. Of the accuracy of this latter Prof. Auwers has spoken in the highest terms. We may offer our congratulations to Dr. Rambaut on the successful completion of a heavy piece of work, and express the hope that the large equatorial, the mounting of which has interfered so much with the progress of his meridian measures, will amply fulfil its early promise.

The parcel from Groningen contains specimens of those laborious calculations to which the astronomers of that University are so much attached, and by which other astronomers have profited. Prof. Kapteyn here gives the results of his discussions of the proper motions of the greater part of the Bradley-Auwers stars on different assumptions of the value of the precessional constant, the position of the solar apex, and of systematic corrections to the proper motions in declination. Of the 3222 stars contained in Auwers-Bradley, 2640 have been discussed. Satisfactory reasons are given for omitting the remainder, so that the material may be considered exhausted. The results, grouped according to the galactic latitude of the stars or the type of spectrum, have been made the groundwork of special investigations. Since these have been before the astronomical world some time, it is not necessary to enter into any lengthy description here. The tables indicate a great amount of care and industry, and will be useful to those who wish to make independent investigations based on the proper motions of the stars.

Dr. Sitter's contribution contains new and useful matter. The tables here arranged show at a glance the times of the year most suitable for making stellar parallax observations, on the assumption that the method of photography will be adopted and that the plates will be taken near the meridian. Some tables are also given that will be of use in the subsequent reduction of the measures. Profs. J. C. and W. Kapteyn add a collection of differential formulæ connected with the solution of spherical triangles. The authors believe that such formulæ would be of more general use if the amount of the neglected terms was known with certainty. To remove this difficulty, the formulæ here given are correct to the squares of the differences. Convenience rather than originality seems to have influenced the authors, both here and in other formulæ applicable to plane and spherical triangles in which certain of the elements are small. Another table for which we have not yet found any extended use is one giving the trigonometrical functions for each degree in the circle to two places of decimals. But the authors say that mathematically trained persons have found it so useful in relieving their mind from mental strain, that they contemplate publishing a similar table giving the natural trigonometrical functions to three places of decimals for every tenth of a degree throughout the entire circle.

Such tables might possibly be of service to the readers of the next work on our list, "Cours d'Astronomie," by M. Louis Maillard, though, as the author does not vouchsafe any word of preface, it is uncertain for what class of students his book is intended. The purpose of the book is the more difficult to comprehend since we have but one volume of the work from which to judge of its aim and extent. But the writer of a text-book on astronomy has to keep within lines which are very well recognised. Especially is this the case when dealing with spherical astronomy. The facts do not materially change or increase. The only choice the writer can exercise is to decide between a work of reference which shall be as encyclopædic as possible, or a text-book which shall present to the reader a manageable amount of matter from which he may acquire an adequate grasp of the facts and principles upon which the science is supported. M. Maillard apparently prefers the text-book, and proceeds on the usual unheroic lines. He begins with the derivation of the ordinary formulæ of spherical trigonometry, to which he adds a few pages giving some elementary notions on the theory of least squares. But these few pages serve no useful purpose, and might have been omitted with advantage. When it is added that the author has some chapters on problems connected with diurnal motion, and a description of the constellations, it will be understood that he is catering for a class that is not very far advanced in astronomical study. But the chapters on parallax and aberration are generally full enough for all who have not to make any practical application of the theory. Finally, the section on the earth and geodetic measurement is made quite interesting. The book ought to have a ready appreciation among students in high schools and colleges, and is an advance on some of those which have long done duty in this country, and still enjoy an honoured position. The book is apparently lithographed, but it is very handsomely finished, and the diagrams are new and well reproduced.

Of a very different calibre and purpose is Mr. Stirling's work. M. Maillard has been developed in an atmosphere of extreme orthodoxy. He is not, and has no wish to be thought, original. His methods have received the sanction of many generations of teachers. For good or for evil,

[1] "Catalogue of 1772 Stars chiefly comprised within the Zone 85°–90° N.P.D. for the Epoch 1900, deduced from Observations made at the Radcliffe Observatory, Oxford, during the years 1894–1903, under the direction of Prof. Arthur A. Rambaut, F.R.S. Pp. xxxvi+81. (Oxford: Henry Frowde, 1906.)

"Publications of the Astronomical Laboratory at Groningen." Edited by Prof. J. C. Kapteyn. Components of the Proper Motions and other quantities for the Stars of Bradley. Tables for Photographic Parallax-Observations by Dr. W. de Sitter. Some useful trigonometrical formulæ and a table of goniometrical functions for the four quadrants, by Prof. J. C. Kapteyn and Prof. W. Kapteyn. (Groningen: Hoitsema Bros., 1906.)

"Cours d'Astronomie," par Louis Maillard. Tome I. Pp. 243. (Paris: Librairie scientifique, A. Hermann, no date.) Price 7.50 francs.

"New Theories in Astronomy." By William Stirling. Pp. xv+336. (London: E. and F. N. Spon, Ltd., 1906.) Price 8s. 6d. net.

these methods have become stereotyped. But the late Mr. Stirling, as an engineer, had to think for himself, and, moreover, his occupation removed him to places far from the busy crowd. He could scarcely have had the opportunity of examining and testing his opinions by comparison with those of others who have been differently trained, for he passed much of his life in furthering railway enterprise in Chili and Peru. There he was free to follow the lines of thought that his uncurbed fancies suggested. His book is therefore marked with much freshness, but also with some errors. In many respects it is interesting, since it shows the confusion which an intelligent mind may create for itself when it disregards the trammels of authority and attacks problems for the study of which it is not fitted by previous training.

We get the first insight into this mutinous disregard for authority when we find our author describing, in his first chapter, the experiments which the late Sir George Airy carried out at the Harton Colliery. It cannot be denied but that these experiments are open to some objection, though possibly not entirely on the grounds on which the author insists. But there is a certain refreshing keenness in his criticism which one can read and enjoy. We next find our author hopelessly blundering over that terrible question of the moon's rotation, and we cannot help thinking that the late Mr. Stirling must have had in his nature a considerable spice of obstinacy. He was far too intelligent not to have recognised the true character of the problem and to have found its solution. It is to be regretted, perhaps, that he did not rely upon his own good sense, and that he consulted so many authorities. He has our sympathy to the extent that these authorities have not always expressed themselves with clearness, and in some cases not even with accuracy. But with perverted ingenuity he seems to have fastened upon any looseness of expression he could find, and has endeavoured to give it a construction that it will not legitimately bear. But when we find the centrifugal force due to the moon's rotation introduced as a cause to explain the transference of air and water from the visible hemisphere of the moon to the hemisphere that we do not see, we are disposed to give up our author as incorrigible. It is not at all surprising after this that he should turn his attention to the nebular hypothesis, that he should find its explanation inadequate, and to need some finishing touches which he is ready to supply. For this is a subject that attracts those most keenly who are least qualified to handle it intelligently. Unfettered by close reasoning and unfamiliar with the bearing of material facts and deductions, they lose themselves in apparently plausible intricacies, and hopelessly puzzle those who attempt to follow them.

W. E. P.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. H. W. Marett Tims, of King's College, demonstrator of anatomy in the University, has been appointed professor of biology at the Royal Veterinary College, London.

At a meeting of the president and fellows of Queens', held on Wednesday, July 18, Prof. H. T. Bovey, F.R.S., professor of engineering in the University of Montreal, was elected an honorary fellow. Mr. Bovey was formerly a fellow of the society.

The master and fellows of Christ's College have elected Mr. Francis Darwin, foreign secretary to the Royal Society, honorary fellow. Mr. Darwin for many years held the readership of botany in the University and a fellowship at Christ's. Dr. G. H. F. Nuttall, F.R.S., has been elected a fellow of the same college. Dr. Nuttall has held teaching posts at the Johns Hopkins University, Baltimore, and at the University of Berlin. He is at present reader in hygiene at Cambridge and chief editor of the *Journal of Hygiene*, which he largely helped to found.

DR. G. C. BOURNE has been appointed Linacre professor of comparative anatomy at Oxford, in succession to the late Prof. Weldon.

A CLASS in experimental psychology, including practical work and demonstrations, will be held by Prof. C. S. Myers on Saturdays in the psychological laboratory of King's College, London, beginning on October 6.

MR. V. H. BLACKMAN has been appointed lecturer in plant cytology in the department of botany of University College, London. In view of the new relationship between the college and the University of London, and in order to avoid confusion with the principal of the University of London, the title of the Principal of University College will be changed to that of Provost of University College.

MR. CLARENCE H. MACKAY and Mrs. John W. Mackay have given 20,000*l*. to the University of California, to endow the chair of electrical engineering. It will be known, says *Science*, as the John W. Mackay, jun., professorship, in memory of Mr. Mackay's brother, and will be filled by Prof. C. L. Cory, head of the department of mechanical and electrical engineering.

THE Board of Education has issued its instructions for the year August 1, 1906, to July 31, 1907, to technical schools, schools of art, and other day and evening schools and classes for further education. As is becoming common in the Board's publications, the volume begins with a prefatory memorandum, and in it great stress is laid upon the value to the student of science and technology of what is commonly called "general" education. Steps are detailed by which the Board proposes to encourage this side of the work of these schools and classes. It is pointed out that the lower classes of a good evening school afford to pupils, who have just left an elementary school, both a continuation of their general training and instruction in the application of that training to matters that come before them in their daily work. It is where, says the memorandum, this double aspect of evening schools is best developed, and where the lower and higher classes are most fully knit together, that the best records of attendance and of real progress are to be found. A distinct advance is recorded, we are glad to find, in the preliminary education of students entering higher classes in day technical schools, and this is to be traced to more efficient evening continuation schools. These regulations also make provision for an inclusive grant to local education authorities, other than London, in place of the separate grants assessed by taking into consideration the number of hours of instruction received by registered students in approved subjects. An authority wishing to receive such an inclusive grant must submit to the Board particulars of the manner in which it is proposed to make provision for the educational needs of the area and for the coordination of the several types and grades of this instruction with the other forms of education available for the area. All such endeavours to prevent overlapping and duplication of educational facilities, and to bring about economy and efficiency, are welcome. It is to be hoped the new plan proposed by the Board will effect the object in view.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 21.—"The Transition from the Liquid to the Solid State and the Foam-structure of Matter." By Prof. G. **Quincke**, For.Mem.R.S.

On June 19, 1905, the author laid before the Royal Society the results of his researches on ice-formation and glacier-grains (see NATURE, September 28, 1905, vol. lxxii., p. 543). The further prosecution of these researches has shown that phenomena similar to those observed in the freezing of water occur in all bodies in nature, and are in agreement with the structure of metals as observed by the author and also by other investigators. Solid bodies, then, are never homogeneous, but always exhibit a foam-structure.

All liquids in nature resemble water in forming, as they cool, oily foam walls, which may be very thin and invisible. The shape and position of these foam walls become visible on freezing or thawing in the following ways:—(*a*) By fissures or fractures at the surface of the foam walls, whenever the liquid contents of the foam cells contracted on solidification, or when the walls and the contents of the foam cells contracted differently as they cooled. (*b*) By the bounding surfaces of the doubly refracting crystals (glacier-grains), which are differently orientated in neighbouring foam cells. (*c*) On illumination with sunlight or electric light, or on warming, when the doubly refracting contents of the foam cells melt and are transformed into singly refracting liquid. (*d*) By lens-shaped masses, foam flakes or air bubbles, suspended in the foam walls. (*e*) By the furrows, or network of lines on the solidified surface formed by the intersection with that surface of the foam walls in the interior of the solidified mass. (*f*) By polishing or etching the natural or artificial surface, in cases when the walls and the contents of the foam cells differ in hardness or in the rapidity with which they are attacked by chemical reagents.

The surfaces of solidified drops of pure molten *metals* show a network of straight lines or arcs of circles (usually inclined to one another at 120° or 90°), or foam walls with embedded lens-shaped masses. This is so in the case of gold, silver, platinum, palladium, iridium, indium, copper, zinc, iron, nickel, cobalt, bismuth, sodium, potassium and mercury. Similar phenomena are to be observed on the surface of solidified drops of sulphur and selenium, or on the surface of carbon which has been distilled with the electric arc in a magnetic field, and deposited on the kathode.

The shapes of the bounding surfaces of molten metals, and the circular arcs in the network of lines on the surface of metals raised to red or white heat, show that these bounding surfaces must be regarded, not as they have hitherto been, viz. as crystalline faces, but as solidified oily foam walls, which, as in the glacier-grains of ice, enclose foam cells with contents differing from the walls. Just as the glacier-grains of ice run together and enlarge by the bursting of the foam walls, so also larger foam cells with fewer foam walls are formed in metals heated nearly to melting point.

Pure molten metals after solidification exhibit on artificial polished and etched surfaces a network of lines or foam cells (similar to the glacier-grains of ice), which are bounded by thin foam walls. These thin foam walls themselves contain still smaller foam cells, as is proved by the visible lens-shaped masses embedded in them, and the wave-like furrows on their surface, which are capable in reflected light of giving diffraction colours like mother-of-pearl. This foam structure of pure metals when solidified after fusion has been demonstrated in the case of bismuth, cadmium, cobalt, copper, gold, iron, indium, iridium, lead, manganese, mercury, nickel, palladium, platinum, potassium, rhodium, sodium, tin, and zinc.

Molten metals solidify on cooling to a liquid jelly, and later to a solid jelly. The walls and contents of the foam cells of such a jelly still consist of viscous liquid, *i.e.* the jelly itself is still liquid—like ice—at temperatures lower than the melting points of the respective metals. The welding of two pieces of metal corresponds to the running together of the cell walls and cell contents of two lumps of jelly, or the regelation of ice.

All the other substances in nature behave like these metals. The soft, plastic condition, which all bodies assume for a larger or smaller interval of temperature on the transition from the solid to the liquid state, proves the presence of jelly, *i.e.* of oily, visible or invisible foam walls, over this interval of temperature.

The heterogeneous oily liquid, which as solidification occurs becomes visible in all substances in nature in the form of thin foam walls of different surface tension, must also appear as a thin liquid skin on the surface of solidifying drops. This explains the variations in the measurements of the surface tension of molten metals and salts, and of liquids in general.

The walls and contents of the foam cells consist of heterogeneous substance. That foreign matter in very small quantities—1/1000000 per cent. and even less—does form oily layers and foam walls in pure liquids is proved by the author's observations on ice and benzene. Traces of foreign matter (gases, carbon, metals, &c.) too small to be shown in any other way are present even in the purest liquids, and are sufficient to explain the observed foam structure of all solidified substances in nature.

June 28.—"On the Ultra-violet Spectrum of Ytterbium." By Sir William **Crookes**, F.R.S.

The rare earth, ytterbia, was discovered in 1878 by Marignac (*Comptes rendus*, vol. lxxxvii., p. 578). In 1880 Nilson (*Ber.*, vol. xii., p. 554), in purifying Marignac's ytterbia, found that it contained another earth, which he named scandia. Cleve, and more recently his daughter Astrid Cleve, have worked much on ytterbia, and within the last few years M. Urbain has taken up the subject, and has succeeded in purifying ytterbia in larger quantities. During the author's own work on the fractionation of the rare earths he also has prepared and worked with ytterbia.

M. Urbain's ytterbia was prepared by the fractional crystallisation of the ethyl-sulphates of crude gadolinite earths (*Comptes rendus*, vol. cxxxii., p. 136). The subsequent separation is by the fusing nitrate method. This after twenty series of fusions gave in the least basic portions a mixture of ytterbia and thoria, which are easily separated by Wyrouboff and Verneuil's method.

The examination for absorption bands in a strong solution is a fairly good test for an earth such as erbia and thulia giving absorption spectra, but it is not so delicate as an examination of the spark spectrum photographed through a quartz train, for dominant lines, which most elements show in some part of their spectrum. For instance, the dominant lines of yttrium are at wave-lengths 3600·9, 3710·4, 3774·5, 4177·7, and 4375·1. The dominant lines of erbium are at 3499·3, 3692·8, and 3906·5. They are, however, not strong, and fortunately the absorption bands of this element are striking and characteristic. The spark spectrum of thulium has only been slightly examined by the author, and he does not think it has any strong lines. Its absorption spectrum, as with erbium, is a very characteristic one. The spark spectrum of ytterbium has strong dominant lines at 3289·5 and 3694·4. Scandium has dominant lines at 3572·7, 3614·0, 3630·9, 3642·9, and 4247·0.

The author's photographs were taken with the quartz apparatus already described, the spectrum of pure iron being used as a standard. The ytterbium spark was taken from a strong solution of the nitrate between platinum poles, sufficient self-induction being introduced to eliminate nearly all the air lines. The ytterbium, by this very severe spectrum test, is seen to be not absolutely free from impurities—thulium, copper, and calcium being present. Thulium is seen by its lines at 3020·7, 3131·4, 3425·2, 3441·6, 3462·4, and 3848·2. Copper is seen by its dominant lines at 3247·7 and 3274·1, and calcium by its dominant lines at 3933·8 and 3968·6.

The platinum lines which are present are easily recognised, and are useful as an additional measure of identification. Besides these, a number of fainter and indistinct lines are seen. These may be due to ytterbium or to traces of hitherto unrecognised impurities.

The wave-lengths of all the recognisable lines of ytterbium are given on the photograph, and also those of thulium, calcium, and copper, but the platinum lines are not marked.

Paris.

Academy of Sciences, July 16.—M. H. Poincaré in th chair.—The absorption of nitrogen by organic substances, determined at a distance under the influence of radio-active materials: M. **Berthelot.** The action of air upon cellulose in the presence of a radium salt has been studied; the effects are comparable with those produced by the silent discharge.—A photometer specially designed for measuring the circumsolar light. Its use during the total eclipse of August 30, 1905: H. **Deslandres** and A. **Bernard.** The standard light used in the comparisons was a small osmium lamp. Two diagrams are given showing the arrangement of the photometer and telescope. The apparatus was used at Burgos during the last total eclipse, but the meteorological conditions were unfavourable.—Study of an apparatus designed by M. Lippmann for the photographic measurement of right ascensions: W.

Ebert and C. **Le Morvan.** A description of the modifications found necessary in the original apparatus, by means of which the error of a single point is less than 0·005. The results are obviously free from personal error, and the deformations produced by the objective are eliminated, since the images of the stars and the slit fixing the meridian, being produced by the same lens, undergo the same deviations.—The rigorous determination of two instrumental constants which intervene in certain meridian observations: H. **Renan.** A method for determining the exact angular relations between the two cross wires of the micrometer and the plane of the telescope.—The arbitrary character of developments of solutions, even unique, of the problems of mathematical physics, and on new properties of generalised trigonometrical series: A. **Buhl.**—Measurements of wave-lengths in the iron spectrum for the establishment of a system of spectroscopic standards: Ch. **Fabry** and H. **Buisson.** The measurements were made photographically by the interference method, the green mercury line given by the Cooper-Hewitt lamp being used as a basis. The measurements given fall between λλ 3606·687 and 6494·994.—The photography of the infra-red rays: Walter **Ritz.** The author has subjected Abney's method of preparing sensitive collodion films to a critical examination, and gives details for the preparation of plates highly sensitive to the infra-red radiations. Photographs were taken of the spectrum from the blue decreasing regularly to 1·4 μ, none of the discontinuities inseparable from the use of colouring materials being apparent.—The reduction of molybdenum dioxide by boron, and the combination of boron with molybdenum: Binet **du Jassoneix.** Previous work on this subject has been vitiated by the use of carbon crucibles, the formation of carbides of molybdenum being unavoidable under these conditions. The author uses a magnesia boat, and readily obtains pure molybdenum by heating boron and molybdenum dioxide in the electric furnace. By increasing the proportion of boron, products, free from carbide, and containing up to 46 per cent. of boron, can be prepared. These are attacked by dilute nitric acid, and show no trace of crystalline structure.—The electrical conductivity of colloidal ferric chloride: G. **Malfitano.**—The influence of non-electrolytes on the mutual precipitation of colloids of opposite electrical sign: J. Larguier **des Bancels.**—The composition of an acetic ferment: E. **Alilaire.** Five grams of a very active mycoderma were obtained from a vinegar works, the conditions allowing of the production of a pure culture on the large scale. Alcohol extracted 1·56 per cent. of a fatty substance containing phosphorus, from which, after saponification with soda, potassium iodide gave iodocholine crystals. The substance thus freed from fat contained 6·9 per cent. of nitrogen and 5·9 per cent. of ash, the analysis of which is given. The presence of a considerable proportion of iron and copper in the ash is noteworthy, the latter metal, according to the author's views, playing an important part in the process of acetification.—The microlitic rocks collected in Grahamsland by Dr. Charcot's Antarctic Expedition: Ernest **Gourdon.**—The presence of neon amongst the gases from some hot springs: Charles **Moureu** and Robert **Biquard.** Previous notes published on the gases from twenty-two hot springs have shown the general presence of argon and helium. A direct examination of these gases for neon gave negative results, owing to the fact that the neon spectrum is completely masked by argon. By the application of the selective absorption of charcoal cooled to −100° C., neon was proved to be present in every case.—The cyanogenetic principles of *Phaseolus lunatus*: M. **Kohn-Abrest.**—The estimation of malic acid and some fixed acids in the juices of fruits, fermented or unfermented: W. **Mestrezat.** The method is based on the insolubility of barium malate, tartrate, and succinate in dilute alcohol.—The phosphohumic compounds of soil: J. **Dumont.**—Remarks concerning the artificial development of *Ascaris vitulorum*: L. **Jammes** and A. **Martin.**—The histological composition of the lymph of ruminants: E. **Forgeot.**—The pigmentation of hair and beard by the X-rays: A. **Imbert** and H. **Marquès.** Light hair darkens under the action of the X-rays.—The geology between Zinder and Tchad: René **Chudeau.**

CALCUTTA.

Asiatic Society of Bengal, July 4.—Some freshwater Entomostraca in the collection of the Indian Museum, Calcutta: R. **Gurney.** An account of the freshwater phyllopods, cladocera, and copepods in the collection of the Indian Museum. Fourteen species new to the Indian fauna are recorded; new species of Daphnia and Estheria, and a new variety of a Streptocephalus are described.—Preliminary note on the chemical examination of the milk and butter-fat of the Indian buffalo: E. R. **Watson.** Pappel and Richmond found that the milk of the Egyptian buffalo contains no lactose, but a different sugar that they name tewfikose. This is not the case with the milk of the Indian buffalo, which contains lactose. In the butter-fat the Indian buffalo's milk proves to contain more butyric acid than either the European cow or the Egyptian buffalo, and also apparently more palmitic or stearic acid.—A new gecko from the eastern Himalayas: Dr. N. **Annandale.** A description of a new form of Gymnodactylus closely allied to the Malayan *G. marmoratus*.—Freshwater fauna of India, No. viii., some Himalayan tadpoles: Dr. N. **Annandale.** The larvæ of *Bufo himalayanus* and *Rana liebigii* are described, and that of *Megalophrys montana* is recorded from the Darjeeling district. Notes are given on the different ways in which different tadpoles which inhabit mountain torrents in the Himalayas are protected against sudden floods.—A parasite upon a parasite. A Viscum—apparently *V. articulatum*—on *Loranthus vestitus* on *Quercus incana*: I. H. **Burkill.** The paper gives an account of the double parasitism recorded in the title together with a review of the geographical distribution of such double parasitism and the names of the associated plants in recorded cases.—Gentianacearum species Asiaticas novas descripsit I. H. **Burkill.** Diagnoses of new species of the genera Gentiana and Swertia from Asia.—Swertiam novam Japonicam ex affinitate Swertiæ tetrapteræ, Maxim., descripserunt S. le M. **Moore** and I. H. **Burkill.** Diagnosis of a new Swertia from Japan.

CONTENTS.

THURSDAY, AUGUST 9, 1906.

THE DETERMINATION OF ORBITS.

Die Bahnbestimmung der Himmelskörper. By Julius Bauschinger. Pp. xv+653; mit 84 Figuren im Text. (Leipzig: Wilhelm Engelmann, 1906.)

Die Gauss-Gibbssche Methode der Bahnbestimmung eines Himmelskörpers aus drei Beobachtungen. Mit einem Anhang zum "Grundriss der theoretischen Astronomie." By Prof. Johannes Frischauf. Pp. 47. (Leipzig: Wilhelm Engelmann, 1905.)

THE development of convenient and general methods for calculating the orbit of any body around the sun from a limited number of observations constitutes a classical problem in the annals of astronomy. Its history, which has yet to be adequately written, now covers a period of rather more than two centuries, and during that time it has attracted the attention of many famous mathematicians whose successes and failures are alike remarkable. At the time of Newton long records had made the principal features of the orbits of the known planets familiar, and no addition to their number was made within the next hundred years. Hence in the eighteenth century efforts were mainly directed to the determination of the parabolic orbits of comets. Yet the completely satisfactory solution was deferred until 1797, when Olbers's celebrated work appeared. Why Olbers succeeded when far greater mathematicians, such as Euler and Lagrange, had met with comparative failure is an interesting question. The fact is that the determination of orbits is an art demanding as such a sense of arithmetical technique and not merely an insight into the mathematical principles involved.

In the nineteenth century, on the other hand, the discovery of minor planets, which are now being found at the average rate of one a week, has required general methods of dealing with planetary orbits. The deduction of an orbit from the necessary three observations has been based mainly on the methods of Gauss's "Theoria Motus." Even in matters of detail the variations which have been added have been for the most part slight and unimportant. In a less degree use has been made of the earlier method of Laplace, which has been generally regarded as inferior in practice. In reality the two solutions are essentially equivalent as regards their mathematical foundation, a remarkable theorem due to Lambert standing as the formal connecting link. Again the difference is a matter of technique rather than of principle.

The determination of orbits, considered in a wide sense, forms a subject so complicated and so closely dependent on other branches of astronomy that comprehensive treatises serving to bring together what experience has shown to be the most practical methods have rendered indispensable service. In England, owing, perhaps, to the too exclusive predominance of one school of thought, little has been contributed to the development of the theory and nothing to its connected presentment. The well-known treatise of Watson we owe to America. Of other works, by far the most notable is that of Oppolzer. Unfortunately, the second volume of this book is now out of print and has become scarce.

In these circumstances a warm welcome must be extended to Dr. Bauschinger's treatise. His position as Director of the Recheninstitut in Berlin, the prominent feature of the work of which is the surveillance of the rapidly accumulating multitude of minor planets, leads us to expect an eminently practical treatment, and we are not disappointed. No great originality will be found, nor was it to be looked for, so far as regards the fundamental methods themselves. The aim of the author has evidently been to follow the path which has been proved by experience, and any originality must be sought in the modes of presentation, which are always elegant, concise, and lucid.

A most important feature of a work of this kind is the choice of illustrative examples of actual computations. In both the liberal selection and the arrangement of these Dr. Bauschinger has done well. The diagrams are neat and clear. The style of printing, a matter of which the importance in the case of a mathematical work can hardly be exaggerated, will bear comparison with the best English examples of a similar class. It is impossible that all errors should have been detected in the course of proof-reading, but though two or three have certainly escaped notice, it is unlikely that there will be any necessity for a list of corrections such as that inserted in Oppolzer's second volume.

Some time ago Dr. Bauschinger published a very useful collection of astronomical tables. Frequent reference is made to these in the present work, which is thus relieved of a large amount of additional matter, while the tables themselves are available in a handier form than as an appendix to a bulky volume. As it is, the author has covered the same ground as Oppolzer's "Bahnbestimmung," and even included some additions within the limits of a single volume. But it is of necessity a large one, and can scarcely fail to suggest the question whether its size could not be reduced by omissions or compression without prejudice to its utility. At first sight this would certainly seem to be the case. The first part, containing a discussion of astronomical coordinates, is occupied with matter which ought to be accessible in general treatises on practical astronomy. The chapter on the method of least squares might be replaced by simple references to some work devoted to that subject, and what is given in the chapter on mechanical integration ought to be found in treatises on the calculus of finite differences. But apart from the fact that this supposes the existence of ideal books which have not yet been written, it is a distinct advantage to be saved the trouble of consulting a number of separate works, even when these are at hand. The fuller treatment must be justified by a severely concise and practical discussion of all subordinate topics, and in this respect little fault will be found with Dr. Bauschinger's handling of his material. It is difficult to believe, however, that some matters of elementary mathematics could not have been omitted without detriment. Thus the discussion, at the beginning of the second part, of the equations of a conic, based on the definition of a conic as the plane section of a right circular cone, must be superfluous for a reader who is capable of following the whole of the first part intelligently. But the fault is doubtless on the right side.

The whole work consists of seven parts. The first deals with those portions of general astronomy which are relevant to the main purpose. The chapters on time and on precession and nutation seem particularly clear and good. That on aberration follows the traditional lines of Gauss and Bessel, and criticism would be out of place here. Yet the exposition of Gauss, which seems to assume the apparent composition of the velocities of light and of the earth as a matter of course, appears to be imperfect in view of the difficulties in the physical theory. Is it not more logical to consider the apparent composition as an inductive result instead of the explanation of the astronomical phenomena?

The second part contains a discussion of undisturbed heliocentric motion. Dr. Bauschinger asserts (p. 170) that Lambert's equation is of little use in the case of ordinary elliptic orbits. This opinion may be disputed. It is true that the development in series is of little assistance owing to slow convergence, but in its original form the equation can be easily solved in all ordinary cases. The natural expression of the formulæ for motion in a hyperbola involves hyperbolic functions. The use of these is entirely avoided, presumably because tables of hyperbolic functions are not as a rule accessible to the computer.

The properties of the apparent or geocentric motion are discussed in the third part. Here will be found Bruns' elegant proof of the theorem of Lambert on the curvature of the apparent orbit. Incidentally it may be remarked that Lambert seems to have missed that measure of fame to which his unquestionable eminence as a mathematician entitles him.

The longest part is the fourth, in which the various methods of determining a preliminary orbit are described. An excellent feature is the compendious arrangement of the working formulæ. This part is followed by that on the adjustment of an orbit by the method of least squares. In both sections numerical examples are fully and clearly worked out.

The sixth part contains the theory of special perturbations. Three methods are given, according to which the perturbations can be calculated in the elements, or in polar or in rectangular coordinates. In the preliminary chapter, on mechanical integration, the usual German notation for interpolation formulæ is employed. It is difficult to see the advantage of this over the ordinary notation of finite differences. The last chapter of this section brings the reader to the determination of the definitive orbit.

Here the work might have ended, but Dr. Bauschinger has added a final part, in which he investigates the determination of the orbits of meteors, satellites, and double stars. These last chapters are necessarily brief, and it may be doubted whether, as regards unity of subject, their inclusion is justified. But that on satellites is certainly valuable, especially in view of recent discoveries.

The source of the numerous theorems which are met with in the work has generally been indicated, but this is not always the case. Thus the theorems on p. 184 are due to M. Radau (Bull. Astr., x. p. 11) and to Mr. Shin Hirayama (Monthly Notices, R.A.S., lxii., p. 620). Such references add greatly to the interest, but of course it is always difficult to be sure that the sources are strictly original. For instance, the proposition attributed (p. 131) to van der Kolk was, as has been recently pointed out, previously given by Whewell. There is an index at the end of the volume, but it is not so complete as it should have been. A full index of names is needed.

An outline of the method of Gibbs will be found in Dr. Bauschinger's work, but for fuller details the pamphlet of Dr. Frischauf may be consulted with advantage. The method is based on the use of a particular expression for the ratio of a triangle to the corresponding sector of an ellipse. The form is mathematically elegant and the degree of approximation is high, but it was thought to entail greater complexity in the computations, while, on the other hand, the method by itself gave little assistance when a still closer approximation proved necessary. This defect was remedied by Prof. Harzer. The modified method is described by Dr. Frischauf in a clear and interesting manner; the practical value of his account would have been enhanced by the addition of a fully worked example. The pamphlet also contains a number of supplementary notes to the author's "Grundriss der theoretischen Astronomie," a work of which a second edition appeared in 1903 after an interval of thirty-two years from its first publication. H. C. P.

INDUCTION AND CONDUCTION MOTORS.

Moteurs a Collecteur a Courants alternatifs. By Dr. F. Niethammer. Pp. 131. (Paris: *L'Éclairage Électrique*, 1906.)

THE title leads one to believe that the author is going to deal with at least all the principal types of modern alternate-current commutator motors, whereas the book is practically restricted to a consideration of the series induction and conduction motors. Shunt induction motors of the commutator type are occasionally touched upon, but all remarks concerning these must be considered as quite erroneous. Generally speaking, the number of mistakes is too great.

In chapter i. the historic part does not deal with the machines out of which those modern single-phase commutator motors have been directly evolved, which are afterwards considered more closely. The preliminary consideration of some of the types now in use is full of errors, and much prominence is given to the least important of these types. The indiscriminate use of the expression "repulsion" motor leads to the usual confusion.

In the second chapter, which is the most important in the whole book, we find the author trying to establish exact diagrams which will cover all types of motors. It may be possible to achieve this, but the task is not an easy one, and the solution offered by the author can certainly not be accepted. Take the two simple diagrams Figs. 32 and 33; the first illustrates the action of the motor shown in Fig. 30, the second (which is not referred to in the text) is probably intended to illustrate the action of the motor shown in Fig. 31. The E.M.F. ($J_a W_a$) in Fig. 32 is responsible for the current J_a flowing in the short-circuited rotor; it must therefore be the resultant of all those E.M.F.'s which are effective so far as the short-circuiting brushes are concerned. These E.M.F.'s are E_r, E_i, E_r', E_i', and E_s'. When the motor is standing, E_r and E_r' are nil, but they increase in direct proportion with the speed, with the result that $J_a W_a$ must, according to the diagram, increase with the speed independently of the load! In other words, the rotor current J_a must increase with the speed, consequently also the stator current J_f. Seeing that the machine is one with a series characteristic, it is very obvious that the diagram in question cannot be correct. In a machine of the kind the tendency of the current is, of course, to diminish with the speed. The fact of the matter is that the phase of E_r' is shown incorrectly. If the direction of rotation is such that E_r is in phase with the flux K_a, then E_r' must be of opposite phase to the flux K_q, for these fluxes are not only at right angles to each other in space, but also nearly at right angles to each other in phase. The presence of this very serious mistake evidently prevented the author from grasping the full meaning of the various vectors of his diagram. (E_i) must be considered as the working E.M.F.; (E_r') is then the back E.M.F., ($E_s'+E_i'$) represents the self-induction of the rotor circuit, whilst E_r (and not E_r', as stated by the author on p. 32) must be looked upon as the compensating E.M.F. It is nearly opposed to ($E_s'+E_i'$), therefore tends to cancel the effect of the self-induction in the rotor and to bring J_a more and more into phase with E_i. Since E_r increases with the speed, it follows that with increasing speed the phase of J_a will approach that of E_i, and that the power factor will rapidly improve.

The writer also fails to agree with the author's Fig. 33. Owing to a mistake similar to that present in Fig. 32, we get the following curious and impossible result. It is obvious that E_r, which appears at the brushes (*aa*), must be responsible for the flux K_q; it is generally admitted that a magnetic field *lags* by about 90 degrees behind the E.M.F. responsible for it, yet in Fig. 33 K_q actually *leads* E_r by nearly that amount. The author also ignores the fact that for the arrangement of brushes shown in Fig. 31 we have *two* currents in the rotor, the one flowing from (*b*) to (*b*), the other from (*a*) to (*a*), the former being the working current, the latter producing K_q.

The value of the next fundamental diagram (Fig. 35) is greatly reduced because the author mistakes, in Fig. 34, the axis K_a for the axis K_q, thus making a comparison between Fig. 34 and Figs. 30 and 31 quite impossible. In Fig. 34 the motor-field axis K_q is the *vertical* axis, and *not* the *horizontal*, as has been assumed by the author, so that E_i' is not nil as stated. No more is E_i nil, although it is now impressed on the rotor by conduction, and not by induction, as in Figs. 30 and 31.

The writer's space is limited, and he must therefore cut his remarks short. The fundamental diagrams of chapter ii. having been proved to be wrong, the value of the whole chapter is naturally greatly discounted. The chapter, however, contains a number of other mis-statements, some of which we will note in passing.

On p. 34 it is stated that the transformer flux in a short-circuited transformer is zero! On p. 42 that the motor shown in Fig. 53 is compensated in the same manner as the Winter-Eichberg machine, whereas compensation is due to the alteration brought about in the phase of the motor field by the introduction into the exciting circuit of the auxiliary E.M.F. derived from S_1. In diagram 43 the E.M.F. (E_r') is shown as being of opposite phase to the E_r' of Fig. 32, although both diagrams refer to the same motor. The remarks on commutation are difficult to follow, because of the attempt to deal with the various types of motors at one and the same time. It is recommended that flux K_a should be chosen low at starting for motors of the series induction type, whereas it is the flux K_q which at that time should be small. Contrary to the author's statement, the commutation difficulties with polyphase commutator motors are just about of the same order as those met with in the series induction motor. In dealing with the power factor (p. 59), the author makes a statement in the last paragraph which reveals a great confusion of ideas. This mistake probably arises out of the confusion of the axes of K_q and K_a already pointed out in connection with Fig. 34; in addition, the notation is now suddenly changed. It is, however, evident that for the case of the series conduction motor (Fig. 34) k_g stands for the field coaxial with the armature brushes and due to the armature ampere turns; k_g is perpendicular to K_q, and by neutralising k_g as shown in Fig. 37 or 39 the power factor is improved as stated. But in a "repulsion" motor such as Fig. 30, k_g does not exist; it is neutralised *ipso facto* because the energy is conveyed into the rotor by induction, and not by conduction as in Fig. 34. Furthermore, if k_g did exist, it would be coaxial with K_a. If k_g is a misprint for K_q, then by neutralising it the torque of the motor would be destroyed, for K_q is the *motor field*. As to speed regulation, and contrary to the author's opinion, any so-called repulsion motor can be satisfactorily controlled by suitably influencing the rotor circuits.

Chapter iii. only deals with motors full descriptions of which have appeared from time to time in the technical Press. As to the notes on the predetermination of alternate-current commutator motors, these are very superficial, and mainly apply to the series conduction machine.

On the whole, the book is more likely to bewilder the reader than teach him anything; it ought to be very thoroughly revised and corrected before it can be recommended. The author will find it easier and more profitable to treat each type of motor separately, and then to point out the differences between the various types, than to try and establish diagrams and formulæ which will meet all cases.

VAL. A. FYNN.

SUBAQUEOUS TUNNELLING.

Tunnel Shields, and the Use of Compressed Air in Subaqueous Works. By W. C. Copperthwaite. Pp. xv+390. (London: Archibald Constable and Co., Ltd., 1906.) Price 31*s.* 6*d.* net.

THIS fine quarto volume furnishes a very valuable and comprehensive history of a system of tunnelling, especially under rivers and in water-bearing strata, which was inaugurated by Sir Marc Isambard Brunel, as regards the employment of a shield, in the celebrated Thames Tunnel between Rotherhithe and Wapping, commenced in 1825, but, owing to the inrush of the river into the works on two occasions through breaks in the stratum of clay, and financial difficulties, only completed in 1843.

The second important step in the development of the system in a practical form was, curiously enough, taken in constructing a second tunnel under the Thames rather higher up the river, crossing just above the Tower, which was commenced in February, 1869, and completed in November the same year. This Tower Subway, originally proposed by Mr. Peter Barlow, but eventually executed by the late Mr. Greathead, whose name will always be prominently associated with the system of tunnelling under consideration, was carried forward through the London Clay under the shelter of a shield, similar in principle to, though much smaller than, the Thames Tunnel shield. The shield in this instance consisted of a short wrought-iron cylinder laid horizontally, $4\frac{3}{4}$ feet long and slightly more than 7 feet internal diameter, stiffened at its front cutting-edge, and provided inside with a vertical plate diaphragm having a central opening, which could be readily closed, through which the men passed for excavating the ground in front preparatory to pushing forward the shield by a series of screws. The novelty consisted in the lining of the tunnel being formed of a series of cast-iron rings, composed of segments bolted together, which were erected under the shelter of the rear part of the cylindrical portion of the shield as it was pushed forward; and as the shield overlapped the lining of the tunnel, and left a slight annular space between the lining and the clay stratum, lime grout was injected through holes provided in the casting, so as to fill up the vacancy left by the shield in its advance. This subway traverses the London Clay throughout, at a minimum depth of 22 feet below the river-bed, no water having been encountered; and it indicates the general method of constructing tunnels by this system. The shield serves to protect the completed end of the tunnel from the fall of earth at the working face, and acts like timbering in supporting the superincumbent mass and preventing settlement above during construction, which is further insured over the completed tunnel by filling the cavities left by the advancing shield with grout.

The system, however, as successfully carried out, in the absence of water, in the Tower Subway, was not adapted for passing through water-bearing strata; and a third step, consisting in the introduction of compressed air, was essential to enable this system to cope effectually with the conditions liable to be encountered in tunnelling under rivers, or at a considerable depth below the surface, in loose ground. The completion of this system of tunnelling, by the combined use of a shield, a cast-iron lining put together under shelter of the shield, and compressed air to exclude the water from the works in traversing water-bearing strata, has enabled abandoned tunnels to be completed, and tunnels to be successfully carried out under such unfavourable conditions as would have been considered impracticable by the methods previously in use. This combination of shield, cast-iron lining, and compressed air, for carrying a tunnel through water-bearing strata, was resorted to by Mr. Greathead for the first time in 1887, in constructing the City and South London Railway, the first of the metropolitan tube railways, where it passes through the loose, water-logged gravel of the Thames basin, overlying the London Clay; and in 1889 it was adopted for continuing the Hudson Tunnel in the silt underlying the Hudson River separating New York from the mainland, when different systems of carrying forward an iron lining by the aid of compressed air, under the shelter of which a brick tunnel was constructed, proved increasingly difficult as the work advanced.

The shield for the continuation of the two single-line Hudson tunnels was $10\frac{1}{2}$ feet long and 20 feet outside diameter; whilst the cast-iron lining has an external diameter of $19\frac{1}{2}$ feet and 18 feet internal diameter, formed of rings $1\frac{1}{2}$ feet long, made up of eleven segments and a key, put in place by a revolving hydraulic erector. This work was stopped for want of funds in 1891, but was resumed in 1903 and completed last year. Where the silt traversed was very soft, the shield was kept closed and pushed forward by sixteen hydraulic rams; and to avoid unequal settlement of the tube under the weight of a train, it has been supported at intervals on iron piles driven down to a hard stratum underlying the silt. Compressed air had been used successfully for many years in constructing foundations and piers of bridges under water, or in water-bearing strata, before it was applied to subaqueous tunnelling; but whereas in bottomless, vertical caissons, the compressed air forces out the water uniformly all over the bottom, the pressure of the air at the open end of a horizontal tube meets with less opposition from the water at the top than at the bottom, where the head of water is greater, in proportion to the diameter of the tube. Accordingly, in large tubes there is a liability in traversing loose soil for the air to escape through the stratum at the top, and for the water to rush in simultaneously at the bottom. To provide for the safety of the men in such a contingency, in addition to two or three platforms at the back of the diaphragm of the shield, with openings at each stage which can be readily closed, a metal screen is hung down the upper half of the tube at the back to provide an air space at the top, to which the men can escape by an air-lock through the screen on the occurrence of an inrush of water, and pass out through an emergency air-lock in the bulkhead behind.

The author has collected together a large quantity of information from a variety of publications, so as to present a fairly complete record of the numerous subaqueous tunnels carried out by means of a shield, and more particularly those where compressed air has been also resorted to, of which there are several interesting examples in Great Britain, France, and the United States, all constructed within the last twenty years. The clear descriptions are very well illustrated by numerous drawings; and the book deserves a cordial welcome from all persons who are concerned or interested in the latest developments of subaqueous tunnelling.

PROBLEMS IN METABOLISM.

Problems in Animal Metabolism. By J. B. Leathes. Pp. viii+205. (London: John Murray, 1906.) Price 7s. 6*d*. net.

THIS volume is the latest of the series that Mr. Murray is issuing in connection with the work of the physiological laboratory of the London University. The subject Dr. Leathes took for his lectures is perhaps the most important one in the whole of chemical physiology. In a study of metabolism one seeks to understand the innermost workings of the living cells, and thus to comprehend the sum total of the chemistry of life. In order, however, to pave the way for such complete knowledge it is necessary to study individual chemical reactions, the items that go to form the final sum; and so in the interesting book Dr. Leathes has produced he is mainly concerned with a separate consideration of the way in which the carbohydrates, fats, and proteids are utilised, and finally catabolised.

The author has taken infinite pains to get his facts correct, and has presented the subject in an extremely clear way. He is able to point out quite lucidly how far present knowledge carries us, and where speculation steps in to fill up the gaps. One becomes conscious of the width of these gaps when one realises that any exact knowledge of how simple substances like sugar are ultimately converted into water and carbon dioxide in the body is at present lacking. In the case of the more complex materials, such as the proteids, hypotheses are still more numerous, because our facts are still scantier.

The whole work is full of pregnant suggestions, and the writing is so attractive that one can confidently recommend it to all those who desire a picture of exactly where physiology stands at the present day in relation to these important matters.

The spirit of the physiological chemist should not be to make this branch of science an offshoot of chemistry, but to use organic chemistry as the means to an end. This is the correct attitude that Dr. Leathes assumes throughout. In the remote past so-called physiology was largely anatomy. When all that anatomy could contribute had been learnt, it was found that the real work of the physiologist was only beginning. So, too, as Dr. Leathes points out, we look forward to a future in which chemistry will have contributed its share, and the workers will discover that physiology has still problems before it which cannot be learnt from pure chemistry, any more than the whole of physiology can be learnt by dissections.

The subject of proteid metabolism is in the air just now, so it is specially interesting to ascertain what views Dr. Leathes holds in relation to it. He accepts the view which is daily gaining greater credence, that in digestion the albuminous molecule is broken up into quite simple substances, mainly of the amino-acid variety. He believes that these are absorbed as such, and that the work of proteid synthesis is carried out by the living cells of the tissues from these crystallisable products transported to them by the blood and lymph. He admits this hypothesis is in the unproven condition, but has himself been successful in showing that the nitrogen of the blood, combined in amino-acids and molecules of that order, is increased during absorption. To identify the individual amino-acids is a matter of much greater difficulty, and a simple calculation shows how greatly even the most abundant of them must be diluted by the whole mass of the blood even during the progress of the absorption of a considerable meal.

His views on the catabolism that proteids undergo very largely coincide with those of Folin. The nitrogen of ingested albumin is readily split off with comparatively little loss of energy and discharged *viâ* the liver as urea. The non-nitrogenous residue is therefore available as a source of heat and energy in much the same way as fat and carbohydrates are. Until, therefore, we know how the cells dispose of such simple organic compounds as fat, our knowledge regarding the fate of the fat-like moiety of proteids must be in abeyance. Dr. Leathes puts this much more fully, but very clearly, which makes one wonder why, in another part of the book, all his arguments are against the possible origin of fat from proteid intra-cellularly.

Is it, then, advisable to limit our proteid intake to the low level advocated so forcibly by Chittenden? Should we take only sufficient to balance the small amount of proteid waste that is associated with tissue activity? In his answer to this question Dr. Leathes has taken an independent and original line. He admits that the necessary minimum is much less than the conventional dietary of 100 grams daily, but he thinks it does not necessarily follow that it is unphysiological to take more than the minimum, any more than it is unphysiological to take any food which yields more than the minimum of fæcal refuse. In the infant, the dietary provided by nature in the amount of milk it takes is, even after making due allowance for growth, at least ten times greater than the minimum. The minimum can therefore hardly be normal for the adult; and a possible reason for this is that there may be a few members of the amino-acid group which are required in large amounts for cell repair, and that it is only the commoner amino-acids which are not required in the amount usually taken, and which are consequently so rapidly discharged from the body.

This example of the manner in which the puzzles of metabolism are grappled with will be sufficient to show the character of the book, and one hopes that those interested in these fundamental questions will themselves study in full what a reviewer is only able to state imperfectly in barest outline or in samples.

W. D. H.

OUR BOOK SHELF.

Poverty and Hereditary Genius; a Criticism of Mr. Francis Galton's Theory of Hereditary Genius. By F. C. Constable. Pp. xvi+149. (London: Arthur C. Fifield, 1905.) Price 2s. net.

THE criticism which Mr. Constable brings forward in this book is that reputation is not a test of ability, and as Galton's theory of hereditary genius is based on this assumption, it has to be discarded. The statistical evidence given in "Hereditary Genius" has to be explained away, and Mr. Constable attempts to do this by what he calls the "swamping effect of poverty." We quite agree with Mr. Constable that it is harder for a poor man with uninfluential parents to achieve success as a judge than for a rich one with influence, but this does not seem to us to justify Mr. Constable in discarding the conclusions of "Hereditary Genius," for if the social conditions of both parents and offspring are relatively about the same, it seems as if the omission of the ability in poverty-stricken parents and their children is rather like leaving out of account the addition of numbers to both the numerator and denominator of a fraction. The omission may therefore not affect the result at all, and whether fuller statistical evidence should modify Mr. Galton's conclusions is a matter which can only be decided by statistics other than those which Mr. Constable discusses. He appears, however, to have overlooked altogether in his argument that other statistics exist and tend to show that psychical and physical characteristics are inherited in the same way, a point which seems to us to upset a good deal of Mr. Constable's criticism.

Mr. Constable does not refer to Mr. Galton's other books, and apparently quotes from the 1869 edition of "Hereditary Genius." It is a pity that Mr. Constable does not always succeed in expressing himself very clearly, and his habit of putting his arguments in the form of questions becomes somewhat tiresome, and makes the book seem a rather disjointed composition.

Modern Cosmogonies. By Agnes M. Clerke. Pp. vi+287. (London: A. and C. Black.) Price 3s. 6d. net.

THIS popular account of the structure of the universe, so far as it can be understood with the means of inquiry now at the disposal of astronomers, should serve a useful purpose in directing attention to the position of the most difficult problem of celestial science. To early philosophers it was sufficient to regard the heavens as a solid and crystalline firmament in which the stars are fixed; facts of observation were not considered essential for the metaphysical foundation upon which the great minds of antiquity sought to support their universe. The ingenious framework of solid concentric spheres and epicyclic motions was shown to be a baseless fabric by Tycho Brahe's considerations of the orbits of comets, and was finally discredited by the law of gravitation.

What may be regarded as the modern era of scientific cosmogony, in which serious attempts were made to explain what is seen on the background of space, opened about a century and a half ago with Wright's "cloven disc" theory of the Milky Way and Lambert's view of it as a sidereal ecliptic. These considerations of the nature of the universe are related to those of its origin adumbrated by Swedenborg and Kant as the nebular hypothesis, and afterwards worked out in mathematical detail by Laplace. During the past few years several objections of a mathematical and physical nature have been raised to this hypothesis, which has proved to be vulnerable at many points. In Miss Clerke's words, "It has, indeed, become abundantly clear that the series of operations described by Laplace could scarcely, under the most favourable circumstances, have been accomplished, and in a thin nebulous medium would have been entirely impossible. The nebular cosmogony has not, then, stood 'Foursquare to all the winds that blew.' Its towers and battlements have crumbled before the storms of adverse criticism. It survives only as a wreck, its distinctive features obliterated, although with the old flag still flying on the keep."

Tidal evolution, the meteoritic hypothesis, and other views developed in recent years to satisfy the demand for a cosmogony consistent with existing knowledge of the heavens, particularly with spectroscopic observations, are described by Miss Clerke. While we cannot subscribe to all her judgments and interpretations, her work contains a large amount of material, both observational and speculative, and general readers will find much to interest them in it.

R. A. G.

The Geometry of the Screw Propeller. By W. J. Goudie. Pp. 47. (London and Glasgow: Blackie and Son, Ltd.) Price 1s. 6d. net.

THIS is a small book presenting "a simple exposition of the geometrical principles connected with the screw propeller, and illustrating the various ways in which these may be applied to obtain a correct delineation of the propeller on paper, in the drawing office, and in the foundry." It is intended principally for the use of engineering students in technical schools, but is likely to prove useful in other directions, since it contains a clear and admirably illustrated account of the geometry of screw propellers.

The writer is a lecturer on mechanical engineering in Paisley Technical College, and possesses a good knowledge of workshop practice in addition to thorough familiarity with the geometry of his subject. He does not attempt any discussion of the design of a screw propeller most suitable for a new ship, but restricts attention to the preparation of drawings, patterns, and moulds required in the manufacture of propellers for which the dimensions and forms have been determined. This is a wise discretion, for while the geometry of screw propellers admits of exact treatment, the selection of the most efficient propeller for an individual steamship is even now a matter not admitting of exact scientific treatment when precedent has to be departed from; experiments alone can be trusted.

Mr. Goudie describes in clear and simple language the methods by which helical surfaces of uniform or variable pitch may be constructed, and illustrates in detail the practical methods of moulding the blades in the foundry. For the benefit of students who may not have the opportunity of actual work in the foundry the author indicates how, with the aid of a few simple tools and materials, skeleton models of the various types of screw surfaces can be constructed. He also gives detailed explanations of the work requiring to be done in the drawing office of an engine factory in connection with the design of screw propellers. While securing sufficient accuracy for all practical purposes, he shows how approximate methods may be substituted in many cases for exact geometrical methods.

The little book may well be placed in the hands of all engineering draughtsmen and apprentices whose training includes attendance at technical schools, as well as workshop practice.

Geographical Gleanings. By Rev. F. R. Burrows. Pp. 75. (London: G. Philip and Son, Ltd., 1906.) Price 1s. 6d. net.

MUCH yet remains to be done before geography is taught and studied in schools according to reasonable methods. Everybody agrees that geography, like most other subjects, can be made a valuable educational instrument provided that it is taught by practical methods and that the teachers are familiar with its realities. Mr. Burrows describes some methods of teaching geography, and shows how the subject may be usefully approached. There is little new in his views or advice; nevertheless, the book may serve to place aspiring teachers in a position to give satisfactory lessons in geography.

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.*]

Chinese Observation of Nature.

I AM venturing to send you two quotations from "L'Empire Chinois," by M. Huc.

(I) Refers to an instance of mutation, and seems to me to be markedly interesting on account of the date of the observation recorded, and the use made of the discovery.

(II) Refers to a different matter—*Polype vinaigre.* Possibly this creature is well known to scientific workers, but I have failed to identify it, although I have searched all reference books at hand. Unfortunately, we have no scientific reference library, and I venture to hope that a reader of NATURE will tell us what it is!

W. HOSKYNS-ABRAHALL.

14 Woodstock Road, Redland Green, Bristol.

I.

Les Chinois doivent principalement à leur caractère éminemment observateur leurs nombreuses découvertes en agriculture, et le parti qu'ils savent tirer d'une foule de plantes négligées en Europe. Ils aiment à examiner et à étudier la nature. Les grands, les empereurs même, ne dédaignent pas d'être attentifs aux plus petites choses, et ils recueillent avec soin tout ce qui peut avoir quelque utilité pour le public. Le célèbre empereur Khang a ainsi rendu plus d'un service important à son pays. On trouve dans de curieux mémoires écrits par ce prince, le passage suivant :

"Je me promenais, dit l'Empereur Khang-hi, le premier jour de la sixième lune, dans des champs où l'on avait semé du riz qui ne devait donner sa moisson jusqu'à la neuvième. Je remarquai, par hasard, un pied de riz qui était déjà monté en épi. Il s'élevait au-dessus de tous les autres et était assez mûr pour être cueilli; je me le fis apporter. Le grain en était très-beau et bien nourri; cela me donna la pensée de le garder pour un essai, et voir si, l'année suivante, il conserverait ainsi sa précocité; il la conserva en effet. Tous les pieds qui en étaient provenus montèrent en épis avant le temps ordinaire, et donnèrent leur moisson à la sixième lune. Chaque année a multiplié la récolte de la précédente, et, depuis trente ans, c'est le riz qu'on sert sur ma table. Le grain en est allongé et la couleur un peu rougeâtre; mais il est d'un parfum fort doux et d'une saveur très-agréable. On le nomme *Yu-mi*, 'riz impérial,' parce-que c'est dans mes jardins qu'il a commencé à être cultivé. C'est le seul qui puisse mûrir au nord de la grande muraille, où les froids finissent très-tard et commencent de fort bonne heure; mais, dans les provinces du midi, où le climat est plus doux et la terre plus fertile, on peut aisément en avoir deux moissons par an, et c'est une bien douce consolation pour moi que d'avoir procuré cet avantage à mes peuples."

L'Empereur Khang-hi a rendu, en effet, un service immense aux populations de la Mantchourie, en propageant la culture de cette nouvelle espèce de riz, qui vient à merveille dans des pays secs, sans avoir besoin d'irrigations perpétuelles comme le riz ordinaire.

Huc, "L'Empire Chinois," vol. ii., p. 359, second édition, 1854.

Kang-hi—1661–1721—"was indefatigable in administering the affairs of the empire, and at the same time he devoted much of his time to literary and scientific studies under the guidance of the Jesuits."

Article "China," "Encyclopædia Britannica," ninth edition.

II.

Polype vinaigre.

Le tsou-no-dze est un être qui, à raison de sa bizarre propriété de fabriquer d'excellent vinaigre, mérite une mention particulière. Ce polype est un monstreux assemblage de membranes charnues et gluantes, de tubes et d'une foule d'appendices informes qui lui donnent un aspect hideux et repoussant; on dirait une masse inerte et morte. Cependant, quand on la touche, elle se contracte ou se dilate, et se donne des formes diverses. C'est un animal vivant, dont la structure et l'existence ne sont pas plus connues que celles des autres polypes. Le tsou-no-dze a été découvert dans la mer Jaune, et les Chinois le pêchent sur les côtes du Leao-tong; mais on n'en prend qu'un petit nombre. Peut-être sont-ils plus abondants ailleurs, où l'on néglige de les prendre faute de connaître leur propriété. On place ce polype dans un grand vase rempli d'eau douce à laquelle on ajoute quelques verres d'eau-de-vie. Après vingt ou trente jours, ce liquide se trouve transformé en excellent vinaigre, sans qu'il soit besoin de lui faire subir aucune manipulation, ni d'y ajouter le moindre ingrédient. Ce vinaigre est clair comme de l'eau de roche, d'une grande force et d'un goût très-agréable. Cette première transformation une fois terminée, la source est intarissable; car, à mesure qu'on en tire pour la consommation, on n'a qu'à ajouter une égale quantité d'eau pure, sans addition d'eau de vie. Le tsou-no-dze, comme les autres polypes, se multiplie facilement par bourgeons, c'est-à-dire qu'il suffit d'en détacher un membre, un appendice, qui végète, en quelque sorte, grossit en peu de temps et jouit également de la propriété de changer l'eau en vinaigre. Ces détails ne sont pas uniquement basés sur les renseignements que nous avons pu recueillir dans nos voyages. Nous avons possédé nous-mêmes un de ces polypes; nous l'avons gardé pendant un an, faisant usage journellement du délicieux vinaigre qu'il nous distillait. Lors de notre départ pour le Thibet, nous le laissâmes en héritage aux chrétiens de notre mission de la vallée des Eaux-Noires.

"L'Empire Chinois," Huc, vol. ii., chap. x., pp. 414–415.

A Large Meteor.

ON Sunday, August 5, at 10h. 33m., I saw what I presume to have been a fine and rather early Perseid. It crossed the star λ Aquilæ, and the flight was recorded from about $287\frac{1}{2}^\circ - 2^\circ$ to $282^\circ - 9\frac{1}{2}^\circ$. The meteor was much brighter than Venus, and left a streak of 5° visible for some twenty seconds, though the full moon was shining brilliantly at the time.

I would be much interested in hearing of any other observations of this meteor. It was probably situated over the English Channel, and must have presented a magnificent appearance as seen from the counties of Somerset, Dorset, and Devon.

W. F. DENNING.

44 Egerton Road, Bishopston, Bristol, August 6.

ATMOSPHERIC PRESSURE CHANGES OF LONG DURATION.

In previous numbers of this Journal (vol. lxvii., p. 224, and vol. lxx., p. 177) I described a barometric variation of short duration and world-wide in extent which behaved in a see-saw manner in an easterly and westerly direction between antipodal parts of the earth. The investigation, which included the examination of pressure changes at ninety-five stations scattered over the globe, indicated that there was a transference of air from west to east and from east to west alternately, a surge, in fact, raising and lowering the mean annual pressure values. Thus, when the pressure in any year in India the East Indies, and Australia behaved alike, while the South American region behaved in an inverse manner. The present inquiry was therefore limited to these areas. For the first three a considerable amount of data is available, but this is not the case for the last-mentioned region; to mitigate this deficiency, curves for several separate stations have had to be employed in order to determine over several years the variation in operation there.

The first step taken to prepare the data for this comparison was to eliminate so far as possible the variation of short duration. This was satisfactorily accomplished by grouping the years in sets of four, and employing the mean values of each of these groups; thus the means for the years 1873 to 1876,

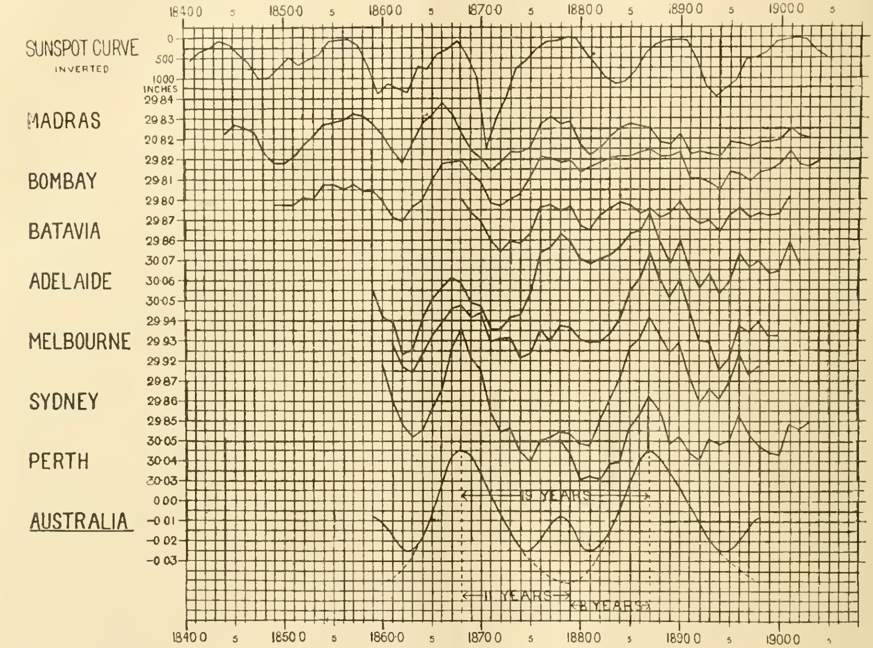


FIG. 1.—Long barometric changes which occur in the Indian, East Indian and Australian areas. The Indian variation is compared with the *inverted* sun-spot curve.

or Australia was in excess, that recorded in South America showed a deficiency.

During this inquiry it was noticed that there were changes going on which extended over a longer period of time than the short one (about 3.8 years) to which reference above has been made. In order to find out whether these long variations were similar all over the earth, or whether they also were of an opposite nature in different areas, several sets of long series of pressure observations have been carefully examined. The result of this limited survey recently formed the subject of a communication by the writer to the Royal Society,[1] and the following is a brief account of the results arrived at in the paper.

In the case of the variation of short duration, India, 1874 to 1877, &c., were determined. The curves here shown are all composed of such means, and are formed by connecting the points plotted on squared paper; the same scales are employed throughout.

Fig. 1 illustrates the series of curves, all drawn on the same scale, for the Indian, East Indies, and Australian areas. Bombay and Madras represent the pressure changes of the first, Batavia the second, and Adelaide, Melbourne, Sydney, and Perth are types for Australia.

An examination of these curves leads one to the following conclusions:—

First, the Indian curves are very alike, and suggest a variation of an oscillatory nature, the maxima or minima occurring about every ten or eleven years. Second, the amplitude of these curves, that is, the difference between the maximum and minimum

[1] "Barometric Variations of Long Duration over Large Areas." By Dr. William J. S. Lockyer. Read June 21, 1906.

values, has decreased considerably of recent years, and has nearly obliterated the eleven-year variation.

Going further afield, the curve for Batavia (East Indies) is very similar to that of Bombay. Coming

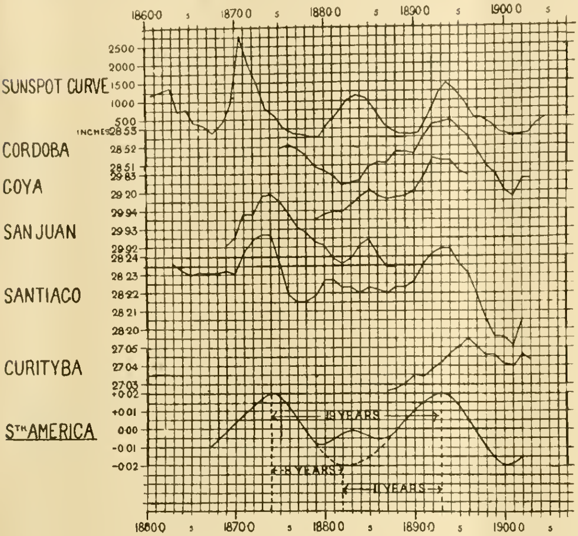


FIG. 2.—Long barometric variations in operation in South America.

to the Australian continent, it will be noticed that the eleven-year variation is well indicated in the Adelaide curve, but the amplitudes are much greater. Particular attention is directed to the maximum about the years 1876–1878, because in the curves for Melbourne, Sydney, and Perth this becomes quite insignificant. In fact, it is the dropping out of this maximum which gives the Australian curves quite a different appearance from those of India, although in many other respects they closely resemble the Indian changes.

The Australian curves thus indicate two principal maxima about the epochs 1868 and 1887, with an intermediate subsidiary maximum about 1878; the principal maxima are thus *nineteen years apart.* The curve given at the bottom of Fig. 1 is drawn to represent in a general manner this variation, and to serve as a comparison to the other curves which follow.

An examination of the South American pressures was next undertaken. Here, as I have said before, the data are not too numerous, but I think they are sufficient to demonstrate a long variation that is in operation and the epochs of the maxima and minima.

The same method of four-year means was employed as before, and curves drawn for five stations. Three series of observations represent the Argentine Republic stations Cordoba, Goya, and San Juan, while Santiago (Chili) and Curityba (Brazil) are also used, as they are stations situated more westerly and easterly respectively. Curves representing barometric changes at these places are all given in Fig. 2, and are drawn on the same scale. Although they extend over different periods of time, there is sufficient overlapping in all cases to allow one to draw conclusions as to the general kind of variation over this area.

As was done in the case of Fig. 1, a curve is here drawn at the foot of the South American curves to show the general nature of the variation in this region. Two principal maxima are very obvious about the years 1874 and 1893, while there seems to be an indication of a subsidiary maximum the mean of which is about the year 1883. We are here in the presence of a barometric change of long duration the principal maxima of which are also about *nineteen years apart*, so far as these observations inform us.

The question now arises, How does this South American variation compare with those shown to exist in India and Australia? This can be easily answered by comparing the curves brought together in Fig. 3.

The first point of importance is that the South American and Australian curves have principal maxima about nineteen years apart, while situated between them is another maximum of a subsidiary nature. The second is that the epochs of these maxima in these two widely separated areas *are not coincident.* Further, we are not here in the

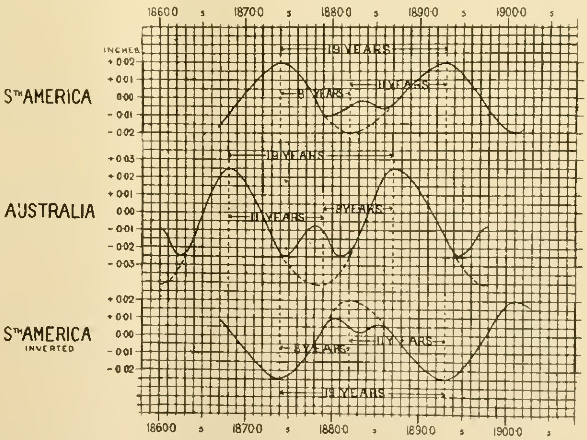


FIG. 3.—The barometric changes in Australia and South America compared with each other.

presence of a barometric see-saw, or opposite pressure variation, because the Australian maxima do not occur simultaneously with the South American minima; there seems to be a general time-difference of phase amounting to about six years, the epochs of the Australian maxima preceding those of the South American region. If a see-saw did exist, then the *inverted* South American curve should represent the Australian variation. That this is not so will be seen by comparing the two lower curves in Fig. 3.

It will thus be seen that the South American pressure type is closely similar to that existent in Australia, but unlike that in operation in India.

The magnitudes of these changes of pressure from year to year are by no means insignificant. The following table shows in compact form approximate measures of the amplitudes of the curves in the cases of both the short and long variations. The third and fifth columns of figures represent, in percentages of the annual variations, the amplitudes given in the second and fourth columns of figures:—

Pressure Amplitudes.

Station	Mean Annual Variation	Short Variation	Per cent.	Long Variation	Per cent.
	Inches	Inches		Inches	
Bombay	0·283	0·033	11·7	0·026	9·2
Madras	0·297	0·036	12·1	0·026	8·8
Means			11·9		9·0
Adelaide	0·226	0·077	34·0	0·054	23·1
Melbourne	0·204	0·076	37·2	0·043	21·1
Sydney	0·212	0·071	33·0	0·058	27·3
Means			34·7		23·8
Cordoba	0·177	0·037	20·9	0·032	18·1
Curityba	0·188	0·028	14·9	—	—
Goya	0·248	0·038	15·3	—	—
San Juan	0·236	0·046	19·5	0·039	16·5
Santiago	0·128	0·042	32·7	0·045	35·1
Means			20·6		23·2

Summary.

	Per cent.	Per cent.
India	11·9	9·0
S. America	20·6	23·2
Australia	34·7	23·8

The brief summary at the foot of the table indicates an approximate mean value of the percentages for each region. In the case of Australia, for example, the fact is made apparent that the amplitude of the variation of short duration amounts to as much as 35 per cent. of that of the mean annual variation, while the variation extending over nineteen years reaches nearly 25 per cent. Such large pressure changes must therefore play an important part in producing variations in the seasonal weather from year to year.

With regard to the origin of these long barometric changes, it is interesting to note that the Indian pressure curves resemble in general the inverted curve representing solar activity as deduced from the area of sun-spots. This fact has for many years been known, and was pointed out by Brown, Hill, Eliot, Blanford, Douglas Archibald, and others. It will be seen from the curves, however, that the resemblance was far more striking before the year 1880 than after it.

Since the Australian curves are allied to but somewhat modified forms of the Indian variation, it seems possible that this modification may be due to some terrestrial cause.

Mr. H. C. Russell, who is a strong advocate of a nineteen-year cycle of weather in Australia, has been led to discard solar action and to consider the moon as being the prime mover or origin of this cycle, a suggestion which he put forward in 1870, and again in 1896.

The present discussion of the barometric pressures seems to indicate that the family likenesses between the Australian and Indian curves, here shown in Fig. 1, and between the Indian curves and the inverted sun-spot curve, are sufficient to suggest for the Australian nineteen-year variation a solar origin with a terrestrial modification without having to appeal to lunar action.

William J. S. Lockyer.

SIR WALTER LAWRY BULLER, K.C.M.G., F.R.S.

Sir Walter Lawry Buller, who died on July 19 at Pontdail Lodge, Hampshire, will be remembered long in the scientific world on account of his accurate and sumptuous works on the ornithology of New Zealand. He was a son of the Rev. James Buller, of Canterbury, in the Southern Island, and was born in 1838. He was proud of being a New Zealander, and passionately devoted to all that concerned Maoriland. At the age of twenty-four, and for ten years subsequently, he filled the post of Resident Magistrate and Native Commissioner and Judge of the Native Land Court of New Zealand. Few had so intimate a knowledge of the Maoris as he possessed. In 1865, during a critical period of the Maori War, when Sir George Grey, the Governor, determined to take a personal hand in the contest in his endeavour "to quicken the slow dragging on of the military operations," Sir Walter served as a volunteer on his staff, and had the honour of being mentioned in despatches.

From an early age Sir Walter was a close observer of the birds of his native country. Fired no doubt by the example of (among others) Mr. Potts, an enthusiastic student and recorder of the habits of the birds of Canterbury, he, it would seem, very early conceived the ambition of making himself the authority on the birds of New Zealand. He was only thirty-four years old when, during the years 1872–3, the publication of his "History of the Birds of New Zealand," a quarto volume illustrated by coloured plates by Keulemans, placed him at once in the undisputed position of ornithologist *par excellence* of the colony. In bringing this splendid work to its successful birth he was greatly aided by the wide experience of his friend Dr. Bowdler Sharpe. The persistent exploration of the recesses of the country and his own continued study of its avifauna soon showed him that he had made but a contribution to the history he had undertaken. After fifteen years he brought out a second edition, in two costly folio volumes, also profusely illustrated by Keulemans, which attained a success which few bird books have ever met with. For seventeen years more Sir Walter continued gathering in the aftermath of his already great harvest, the results of which he had determined to issue as a supplement in two volumes, which, superbly illustrated like their predecessors, were only quite recently distributed.

Early in the year Sir Walter Buller was taken seriously ill, and only a few months ago the writer was permitted, during what was hoped by the sufferer himself and his friends was a true convalescence, to see him, alas! for the last time. He was dictating from his couch the concluding pages of the final volume of his supplement "to get them off his mind." Unfortunately, a relapse supervening he was removed into the country to the home of Mrs. Madocks, the daughter to whom the supplement is "affectionately dedicated," "his constant companion during its preparation, and the contributor of some beautiful photographs of New Zealand scenery to its pages." It was hoped that the change would restore the patient sufficiently to enable him to take a long, curative sea voyage. These hopes have been disappointed, and this distinguished ornithologist's life closed at the comparatively early age of sixty-eight years, with the last page of the work on which he laboured so enthusiastically for half a century.

Sir Walter Buller published many natural history papers, especially in the Transactions of the New Zealand Institute, on other subjects besides his favourite birds. He was elected to the Fellowship of the Royal Society in 1879, and the honorary degree of D.Sc. was conferred by Cambridge in 1903 in recognition of his scientific work.

Besides being a busy City man, Sir Walter held many public offices. He acted as Commissioner for New Zealand at the Colonial and Indian Exhibition of 1866, on the executive council of the Paris Exhibition in 1889, and for five years on the governing body of the Imperial Institute. He was created K.C.M.G. in 1886. A large donor to many museums at home and abroad, he received decorations from many foreign States in recognition of his generosity.

F.

THE YORK MEETING OF THE BRITISH ASSOCIATION.

The seventy-sixth meeting of the British Association may be described as a very successful one. The Association was founded in York in 1831. It visited York again in 1846, and also in 1880. On the present occasion the citizens, who are proud of the connection of their ancient city with the association, welcomed the members with the greatest cordiality and hospitality. The meeting was favoured with exceptionally good weather, and as the programme left little to be desired, those who visited York on this occasion carried away with them very pleasant memories.

The old city looked its best. Socially, the meeting was everything that guests and hosts alike could have wished. The attendance at the meeting was 1959; that at the meeting in 1831 was 359.

We gave in our last number Prof. E. Ray Lankester's presidential address, as well as the names of the distinguished foreign men of science who attended the meeting, a number of whom received honorary degrees at Leeds University on Saturday, August 4.

The exhibition building proved very satisfactory; it would, in fact, be difficult to find a building better adapted for such a *rendezvous*. The reception room was adequate in all respects, and the great hall, handsomely decorated, had the appearance of a new building. Shrubs and bamboos with a well-judged sprinkling of *Lilium speciosum* relieved the eye, and hanging baskets at intervals depended from the galleries. The best thanks of citizens and visitors alike are due to the local secretaries, Mr. Charles E. Elmhirst and Mr. Henry Craven (Town Clerk of York), as well as to the acting secretary, Mr. Fred. Arey, whose experience in such matters proved invaluable

The two evening discourses in the great hall of the exhibition buildings were delivered by Dr. Tempest Anderson and Dr. A. D. Waller, F.R.S., the subject of the former being "Volcanoes," while that of the latter was "The Electrical Signs of Life, and their Abolition by Chloroform." Large and attentive audiences packed the building, and showed every sign of interest in the subjects laid before them. The photographs of the late eruption of Vesuvius and its results were specially attractive.

The various sections were attended by large audiences, and offered so many subjects of interest that it is difficult to say which proved the most generally attractive. In many of the sections the presidents, in their opening addresses, dealt with the advance of science during the period of twenty-five years which has elapsed since the last meeting of the society in York.

At a meeting of the General Committee on August 1, the report of the Council was read. Action has been taken by the Council in accordance with the recommendations made in the following resolutions from Sections A and H:—

From Section A.—(1) The Committee, being of opinion that the completion of the Geodetic Arc from the South to the North of Africa is of the utmost scientific importance, and that the establishment of a Topographical Survey is of an importance that is at once scientific and economic, respectfully request the Council to make representations in such form as they think fit to urge upon the British South Africa Company the desirability of taking advantage of the present favourable opportunity for joining up the triangulation north and south of the Zambesi, and also to urge upon the Governments of the South African Colonies the immense practical and economic importance of commencing the topographical survey.

(2) The Committee desire to draw attention to the importance of a Magnetic Survey of South Africa, and respectfully request the Council of the Association to approach the Cape Government with a view to urging on them the great advantages which would accrue to Science and to South Africa if the Government would further support and assist the Survey which has already been partly made by Prof. Beattie and Prof. Morrison, and for the continuation of which a Special Committee of the Association is being appointed to cooperate with these gentlemen.

A grant of 300*l.* from the Special South Africa Fund has been made by the Council to Sir David Gill, for the purpose of completing the connection between the Rhodesian and Transvaal triangulations along the thirtieth meridian of East longitude.

From Section H.—(1) That it is desirable that the Governments of the South African Colonies be urged to take all necessary steps to collect, record, and preserve the knowledge and observations of men, such as missionaries, administrators, and others, who were living in intimate relations with the native tribes before the advance of civilisation began to obscure and even obliterate all true traditions, customs, and habits of the South African peoples; such steps to be taken without delay, especially in view of the old age and growing infirmities of most of the men referred to, and of the danger that with their deaths the knowledge which, if carefully recorded and preserved, would form a most valuable contribution towards the history of the aboriginal population, would be irrecoverably lost; and that the Council be recommended to communicate with the South African Association and suggest the appointment of a committee to deal with the matter.

(2) That, owing to the use by different writers and Government authorities of various names for the same groups of South African natives, much confusion and difficulty have arisen in anthropological and historical literature; that it is consequently desirable that Government authorities and others should confer as to the proper nomenclature of such groups (clans, tribes, and nations), with a view to ascertaining their inter-relationships, and to suggesting the most appropriate name for each group, and the best method of spelling that name phonetically; and that the Council be recommended to communicate with the South African Association and take such other steps as may conduce to this object.

(3) That the Committee are of opinion that it would conduce to the greater efficiency of officers who have to administer native affairs, and contribute to the advancement of anthropological science, as well as prove of considerable advantage to the well-being of the natives themselves, if opportunity could be given to such officers before or after their appointment to study comparative ethnology for at least two terms in one of the Universities of the United Kingdom which presents facilities for the study; and that in the case of junior officers already on active service such a course of study would facilitate their comprehension of native institutions and ideas, and help to render their services more efficient; and the Committee recommends the Council to take steps for the purpose of bringing this matter before the proper authorities.

At the meeting of the General Committee on August 3, the date of the opening meeting at Leicester next year was fixed for July 30. Sir David Gill, K.C.B., F.R.S., will be the president. The meeting in 1908 will be in Dublin, and that of 1909 at Winnipeg, Canada.

Subjoined is a synopsis of grants of money appropriated to scientific purposes by the General Committee :—

	£	s.	d.
Section A.—Mathematical and Physical Science.			
Electrical Standards	50	0	0
Seismological Observations	40	0	0
Magnetic Observations at Falmouth	40	0	0
Magnetic Survey of South Africa...	25	7	6
Further Tabulation of Bessel Functions... ...	15	0	0
Section B.—Chemistry.			
Wave-length Tables of Spectra	10	0	0
Study of Hydro-aromatic Substances	30	0	0
Dynamic Isomerism...	30	0	0
Section C.—Geology.			
Life Zones in British Carboniferous Rocks ...	12	7	7
Erratic Blocks	21	16	6
Fossiliferous Drift Deposits	25	19	0
Fauna and Flora of British Trias	10	0	0
Crystalline Rocks of Anglesey	7	18	11
Faunal Succession on the Carboniferous Limestone of S.W. England	15	0	0
Correlation and Age of South African Strata, &c.	10	0	0
Investigation of the Speeton Beds at Knapton...	10	0	0
Section D.—Zoology.			
Index Animalium	75	0	0
Table at the Zoological Station at Naples ...	100	0	0
Development of the Frog	5	14	6
Respiratory Phenomena and Colour Changes in Animals	11	2	0
Experiments on the Development of the Sexual Cells	5	0	0
Section E.—Geography.			
Oscillations of the Land Level in the Mediterranean Basin	50	0	0
Rainfall and Lake and River Discharge ...	10	0	0
Section F.—Economic Science and Statistics.			
International Trade Statistics	15	0	0
Gold Coinage in Circulation in the United Kingdom	10	0	0
Section H.—Anthropology.			
Excavations in Crete	100	0	0
Glastonbury Lake Village...	30	0	0
Excavations on Roman Sites in Britain... ...	15	0	0
Anthropometric Investigations	17	17	3
Age of Stone Circles	3	0	0
Anthropological Photographs	3	3	6
Section I.—Physiology.			
Metabolism of Individual Tissues...	45	0	0
The Ductless Glands	25	0	0
Effect of Climate upon Health and Disease ...	55	0	0
Section K.—Botany.			
Physiology of Heredity	30	0	0
South African Cycads, &c....	35	0	0
Botanical Photographs	5	0	0
Structure of Fossil Plants	5	0	0
Peat Moss Deposits	7	5	7
Marsh Vegetation	15	0	0
Section L.—Educational Science.			
Studies suitable for Elementary Schools... ...	10	0	0
Conditions of Health in Schools	5	0	0
Corresponding Societies Committee.			
For Preparation of Report...	20	0	0
Total	1061	12	4

SECTION A.

MATHEMATICS AND PHYSICS.

OPENING ADDRESS BY PRINCIPAL E. H. GRIFFITHS, Sc.D., F.R.S., PRESIDENT OF THE SECTION.

MY predecessors in this Chair have in general been able to make communications to the Section conveying the results of investigations of their own, or enunciating some principle which would throw a fresh light on the discoveries of others. Mine is a far less happy lot. During the past four years and a half I have been engaged in administrative duties of such a nature that no time has been available for personal scientific work, and little energy even for the study of the work of others. In these circumstances it might have seemed more fitting if I had refused the honour which the Council of the British Association conferred upon me by the request that I would undertake the arduous duties which fall to the lot of the President of Section A. Nevertheless, after much hesitation, I decided to accept the invitation, in the hope that as a looker-on at the struggle of others, and with the experience of an old participator in the fray, I might be able to communicate some impressions which had possibly escaped the notice of those whose attention was necessarily more directed to some special branch of inquiry.

I trust that these words of apology may to some extent explain the nature of what must appear a fragmentary discourse.

In the interval which has elapsed since the last meeting of the Association we have lost many men whose names were household words within the walls of the physical laboratory. It is here only possible briefly to refer to the labours of a few of those distinguished seekers after natural knowledge.

The work of Dr. Sprengel has been by no means an unimportant factor in the advance of our knowledge of radiant energy, X-rays, &c., if only on account of the perfection of the apparatus for obtaining high vacua which will ever be associated with his name. The practical effect of his discoveries was considerable, for the business of electric lighting is undoubtedly greatly indebted to his labours. Born in 1834, he settled in England at the age of twenty-live. He was elected a Fellow of the Royal Society in 1878, and resided in this country during the remaining years of his life.

The death of Charles Jasper Joly, F.R.S., at the early age of forty-one, robbed mathematics and astronomy of one of their most devoted disciples. His "Manual of Quaternions" is well known, and those acquainted with his astronomical work are confident that, had his life been spared, he would, as Astronomer Royal of Ireland, have added lustre to an office held by many distinguished predecessors.

Samuel Pierpont Langley was born in 1834. In 1866 he became Director of the Alleghany Observatory at Pittsburg. His first work was the institution of a uniform system of time from the Atlantic seaboard to the Great Lakes. This, the first successful attempt to introduce uniformity of time over a large area, was subsequently widely imitated. In 1880 he invented the bolometer, and thus opened out a large new field of investigation into the invisible rays of long wave-length proceeding from heated bodies. He analysed in minute detail the lunar heat spectrum, and, more recently, he conducted an inquiry into the nature of the radiations emitted by the glow-worm. In 1881 he conducted his researches into the solar heat of the earth's atmosphere. In 1887 he became Secretary to the Smithsonian Institution. The result of twenty years' labour is to be found in the accurate determination, by temperature alone, of more than seven hundred lines in the invisible red spectrum, lines which are fixed with an average probable error of about one second of arc. In 1891 he published his experiments in aërodynamics, in 1893 "The Internal Work of the Wind," and in 1896 he demonstrated by actual experiment that a body nearly a thousand times heavier than air can be driven through and sustained by it. His published works show great literary charm. He especially excelled in the presentation of abstruse subjects in simple and non-technical language. This is, perhaps, hardly the occasion to refer to his social qualities. Those who had the privilege of his acquaintance, however, can best testify to his quickness of insight, his intense sympathy, especially with the young, and the impression of capability which he produced upon all with whom he came in contact.

The tragic death of Prof. Curie was felt as a calamity, not only by those closely interested in the march of scientific discovery, but also by those who had but a superficial knowledge of his work. A teacher for more than twenty years, he was nevertheless enabled by his enthusiasm and energy to perform those researches which will ever be connected with his name and that of his wife. So entirely has public attention been attracted to their joint work on the separation of the compounds of radium and their properties that we are apt to overlook other great services he rendered to science. His paper on "The Effect of Temperature on the Magnetic Properties of Bodies" led to the discovery of the law that for feebly magnetic substances the coefficient of magnetism varies inversely as the absolute temperature. He also pointed out that the magnetisation of diamagnetic substances appeared to be independent of the temperature and physical state, indicating diamagnetism as an atomic property.

It is pleasing to reflect that the importance of his discoveries received immediate recognition. It was but three years before his death that he announced to the French Academy the discovery of the new element, and in the same year he and Mme. Curie received the Davy Medal of the Royal Society and the Nobel Prize; and in July of last year he was elected to the French Académie des Sciences. He was one of the most modest and retiring of men, and this honour came to him unsought; his name will ever be remembered as one of the most notable of that brilliant band of workers who have within recent years so greatly extended the domain of physics by the discovery of radio-activity.

A quarter of a century has passed since this Section, meeting in this city of York, had the privilege of listening to a Presidential address by the pioneer of natural knowledge whom we now know as Lord Kelvin, and it may possibly be a not unprofitable task to review briefly a few of the advances which must render the interval a memorable one in the annals of science.

Lord Kelvin summarised the stores of energy from which mechanical effects can be drawn by man as follows:—

(1) The food of animals.
(2) Natural heat.
(3) Solid matter found in elevated positions.
(4) The natural motions of water and air.
(5) Natural combustibles.
(6) Artificial combustibles.

The twenty-five years which have since elapsed have not made it possible to extend this list. It is true that within the last few years the discoveries connected with radio-activity have enormously increased our estimate of the stores of energy surrounding us, but so far these additional stores cannot be regarded by us as stores from which "mechanical effects may be drawn by man." It is possible that in the ingenious radium clock which we owe to Mr. Strutt we have a source of mechanical energy unsuspected in 1881, but, at all events, regarded from a commercial standpoint, it can hardly be considered as "available by man." Nevertheless, there is a sense in which it may be said that we are profiting by atomic energy, for we are no longer bound to limit our estimate of the energy due to the radiant heat of the sun and the internal heat of the earth by previously known dynamical considerations, and, in consequence, our opinions with regard to the limit of the ages which the physicist could allot to the evolutionist have undergone profound modification.

I here wish to draw attention to some of the conclusions to which we are led by the work of Mr. Strutt.

Assuming the earth to be in thermal equilibrium, then, even if the whole of this interior heat be due to radium alone, the mean quantity per cubic centimetre cannot much exceed $1{\cdot}75 \times 10^{-13}$ gram. The conclusions of Rutherford, based on somewhat different values for the constants involved, give an equivalent of $1{\cdot}52 \times 10^{-13}$. Now Strutt has found that the poorest igneous rock examined by him, namely, Greenland basalt, contains more than ten times this quantity, and an average rock fifty or sixty times the amount. The assumption that the earth is cooling only aggravates the difficulty, and facts appear to tell against the theory that it is getting hotter. Also, we must take into consideration the heat due to the existence of uranium, thorium, &c.

We appear, therefore, to be driven to one of two assumptions: either (*a*) that the rate of heat production by radium diminishes as we approach the centre of the earth; or (*b*) that the interior of the earth differs markedly in constitution from the exterior crust.

It is true that Mr. Makower has shown that there is a slight change of activity in one of the radium products about the temperature of 1200° C., and it is very desirable that this inquiry should be pushed to much higher limits. At the same time, it appears evident that but a very slight change in activity takes place at temperatures below 1500° C.

Now Mr. Strutt has shown, arguing from known data, that the maximum temperature at the bottom of a crust of about forty-five miles in thickness, must be in the neighbourhood of 1530° C., although some amount of uncertainty is necessarily induced by our want of knowledge of the conductivity of rock at high temperatures. Anyhow, it is probable that at the depth indicated the temperature does not exceed the melting-point of platinum. Such a crust would contain about one-thirtieth of the earth's volume, and if throughout it the radium heat energy were of the average of that exhibited by many samples examined by Strutt, the temperature of the earth could be maintained until our stores of uranium suffered sensible depletion. Such an assumption would lead to the conclusion that the whole of the central portion of the earth consists of non-radio-active substances at an approximate uniform temperature somewhat below the melting-point of platinum. A brief summary of the evidence previously at our disposal may not be out of place.

In the first edition (1867) of Thomson and Tait's "Natural Philosophy" we find the tidal evidence summarised as follows: "It seems certain, therefore, that the tidal effective rigidity of the earth must be greater than that of glass."

In the 1883 edition of the same work a discussion of the question by Prof. George Darwin is given. He states: "On the whole we may fairly conclude, whilst there is some evidence of a tidal yielding of the earth's mass, that yielding is certainly small, and that the effective rigidity is at least as great as steel."

In a later paper (Proc. Roy. Soc., 1885) Darwin pointed out that this conclusion was based on the assumption that oceanic tides would have their equilibrium value, and that the validity of this assumption was open to doubt. Nevertheless, the evidence clearly indicated a high degree of effective rigidity.

Hough (Phil. Trans., A, 1895, 1896) discussed the variation of latitude, and, after correcting a small mistake of Newcomb's (who was the first to suggest the explanation), found the prolongation of the Eulerian Nutation from 305 to 430 days as indicating an effective rigidity of the earth about equal to that of steel. Wiechert (Trans. Roy. Soc. Göttingen, 197), of Göttingen, found that the mean density, ellipticity, and precessional constant were consistent with the hypothesis of homogeneous core with lighter surface layer.

Mr. R. D. Oldham (Phil. Trans., 1900), in a paper on the "Propagation of Earthquake Waves," came to the conclusion that the evidence pointed to a central metallic core, and to the existence of marked differences in the physical constants of the core and the surrounding crust. He, however, assigned a comparatively small radius to this core, viz., about 0·55 that of the earth.

I will now call your attention to the light thrown on this subject by the recent investigations of Prof. Milne. The difference in the rate of propagation of earthquake waves through the earth's interior and through the crust has led him to the conclusion that the material below a depth approximating to thirty miles is of a uniform nature, and that the change in physical constitution is abrupt at some such depth as that indicated. He writes as follows:—

"For chords which lie within a depth of thirty miles the recorded speeds do not exceed those which we should expect for waves of compression in rocky material. This, therefore, is a maximum depth at which we should look for materials having similar physical properties to those we see on the earth's surface; beneath this limit the materials of the outer part of this planet appear rapidly to merge into a fairly homogeneous nucleus with a high rigidity."

In the Transactions of the Royal Society for 1905 will be found a paper by Lieut.-Colonel S. G. Burrard on "The Intensity of the Force of Gravity in India." Colonel Burrard writes as follows:—"Geodetical observations have shown that the density of the earth's crust is variable, but they have not given any positive indications of the depths to which these observed variations extend. All calculations of the depths of subterranean variations in density and of the mountain compensation have, therefore, to be based on arbitrary assumptions of depth. The fact that the plumb-line seems generally to respond readily to the results given by the pendulum perhaps justifies the inference that the observed variations in the density of the earth's crust are not deep-seated. If an abnormal amount of matter exists in the crust near the surface, it will exercise direct effects upon plumb-lines and pendulums in the vicinity, but if it lies at a great depth its effects, especially on plumb-lines, will be less perceptible. . . . I have taken several instances of abnormal pendulum results from table, and have found in each case direct response from the plumb-lines at neighbouring stations. This conformity could hardly ensue if the variations in density extended to greater depths than thirty or forty miles. Our results do not justify us in asserting that no deep-seated variations in density exist, but they do justify the belief that the variations in density which have been discovered are apparently superficial."

It is interesting to notice the agreement between results drawn from such dissimilar sources. On the one hand we have had to deal with effects produced by almost inconceivably small particles travelling with immense velocity; on the other, with effects dependent upon the behaviour of "the huge terrestrial globe." That travellers starting from such opposite extremes should arrive at a common destination is in itself a striking example of the scope and accuracy of the work undertaken by investigators in physical science.

It is possible that the evidence from each source, considered independently, might be regarded as inadequate, but the cumulative effect is sufficiently strong to justify the belief that some marked physical change in the constitution occurs at a depth of some thirty to fifty miles.

At all events, we have indications that, with the exception of a comparatively thin crust, the earth consists of a non-radio-active substance with a rigidity approaching that of steel, with an average temperature in the neighbourhood of 1500° C., and a density at that temperature of about 5°·6 C.

An interesting question awaiting solution is the probable constitution of this core.

The above is but an example of the many fascinating problems upon which fresh light has been thrown by the revelations of recent discoveries in radio-activity, and the temptation to dwell on such themes is correspondingly great: but I feel that such a task should be committed to hands more capable than mine.

Fortunately, in the discussions which will take place during our meeting ample opportunity will be afforded those entitled to speak with authority. Nevertheless, there are one or two further aspects of the matter which I will venture to touch upon, although but an onlooker. I would, first of all, urge the importance of a study of what may be termed the natural history of the elements. We require more information as to their comparative proportions in different localities. The fact that, given the amount of uranium in a sample of native rock, we can predict with certainty the amount of radium contained in the same specimen is of startling significance.

The natural law which governs the proportions of these two substances may have a far wider reaching scope than we at present suspect. Nature appears to present to us a grouping which would not naturally have occurred to the mind of the chemist; lead and silver, copper and gold, and, again, platinum and iridium, seem invariably to be introduced to us by Nature as if bearing to each other some kind of blood relationship.

The facts we already possess seem dimly to indicate some close relation between elements which we have hitherto considered as outside the bounds of consanguinity, and for a fuller knowledge of this important branch of natural history we require the assistance of the practical engineer, the geologist, the metallurgist, and the chemist.

Many of the results arrived at by the investigators into the phenomena of radio-activity can apparently only be verified by the lapse of considerable intervals of time. It is probable, for example, that we can estimate with some degree of accuracy the time required for the dissolution of half a given mass of uranium or radium, but the complete verification of our inferences must probably be left to a future generation. If we accept this view, it is our duty to provide our successors with data on which their conclusions may be based. If, for example, carefully determined masses of the more radio-active substances could be placed in such circumstances as to remain untouched until the meeting of this Association some hundred years hence, our successors, who would doubtless be equipped with apparatus of research more accurate and more sensitive than any in our possession, would at all events be placed in a position to establish by direct methods the accuracy of inferences based upon the experimental data now at our disposal. This task is one which, it appears to me, might well be undertaken by Section A, and I trust that this suggestion may be held worthy of some consideration.

It appears probable that one gram of radium diminishes in weight by about half a milligram per annum; hence, if the funds of this Society admitted of the imprisonment of some definite mass of radium, our successors a hundred years hence would, even if they possessed only the apparatus now at our disposal, be able to determine its loss with sufficient accuracy to enable them to verify the truth of the conclusions arrived at by the physicist of to-day, while the investigation of the radio-activity of the residue would possibly throw light on many problems now awaiting solution.

It would appear that if we made a similar imprisonment of uranium, a like degree of accuracy would not be attainable until after the lapse of half-a-million years, and I am afraid that our interest in the work of our successors cannot be expected to cover so long a period. Nevertheless, it is probable that the presence of the products of decomposition could easily be detected after the lapse of a comparatively short interval of time.

The experiment might well be extended so as to include examples of all the elements capable of such treatment; and with each prisoner should be placed a full record of its physical constants, such as mass, density, electrical conductivity, specific heat, &c., with a clear indication of what is believed to be the probable accuracy of such determination.

During the past twenty-five years much thought has been devoted to the accurate determination of certain physical constants. This is very apparent in the case of one of the most important—namely, that commonly termed the "mechanical equivalent of heat," or, as I prefer to define it, the "thermal equivalent of energy." When Lord Kelvin addressed you in 1881, I think it probable that he would have indicated the value obtained by Joule—viz., 772·6 foot-pounds—at Manchester, as the quantity of work required to raise the temperature of one pound of water through 1° F. at 62° F. It is true that the results of Rowland's classical investigation were published in 1880 and 1881, but the discrepancy between his conclusions and those of Regnault regarding the change in the specific heat of water at temperatures between 0° C. and 30° C. introduced an element of uncertainty.

As a consequence of this discrepancy much experimental work on the subject has been performed in the last quarter of a century, and I think it may be said without hesitation that the value of this important constant is now ascertained with an accuracy of about one part in 2000. The amount of labour which has been employed in the determination of this thermal constant is extraordinary, and, as I have pointed out elsewhere, it well illustrates the cosmopolitan character of scientific investigation.

I have given reasons (Griffiths, "The Thermal Measurement of Energy") for specially selecting for consideration the determinations of Rowland, of Bartoli and Stracciati, of Ludin, of Callendar and Barnes, of Schuster and Gannon, and I have ventured to add my own. Thus Baltimore, Pisa, Zurich, Montreal, Manchester, and Cambridge have all contributed to the solution of the problem, and we may now with some certainty say that 777·7 foot-pounds at Greenwich are very closely the equivalent of the amount of heat required to raise 1 lb. of water through 1° on the hydrogen scale at 63°·5 F.

It may possibly appear that the result just quoted is a somewhat poor return for the expenditure of so much thought and labour. I would call attention, therefore, to the fact that the value of this equivalent is dependent on the measurements of many other natural constants; hence any agreement between the results obtained by the observations of Rowland and some of the other observers I have mentioned would only be possible in the absence of errors of appreciable magnitude in the determinations of mass, of change of temperature, and of electrical resistance and current. Certain discrepancies have led to the discovery of a hitherto unsuspected cause of inaccuracy, especially in the determination of temperature, and thus the inquiry has rendered valuable service in many branches of physical inquiry.

For example, so far back as 1893 I ventured upon a prophecy that the value assigned to the E.M.F. of a Clarke's cell was somewhat too high, and that it was possible that 1·4328 represents more truly the potential difference of a Clarke's cell at 15° C. than the ordinarily accepted value of 1·4342. In the report of the Electrical Standards Committee for 1897 will be found a discussion of this matter, and one of the consequences of the deliberations of that Committee is to be seen in the ampere balance now standing in the National Physical Laboratory.

The results of the observations obtained by this instrument will, I believe, shortly be published by Prof. Ayrton and Mr. Mather, but I am at liberty to state that, so far as the observations have been reduced, they point to the conclusion that the prophecy to which I have referred is closely fulfilled. We may say, therefore, with some confidence that the values of those units which form the basis of our system of electrical measurement are not only practically determined with a high degree of accuracy, but that also our measurements of temperature and of energy are placed on a satisfactory footing.

The last few years have been fruitful in revelations which not only profoundly affect the views of students of science, but also are of such a nature as to catch the eye of the public. In some cases the applications of these discoveries to the purposes of mankind have been evident and immediate. Every well-equipped hospital possesses apparatus for the production of Röntgen rays, and I suppose that every bluejacket in the Navy has some degree of acquaintance with those applications of science which have resulted from the discovery of Hertzian waves.

The ambition of the student is naturally fired by such examples, and there is a possible danger that the plodding but absolutely necessary work of accurate measurement may suffer by neglect. I therefore venture to repeat the well-established axiom that our advance in scientific knowledge is a function of accurate measurement, and that the student who devotes his energy to the determination of some physical constant is probably giving a "point of departure" to the pioneer. For it must ever be remembered that to the scientific investigator the rule of three has ceased to hold any significance.

When Lord Rayleigh discovered that the mean weight per litre under standard conditions of chemical nitrogen was 1·251, and that of atmospheric nitrogen was 1·257, the believer in the rule of three would have been unlikely to suspect that this difference of 0·006 would supply the clue which led Lord Rayleigh and Sir W. Ramsay to the discovery of a new element, a discovery which in its turn led to others of possibly even greater importance. For all we know the next decimal place in any hitherto accepted value may afford another example of the truth of the statement that a part may be greater than the whole.

At the time when Lord Kelvin delivered the Address to which I have already referred the truth of the second law of thermodynamics was probably not so generally accepted as is the case at the present time. Each apparent example of violation of that law has on closer examination proved to be additional evidence of its validity. We seem unable to find those "sorting demons" of Maxwell's the existence of which appears necessary for its violation.

Mr. Campbell recently expressed doubts as to the application of thermodynamic considerations to osmotics. He contended that the errors in the determination of osmotic pressure were greater than those which could be attributed to experimental sources. Now, the theoretical relation between osmotic pressure and the freezing-point is based directly on thermodynamic considerations, and it was because I entertained a belief that the most direct evidence of this much-debated matter could be obtained from the observation of the freezing-point of a very dilute solution that I embarked on a series of somewhat elaborate experiments during the years 1897 to 1901. My removal from Cambridge and the death of my assistant, Mr. C. Green, compelled me to leave that inquiry in an unfinished condition. Nevertheless, I had investigated the depression of the freezing-point in certain solutions varying in strength from 0·0003 to 0·025 gm.-molecule per litre.

Subsequently to my departure from Cambridge Mr. Bedford re-erected the apparatus in another building. After having surmounted great difficulties, he repeated many of my experiments, and he informs me that the numbers he has so far obtained are in almost entire agreement with those previously obtained by me. The molecular depression in the case of cane sugar I found to be 1·858, of potassium chloride 3·720, and I understand that Mr. Bedford's experiments agree with these results with a discrepancy of less than 1 part in 1000. The most probable number obtained from theoretical considerations would be in the former case 1·857, in the latter 3·714. As Mr. Whetham has pointed out, unless there is some balancing of opposite errors of a very improbable nature, it is difficult to imagine a more direct vindication of the application of thermodynamic considerations to the phenomena of solution. I may add that I also examined correspondingly dilute solutions of sodium chloride, barium chloride, sulphuric acid, potassium bichromate, magnesium chloride, and potassium iodide; but, owing to the circumstances to which I have referred, I was unable to repeat these experiments in such a manner as to enable me to attach great importance to the resulting figures. Nevertheless, I obtained values which strengthened the conclusions to which I was led by the more exhaustive examination of the dilute solutions of sugar and potassium chloride.

So far back as the Liverpool Meeting of this Association I expressed a hope that the experimental difficulties of the direct measurement of osmotic pressures would be overcome, as such direct measurement would afford the most useful data by means of which to obtain further light on the much-vexed question of the nature of solutions. I remember, also, that it was the general opinion of those who had given attention to this matter that the experimental difficulties were insuperable.

I am glad, therefore, to have this opportunity of stating my high appreciation of the manner in which Lord Berkeley and Mr. Hartley have grappled with the difficulties of this investigation. They have proved that the osmotic pressure obtained by direct measurement agrees with that derived from vapour-pressure observations to within less than 5 per cent.[1] The agreement is of great importance, as it diminishes our doubts as to the extent to which the imperfections of semi-permeable membranes may affect the validity of results dependent upon their behaviour, and points to the possibility of determining the osmotic pressures of concentrated solutions by measurement of their vapour pressures.

I trust it will not be thought out of place if I here refer to the interesting correspondence which has recently appeared in NATURE on the thermodynamic theory of osmotic pressure, and the allied, but by no means identical, problem of the difference between electrolytic and non-electrolytic solutions.

On the one side we have Prof. Armstrong, whose chief desire appears to be the vindication of the moral character of what he terms "the poor molecule"; and Mr. Campbell, whose doubts concerning the second law of thermodynamics are closely connected with a lurking belief in the existence of Maxwell's "sorting demons"; and by way of reserves we have Prof. Kahlenberg, who contends that "thermodynamic reasoning cannot be applied to actual osmotic processes" on account of the "selective action of the membrane" and "insists that the formation of crystals from a solution or the concentration of a solution by evaporation are not osmotic processes."

On the other hand we have Mr. Whetham, who, I confess, seems to me to be capable of holding his own without need of reinforcements. He has pointed out that confusion has arisen from the use of the term "osmotic pressure" to denote the actual pressure experimentally realised in certain conditions, as well as the ideal pressure required in thermodynamic theory. With regard to the theory of electrolytic dissociation, Mr. Whetham shows that the fact that the velocities of the ions are constant in dilute solutions and decrease slowly with increasing concentration, while the conductivity of a dilute solution is at most proportional to the first power of the concentration, appears irreconcilable with any assumption as to the existence of the active part of an electrolyte in the form of combined molecules when in solution. I would here join with Mr. Whetham in the request that those who oppose the theory of ionic dissociation would state their views as to the mechanism of electrolysis, and their reasons for supposing that the application of the principles of thermodynamics to the phenomena of solution is unjustifiable.

Prof. Armstrong remarks that it is unfair to "cloak the inquiry by restricting it to thermodynamic reasoning, a favourite manœuvre with the mathematically minded." He adds that such a course may satisfy the physicist, but "is repulsive to the chemist."

The inquiry, "Why is the application of thermodynamic reasoning repulsive to the chemist?" naturally suggests itself. I confess that at one time I regarded the extreme advocates of the theory of ionic dissociation with a certain amount of suspicion, but I think that most of those who have studied the evidence now at our disposal, or who have been engaged in experimental investigation into this interesting branch of physics, cannot fail to agree with Mr. Whetham that, as regards the fundamental conceptions of the theory, "the cumulative evidence seems overpowering." At all events, we may consider that the application to the phenomena of solution of reasoning based on thermodynamic considerations is justifiable, until we are presented with stronger arguments than those based on the repulsiveness to certain chemists of the conclusions to which it leads, or the doubt it throws upon the activities of Maxwell's demons and the selective action of semi-permeable membranes.

I will now trespass upon your forbearance and pass from the consideration of such special departments of natural science as usually engage the attention of members of this Section to some more general considerations, which naturally arise in any comparison of our knowledge of to-day with that which we possessed when we last met in this city.

It will, I think, generally be admitted that during the last twenty-five years the increase in our "natural knowledge" has been greater than in any previous quarter of a century.

Day by day we are adding new facts to our storehouse of information, until it has now become impossible for the individual to have more than a superficial knowledge of the contents of the building. And although this accumulation is one which we may well regard with satisfaction, it necessarily gives rise to difficulties unfelt by our predecessors.

I venture to indicate one of such difficulties, one which has been brought home to me both by my experience as an examiner and by the fact that during the past few years I have had to preside over many meetings of examiners, and to mark the effect of examinations on the teaching in our universities.

We now expect a student to acquire in a three years' course a far greater amount of information than was considered necessary, say, twenty-five years ago. The attention both of the teacher and of the taught is naturally directed to those extremities of the branches of science in which the growth has been most marked in recent years, and I venture to think that there is in consequence some danger of our neglecting the roots of the whole matter. Compare, for example, a Final paper in chemistry in any one of our universities with its predecessor of a quarter of a century ago.

The enormous advance of organic chemistry has necessarily reacted on the examinations, and thus the student is unable to devote an adequate proportion of his time and attention to the foundations of the subject. The same remark applies in the domain of physics. There is a danger, therefore, of our educational edifice becoming top-heavy.

I have heard complaints, on the one hand, from the examiners that while the candidates frequently exhibit considerable knowledge of the most recent scientific developments, they show a lamentable ignorance of the simple phenomena and the principles they illustrate. On the other hand, I have heard from candidates that many of the questions were too simple—that they were concerned with principles and facts to which their attention had not been directed since they first began the study of natural science.

My own experience has been that the simplest questions are those answered in the least effective manner. A candidate unable to give satisfactory illustrations of Newton's Laws will discourse upon the mass of an electron or the nature of the Röntgen rays, and attempt the solution of problems on such subjects as Hertzian waves and electric convection.

[1] Concentration	Direct O.P. at 0° C.	O.P. deduced from vapour pressure at 0° C.
540 grains per lit. solution	67·5	69·4
660 " " "	100·8	101·9
750 " " "	133·7	136·0

Proc. Roy. Soc., June, 1906.

I hope that the attention of both examiners and teachers may be directed to the best methods of dealing with what appears to me to be not only a serious but an increasing evil.

To pass from one of the inconveniences which inevitably arise from growth, it is pleasant to dwell upon its more gratifying consequences.

Perhaps one of the most marked characteristics of the progress of science in recent times is the increasing public appreciation of the importance of original investigation and research.

The expansion of the university colleges in number and importance has greatly assisted and quickened this movement.

Twenty-five years ago there were comparatively few laboratories which held out any possibility of research to the English student. True, there were giants in those days, men, as a rule, working under difficulties greater than those encountered by their successors of to-day. The better equipment of our laboratories and the growth in the number and activity of our scientific societies have played no small part in stimulating public interest. Nevertheless, much remains to be done. Those who have read Prof. Perry's somewhat pessimistic words on England's neglect of science must admit that, however rapid our progress, the British people have not yet so fully awakened to the national importance of this question as some of our competitors.

The idea that a degree is one of the chief objects of education yet lingers amongst us. The conviction that it is a national duty to seek out and, when found, utilise the latent scientific ability of the rising generation for the purpose of adding to our stores of natural knowledge still needs to be brought home to the "man in the street." And here I would venture to indicate my personal belief in the necessity of more free communication between the laboratory and the market-place. It is possible that the language of science is becoming too technical, and that the difficulties with which scientific inquirers have been faced in past times have tended to habits of exclusiveness. For example, complaints are frequent that our manufacturers are less alert in grasping the practical applications of scientific discovery than their competitors in Germany and the United States. I confess, however, that it seems to me possible that the fault is not altogether on the side of the manufacturers. We want missionaries to preach the doctrine that one of the greatest of national assets is scientific discovery. If we can convince the men of business of this country that there are few more profitable investments than the encouragement of research, our difficulties in this matter will be at an end.

It is my lot to serve on the education committees of three county councils, and I have been much struck by the readiness of the members of those bodies to extend such encouragement whenever it has been possible to convince them that the results may conduce to the prosperity, the comfort, and the safety of the community.

It has also been my privilege to address meetings of the men who work in the coalfields of South Wales. I have attempted to direct their attention to the advantages which they have derived from the labours of those who have endeavoured to probe the secrets of Nature in the laboratory; I have tried to show how discoveries based on the researches of Humphry Davy, Faraday, Joule, for example, have not only diminished the dangers to which miners are exposed, but have also, by increasing the demands upon our stores of energy, given employment to thousands of their fellow-workers.

My experiences lead me to the belief that these men are ready to support the action of their representatives in extending support and encouragement to all efforts to assist the advance of scientific discovery.

It is possible that in dwelling on this matter I am trespassing on your forbearance, but I cannot resist this opportunity of pleading for the extension of your sympathies beyond the walls of the laboratory. The old toast, "Here's to science pure and undefiled; may it never do a ha'porth of good to anybody," may possibly be an excellent one in the laboratory; for, so far as I know, no great scientific principle has ever been established by labours prompted solely by desire for financial gain. Nevertheless, if we wish for the support of our fellow-countrymen, that toast is not one for public dinners. There is no scientific society which is brought into such close contact with the public as is the British Association, and affiliated with that Association are some scores of local scientific societies, containing many thousands of enthusiastic observers and inquirers. If this great organisation were seriously to take up the task of bringing home to the minds of the people of this kingdom the enormous value of the results of scientific inquiry, I believe it might be possible to change the indifference and apathy of our public bodies into active interest and encouragement. If each affiliated society would institute a series of public non-technical lectures, of such a nature as to bring home to the minds of the hearers some comprehension of the results of the work of Faraday, of Wheatstone, of Pasteur, of Maxwell, of Lister, and of Kelvin, the change in the public attitude would be real, evident, and fruitful.

In conclusion, one is tempted to seek for the underlying cause of the acceleration in the rate of advance of natural knowledge. Is it to be found in the increase in power of the human intellect, or the diversion into one particular channel of activities previously otherwise employed? It is possible that the human intellect has, by the processes of evolution, become more powerful, and that man's ability to decipher the secrets of Nature has thereby increased. I think, however, that it would require a bold advocate to support this thesis. If any such mental evolution has taken place, it is strange that it should be restricted to one particular sphere of activity. Are our poets and authors of to-day greater than Homer, our statesmen than Pericles? Or, passing into the domain of science, can we say with confidence that, in pure power of reasoning, Maxwell was undoubtedly the superior of Archimedes?

I have elsewhere indicated what appears to me to explain the mystery of this acceleration, namely, *the extension of our senses* by mechanical appliances. When we supplement our eyes by the bolometer and the electric coherer, the range of our vision is augmented a thousandfold. By the use of the electroscope and the galvanometer we have extended our senses of sight and touch until we can detect the presence of an electron.

Having realised the imperfection of our faculties, we have called upon Nature in all departments of science to supply our deficiencies, and are thus enabled to walk with confidence where previously all seemed dark.

From the time of Archimedes to that of Bacon we despised Natural Knowledge while we deified intellect and authority; hence for nearly 2000 years our record was one of retreat rather than advance. When the philosopher left his study and applied his powers of observation to the phenomena of the universe, progress became a reality, and thenceforward the march of discovery has known no backward step. We have therefore every reason to believe that when the Association again visits this ancient city our President will be able to chronicle an increase in Natural Knowledge even greater than that which has been one of the distinguishing characteristics of the last quarter of a century.

SECTION B.

CHEMISTRY.

Opening Address by Prof. Wyndham Dunstan, M.A., LL.D., F.R.S., F.C.S., President of the Section.

Some Imperial Aspects of Applied Chemistry.

The President of the Chemical Section of the British Association must always have a large choice of subjects for his Address. He may attempt to review the chemical progress of the year, or to give an account of researches in that division of the science in which he is most interested. He may deal with the ever-recurring problems of education; or, again, he may draw attention to the importance of our science in one or other of its many relations to National and Imperial affairs. I have decided to adopt the last course, and to invite your attention at York, where several tropical products furnish the basis of important industries, to the intimate connection of our science with the problems that await solution in connection with the utilisation of the raw materials and economic products of our Colonies, and especially those of our tropical Possessions. There is a pressing need that the Imperial Government should recognise much more fully than it has hitherto done, and at least as fully as foreign Governments are already doing, the claims of scientific investigation to be regarded as the pioneer instrument of this work, and as the essential first step in the material and commercial development of our Possessions.

Although my remarks will be chiefly directed to the importance of chemistry in this connection, my plea will be more general. It is that the scientific method of experimental research should be systematically applied in each division of the sciences concerned. In the case of raw materials, however, whether vegetable or mineral, their commercial value must depend chiefly, if not entirely, upon their composition, and sooner or later the method of chemistry must therefore be applied.

In determining the value of the mineral resources of a country other specialists are also concerned, and the assistance of the geologist, the mineralogist, and eventually of the metallurgist may be required. Similarly with vegetable and agricultural products the services of the economic botanist and of the entomologist will be needed. It will therefore be necessary for me in dealing with the subject as a whole to touch upon several aspects in which other sciences are concerned, and with which the science of chemistry must cooperate in attaining a practical end—namely, the material development of the countries concerned. I need make no apology for many allusions to scientific agriculture, for this subject is this year attached to this Section, and indeed the science of chemistry is of fundamental importance to agricultural practice both at home and in the tropics.

In the first place I must ask you to allow me to say a few words as to the very wide interests that are involved in the proper solution of the problem of colonial development.

It is all-important that the wage-earning community of this country should have an adequate supply of tea, coffee, cocoa, rice, tobacco, and other commodities, and that our manufacturers should be able to count upon a regular supply of cotton, jute, rubber, and other raw materials as far as possible under their own control. All these products are derived almost exclusively from the tropics, and experience shows that it is a great disadvantage to the manufacturer not to be able to exercise control in the direction of securing the regular production of these materials, and especially not to be able to avoid the great and sudden fluctuations in their price, which are often the result of financial speculation on the part of a foreign capitalist who has secured the control of the output of a foreign country.

The almost entire dependence of the great textile industries of Lancashire upon the cotton crop of the Southern States of America has placed this industry at the mercy of American speculators, whose tactics may lead, as in 1903, to such a rise in the price of the raw material as to render it imperative for the manufacturer to close his mills, and by throwing large numbers out of employment to bring poverty and misery to many thousands of people.

The great principle which must now necessarily guide our system of administration and expenditure in our tropical Colonies and Protectorates has as its purpose the utilisation of natural resources and the creation and development of native industries with the aid of European supervision and advice. Adequate supplies of produce, natural and agricultural, will thus be ensured to British manufacturers and consumers from territories within the administration of the British Crown. This principle of employing our "undeveloped estates" for the advantage of our manufacturers and consumers, and at the same time for the benefit of the natives who inhabit these countries, was put into action by Mr. Chamberlain during his long tenure of office as Secretary of State for the Colonies, and this recognition of a vitally important principle must always be associated with his name.

Excepting India and the self-governing Colonies, the Crown Colonies and Protectorates, for which alone the Imperial Government is directly responsible, include an area of about two and a half million square miles and a population of about forty millions. The value of these possessions to us at the present time may be judged from the value of their import and export trade with the United Kingdom. The value of the exports of these countries in 1904 was estimated at about four and a half million pounds sterling, and the imports from the United Kingdom at about twelve and a half million pounds sterling. In gauging the importance to this country of the development of these Possessions, the export trade of which is only in its infancy, it should be remembered that the profits arising from the export as well as from the import trade are chiefly domiciled in this country; since practically the whole of this trade is in the hands of British merchants, and the entire profits, including those of shipping, &c., are therefore subject to our national system of taxation, and represent a very substantial annual contribution to the British Exchequer.

It is therefore only reasonable that a certain sum should be expended from British funds to aid the applications of science to the commercial development of these Possessions. Such an expenditure in the light of the facts to which I have drawn attention may be regarded as an investment with the certainty of a profitable return.

I have thought it necessary to give this brief account of the position of our still undeveloped Crown Colonies and Protectorates and the national importance to us of their systematic development before proceeding to the principal subject of this Address, which is to emphasise the aid which science in several of its branches can render to this work of development, and especially the science of chemistry, the capacities of which in this connection have so far not been sufficiently recognised.

The importance of utilising our own tropical Possessions as sources of the raw material required by the manufacturer is now generally recognised, and very considerable progress has been made in recent years. The tea produced in India and Ceylon has largely superseded the China tea formerly used in this country. Similarly, coffee is extensively grown in India, in the West Indies, and in several of our African Possessions. The jute cultivation in India has been very successful, and the demand for this fibre is so great that the question of its cultivation in our West African Colonies is now under consideration. India-rubber, hitherto chiefly obtained from South America, is of increasing importance as a commercial article, and the South American tree has been introduced with success in Ceylon, the Straits Settlements, and the Federated Malay States, which are rapidly becoming important rubber-producing countries the produce of which is competing successfully with that of South America. The cultivation of cotton, hitherto principally carried on in the United States, is being vigorously proceeded with in India, the West Indies, and in West Africa, as well as in Egypt and the Sudan, and we may look forward in the future to these countries supplying the British manufacturer with a large proportion, if not the whole, of the cotton he requires.

There are, however, vast resources, both mineral and vegetable, in our Colonies and Protectorates which are awaiting development for an exact knowledge of their composition and properties, which can only be ascertained by scientific means and chiefly through chemical investigation, whilst the British manufacturer is in need of increased and better supplies of the raw materials on which his industrial activity depends. This demand for increased supplies now affects nearly every industry in this country. Rubber and fibres are well-known examples; oils and fats for the manufacture of soap and perfumes; and tanning materials, as well as numerous minerals, are other instances in which our manufacturers are at present anxious to discover new sources of supply. These sources can only be discovered and their value ascertained by properly directed scientific investigations.

We have heard much recently respecting the assistance which science can bring to the maintenance and development of the industrial efficiency of this country, and the Imperial Government is being urged to give its help especially by providing increased facilities for the education of scientific men, competent to aid the manufacturers of this country in improving their methods and processes. In this work the science of chemistry is one of the most important. There is scarcely an industry to which it is not able to render immense service. Within recent years this fact has slowly gained recognition, and the principle of State assistance to industry is virtually admitted, both in respect of education and of research. The most recent examples of a recognition of the principle are the grants made from the National Treasury to the new Technological College at South Kensington and to the National Physical Laboratory.

Not less important than the service which science can render to existing industries and their extension is that which it can contribute to the Imperial problem of ascertaining and rendering available for the manufacturer the vast undeveloped resources of our own Possessions. Our own experience and the example of other countries have shown that such work cannot be systematically carried on by private enterprise. Upon its successful accomplishment depends, not only the unrestricted supply of the necessary raw materials for which the manufacturer looks in increasing quantity, but also the prosperity of the country which produces these materials. This success can only be brought about by a combined effort on the part of the manufacturer and of the Government. The manufacturer can provide information as to the materials he needs. The preliminary work of discovering suitable material by scientific means, as several foreign Governments have already recognised, must be endowed, directed, and carried on with Imperial funds. It cannot be expected that private enterprise will take steps to explore the resources of little-known countries on the chance of a particular material being discovered, nor can the work, as a rule, be successfully done by this means. Experience shows that the most effective manner of promoting the commercial development of a new country is for the Government to carry out systematically with its own officers the preliminary work of exploration and examination of the natural resources, with the aid of such technical advice as may be necessary from manufacturers and users, and then, having established the fact that particular products of value can be found or cultivated in a given country, to leave commercial enterprise to do the rest. By action on these lines immense progress is being made in French, German, and Dutch possessions, whilst the United States Government has taken similar action with the Philippines. In our own case, where this work exists it is in most cases in a more or less embryonic condition, and lacks the organisation which is necessary for success.

In many of our Crown Colonies and Protectorates there already exist, or are in the process of organisation, agricultural and other scientific departments, many of which include officers who are engaged in the work of exploring and developing the vegetable resources of these countries especially by experimental planting. Chemists are attached to some, but not to all of these departments. In the West Indies the valuable work accomplished by Prof. Harrison, Mr. Francis Watts, Prof. Albuquerque, Prof. Carmody, and Mr. Cousins is well known, and illustrates the great services which the science of chemistry may render, not only to tropical agriculture, but to every branch of economic development. It is clearly desirable that at least one scientific department should be attached to the Government of each of the principal Crown Colonies and Protectorates. As a rule, it is convenient that this should be an agricultural department with the services of a scientific chemist at its disposal. In a tropical climate, and with limited appliances at his command, it must be admitted that a chemist is severely handicapped, and, as a rule, he cannot be expected at first to be able to do much beyond the comparatively simple and preliminary work, chiefly analytical, which, however, in a little-known country is of the greatest importance to an agricultural department. In addition, he would have to deal with the composition of natural products of all kinds, both vegetable and mineral, as well as with the improvement of native industries. If the chemist is able to refer complicated or special investigations to a central department at home, and is provided with assistance in the routine work, he would be in a position to undertake the scientific investigation of a selection from the numerous problems with which a chemist will be confronted.

A chemist working in the spirit of an investigator will be able to render special services to the cause of tropical agriculture, and it is therefore of importance that in future the men appointed to these posts should be chosen as far as possible on account of the promise they have shown as investigators. The determination of the constituents of little-known indigenous plants as the first step towards ascertaining their economic value is another department of work which cannot be carried out without a chemist, and the same applies to the examination of poisonous plants, and also of minerals, in addition to the determination of the composition of foods and feeding stuffs.

Tropical agriculture is a subject which is now of the first importance, especially in those countries in which our policy is to depend on a native population for the actual cultivation of the soil. We have two functions to perform in our position as supervisors: the one is to ascertain the nature and capabilities of the soil by actual experiment, for which well-organised experimental stations are a necessary part of every agricultural department; the other duty is to convey to the natives, chiefly by means of demonstration, the results of this experimental work, so that they may be persuaded to make it a part of their agricultural practice.

Work on these lines is being done under Government auspices in the French and German Colonies, and I may allude to the French successes in Algeria, in Senegal, and in the Sudan, and to the advances made by Germany in East Africa. These achievements are mainly due to a policy of continuous scientific work on agricultural lines. We shall have the privilege of hearing from Dr. Greshoff, the eminent director of the Colonial Museum at Haarlem, an account of the chemical investigations which are being carried out in connection with Java and the Dutch East Indies.

In many of our own Colonies and Protectorates active agricultural departments, equipped with the means of experimental working, are only now in process of organisation. One of the most recently organised of these is that of the Transvaal, which, at Lord Milner's initiation, has been completely equipped on the lines of that model for all such effort, the agricultural department of the United States. This department has as its chief chemist Mr. Herbert Inglis, of the Yorkshire College, now the University of Leeds.

If we are to compete successfully with foreign countries it is necessary that the position of science in relation to tropical agriculture should be definitely recognised. The days when a botanical garden served the purpose of an entire scientific establishment in a Colony have passed away, and we now require, in order that a proper return should be obtained, and the natives assisted in their agricultural practice, a scientific department with a proper complement of specially trained officers, including a consulting chemist, other specialists being added to the staff as the requirements arise. These officers should be remunerated on a scale likely to attract some of the best educated men from this country, which is at present far from being the case.

It would be out of place to discuss here the detailed organisations of these scientific departments. I merely desire to urge the necessity of their functions being extended, and of their receiving adequate financial support.

It is important that the scientific work which is being accomplished by these various departments should be brought to a focus, and that the results obtained in one Colony should be available for the information of the departments in other Colonies. The work of all such establishments requires to be unified by cooperation with a Central Department which can extend the investigations conducted in the Colonies, carry out investigations and inquiries which cannot be undertaken on the spot, maintain the necessary touch with the manufacturers, and coordinate the work undertaken and the results obtained in each of the separate Colonial establishments and systematically collate it, so that each may be aware of the results that are being obtained in other countries.

In our African Possessions at present the same investigations and inquiries have to be conducted independently, and often without the knowledge that the problem in question has been already solved.

Another increasingly urgent duty of the Central Department is to inform the Colonial establishments of the results of the work which is being conducted in foreign countries, and of the progress which is being made in the utilisation of raw materials all over the world, and to bring to their notice the constantly changing requirements of the manufacturers and users of raw materials.

So far as botany is concerned, this coordination has been to a large extent effected through the agency of the Royal Gardens, Kew, which is in touch, through the Colonial Office, with all the botanical gardens in the Crown Colonies and Protectorates. In chemistry, as well as in certain other subjects, these duties have been performed in recent years by the Scientific and Technical Department of the Imperial Institute, which is now working in cooperation, not only with the Governments of the Crown Colonies and Protectorates, but also with those of several of the self-governing Colonies, and also with the Scientific Departments which have been brought into existence in India, where at last the importance of scientific agriculture is receiving due recognition from the Government.

So little has hitherto been done in this direction that the number of problems requiring attention is exceedingly large; and even with a specially trained staff of workers and extensive laboratories, such as now exist at the Imperial Institute, it becomes necessary to select as the principal subjects for investigation those which are regarded by the Governments of the countries concerned as of the most practical importance, and in which the British manufacturer is at the moment most concerned. There must therefore remain a large number of materials of unknown composition and of problems of purely scientific interest which offer an attractive field for the chemical investigator. Already steps have been taken to provide for the investigation of these subjects by scientific men who are willing to undertake them in communication with the Institute. For example, Mr. A. G. Perkin, F.R.S., has been furnished with material which has led to the identification and determination of the constitution of the colouring matters of a number of plants which are employed as dyes in India and the Colonies. Prof. A. H. Church, F.R.S., has determined the composition of many new or little-known food grains. Dr. Crossley, Mr. Le Sueur, and Dr. Lewkowitsch have examined the constituents of a large number of fats and oils furnished by seeds of Indian and African origin. Dr. W. J. Russell, F.R.S., has been furnished with selected materials for examination in connection with his interesting investigations of those substances which affect the photographic plate in the dark, whilst the Hon. R. J. Strutt, F.R.S., has investigated the radio-activity of a number of new or little-known minerals containing rare earths. Last year more than 500 different materials and problems were submitted from the Colonies and India for investigation to the Scientific Department of the Imperial Institute, and each year there must remain an increasing number of interesting subjects which cannot be included in the Department's annual programme of work. Many of these would furnish excellent subjects for chemical research by advanced students in connection with the universities and technical colleges throughout the country. It is nearly always possible to arrange to furnish the necessary material for any competent worker to deal with. Next year a list of such subjects awaiting investigation will be available at the Imperial Institute for those in search of subjects for chemical research.

Whilst the investigation of some of these subjects may at once produce results of scientific value, many of them present difficulties in their investigation which are far more serious than those which attend the usual synthetical work in organic chemistry. I do not know of any more profitable experience for the advanced student who is already familiar with the principles of organic chemistry and of laboratory practice than the separation in the pure state of the chemical constituents of a plant and the determination of their chemical constitution. In inorganic chemistry the examination of a new mineral furnishes similar experience.

In carrying out research of the kind I am advocating, the chemical investigator will have the additional advantage of knowing that the scientific results he obtains will contribute to the knowledge of the resources of the British Empire, and possibly be the means of laying the foundations of new industries.

I need hardly remind chemists that some of the most important discoveries in our science, and many of those which have had the most profound influence on the development of chemical theory, have arisen from the examination of the constituents of raw materials. The discovery of morphia in opium led to the recognition of the new class of alkaloids; the discovery of amygdalin in the bitter almond of the new group of glucosides; the investigation by Liebig and Wöhler of the chemical properties and composition of the essential oil of the bitter almond was largely instrumental in laying the foundations of modern organic chemistry; whilst it was during the examination of the constituents of bran that Fownes was led to the discovery of furfurol and the subsequent recognition of a new type of organic compound. In more recent times the examination of the constituents of oil of turpentine and various essential oils yielded by different plants has been the means of elucidating the chemical theory of the great group of terpenes, and latterly Harries's investigation of caoutchouc has led to the discovery of the ozonides which seem likely to be of much importance as a new means of determining the constitution of certain classes of organic compounds. Lastly, I may remind you that the discovery of helium might have been long delayed had not Prof. Miers drawn Sir William Ramsay's attention to the so-called nitrogen furnished by the mineral cleveite.

I have thought that it would be of interest on the present occasion if some account were given in the Section of the chemistry of certain of the raw materials employed in the principal manufacturing industries of the city of York. These industries are vitally concerned with an adequate supply of certain raw products of tropical origin, especially cocoa and gums. In connection with the first of these, which has hitherto been obtained chiefly from the West Indies, a new industry of cocoa production has sprung up in West Africa, notably in the Gold Coast and in Lagos. This West African cocoa presents some peculiarities which have rendered it desirable to examine the nature of its constituents. Gums of the nature of gum arabic are at present chiefly derived from the French Colony of Senegal. It is, however, clear from the examination of gum collected in West Africa that that country, and especially Northern Nigeria, will be able in the future to contribute to the needs of the British manufacturer, in addition to the Sudan, India, and Australia, which will also be able to make important contributions. In connection with the investigation of these gums derived from new sources at the Imperial Institute, the very remarkable observation has been made that certain gums from India and the Colonies possess the property of evolving acetic acid when exposed to the air. The chemical constitution of one of these gums has been fully investigated at the Imperial Institute by Mr. H. H. Robinson, who will contribute a paper on the subject to the Section, in which he will show that the production of acetic acid is due to the elimination of an acetyl group by hydrolysis through the moisture of the air. He has also succeeded in elucidating to a large extent the chemical nature of the gum. Mr. Robinson will also make a report on the present position of the chemistry of gums, a class of substances the constitution of which is exceptionally difficult to unravel. Little, if any, advance has been made in recent years on the well-known researches of O'Sullivan.

There is no more important group of questions demanding attention from the chemist at the present time than those connected with the production of india-rubber or caoutchouc. An enormous increase in the demand for india-rubber has taken place in the last few years, and last year the production was not less than 60,000 tons. Until recently the supply of rubber came chiefly from two sources—the forests of Brazil, which contain the tree known as *Hevea brasiliensis*, furnishing the Para rubber of commerce which commands the highest price, and the forests of Africa, where climbing plants, generally of the Landolphia class, also furnish rubber. The increased demand for caoutchouc has led to the extensive planting of the Para rubber tree, especially in Ceylon and in the Federated Malay States. Systematic cultivation and improved methods of preparation are responsible for the fact that the product of the cultivated tree, which begins to furnish satisfactory rubber when six or seven years old, is now commanding a higher price than the product of the wild tree in Brazil. It is estimated that within the next seven years the exports of cultivated india-rubber from Ceylon and the Federated Malay States will reach between ten and fifteen million pounds annually, and that after fifteen years they may exceed the exports of the so-called wild rubber from Brazil.

The services which chemistry can render to the elucidation of the problems of rubber production and utilisation are very numerous. Methods of treatment depending on a knowledge of the other constituents of the latex have led to the production of rubber in a purer condition. Much still remains to be elucidated by chemical means as to the nature of the remarkable coagulation of the latex. As is well known, the latex is a watery fluid resembling milk in appearance which contains the rubber, or, as I think more probable, the immediate precursor of rubber, together with proteids and other minor constituents. The constituent furnishing rubber is in suspension, and rises like cream when the latex is at rest. On the addition of an acid, or sometimes of alkali, or even on mere exposure, coagulation takes place and the rubber separates as a solid, the other constituents for the most part remaining dissolved in the aqueous liquid or "serum." The first view taken of the nature of the coagulation process was that, like the coagulation of milk by acids, it is dependent upon a process of proteid coagulation, the separated proteids carrying down the rubber during precipitation.

This explanation cannot, however, be considered complete by the chemist, and there are peculiarities connected with the coagulation of the latex which are opposed to the view that it is wholly explained by the coagulation of the associated proteids. The experimental investigation of the question on the chemical side is beset with many difficulties, which are increased if access cannot be had to fresh latex. A number of experiments were made at the Imperial Institute with latex forwarded from India. The difficulties contended with in preventing coagulation during transit were great, but in the case of the latex derived from certain plants these were to some extent surmounted, and the results obtained, especially with reference to the behaviour of certain solvents towards the latex, led to the conclusion that "coagulation" can take place after removal of the proteids, and that in all probability it is the result of the polymerisation of a liquid which is held in suspension in the latex and on polymerisation changes into the solid colloid which we know as caoutchouc. Weber, by experiments conducted in South America with fresh latex, arrived at a similar conclusion, which later workers have confirmed. Although the nature of the process is not yet completely elucidated, there is little room for doubt that the coagulation is due to the polymerisation of a liquid and possibly of a liquid hydrocarbon contained in the latex. For the chemist the important question remains as to the nature of this liquid from which caoutchouc is formed.

The chemical nature of caoutchouc is a subject which has attracted the attention of distinguished chemists from the middle of the eighteenth century, among them being Faraday, Liebig, and Dalton. Faraday was the first to examine the constituents of the latex of *Hevea brasiliensis*. It is only in recent years that our knowledge of the constitution of organic compounds, and especially of the terpene group, has rendered it possible to make any great advance. It is interesting to record that Greville Williams, in 1860, made most important contributions to this subject. He identified a new hydrocarbon, isoprene, as a decomposition product of caoutchouc, and recognised its polymeric relation to caoutchouc.

The results obtained from the analytical side, and especially the formation of di-pentene and isoprene by pyrogenic decomposition of caoutchouc, had pointed to the fact that caoutchouc was essentially a terpenoid polymer of the formula $C_{10}H_{16}$. Harries finds, however, that the ozonide of caoutchouc, when distilled with steam, breaks up into lævulinic aldehyde, lævulinic acid, and hydrogen peroxide, and he concludes from this that caoutchouc is a polymer of a 1:5 dimethyl cyclo octadien. Whilst Harries's work has brought us much nearer the goal, and has led to the discovery of a new method of investigation through the ozonides, which is obviously of wide application, it cannot yet be said that the constitution of caoutchouc has been settled or its relation to the parent substance of the latex definitely established. It has still to be shown how a closed-chain hydrocarbon such as Harries's octadien can undergo polymerisation forming the colloid caoutchouc.

There are strong arguments for the view that the constitution of the parent substance present in the latex is nearly related to that of isoprene. This remarkable hydrocarbon of the formula C_5H_8, first obtained by Greville Williams from the dry distillation of rubber, is an unsaturated olefinic hydrocarbon which is found among the products, resulting from heating caoutchouc. It readily polymerises, forming di-pentene. Bouchardat noticed that this hydrocarbon obtained from the pyrogenic decomposition of caoutchouc furnished a substance identical with rubber when acted on by hydrochloric acid and under other conditions. To Wallach and also to Tilden is due the further important observation that when isoprene prepared from oil of turpentine is kept for some time, it gradually passes into a substance having all the characteristic properties of caoutchouc.

I have very briefly drawn attention to the present position of our knowledge of the chemistry of caoutchouc in illustration of the interest which attaches to the examination of vegetable products, and also because of the immense importance of the problem from the practical and commercial standpoint. Chemistry in this case holds the premier position in reference to this subject, and to a large extent may be said to hold the key to the future of the rubber industry in all its phases. The discovery of better methods of coagulation, preparation, and purification will be effected through chemical investigation, as will also the determination of the manner of utilising the various other plants which furnish rubber-like latices. That the physical properties of raw rubber, on which its technical value depends, are to be correlated with the chemical composition of the material there can be no doubt. The chemical analysis of raw rubber, as at present conducted, is, however, not always to be taken by itself as a trustworthy criterion of quality, and more refined processes of analysis are now needed. Although the finest caoutchouc for technical purposes is only yielded by some half-dozen plants, under the names of which these varieties of caoutchouc pass, there can scarcely be a doubt that the elastic substance in each case possesses a very similar, if not identical, chemical structure. Nearly all the latices and similar fluids furnished by plants contain more or less caoutchouc. Even opium, which is the dried juice of the capsule of the poppy, contains caoutchouc, whilst the opium yielded by certain Indian species contains a notable proportion. Chemistry must determine the means by which caoutchouc can best be separated from these relatively poor latices. In view of the increasing production of the nearly pure caoutchouc which is furnished by *Hevea brasiliensis*, *Funtumia elastica*, *Castilloa elastica*, *Ficus elastica*, and a few other plants which occur or can be cultivated in several of our tropical Possessions, the question is not a pressing one at the moment.

Moreover, it cannot be doubted that chemical science will sooner or later be able to take a definite step towards the production of rubber by artificial means.

The production of caoutchouc by chemical means has, indeed, virtually been accomplished in its formation from isoprene. The exact nature of this change has still to be determined. When this has been done it will only remain to cheapen the cost of production to make the manufacture of synthetic rubber a purely practical problem. I should be the last to discourage the great extension of rubber planting which is now taking place. It is warranted by the present demand for the material. It has also to be remembered that the actual cost of producing raw rubber, which is at present about one shilling per pound, will probably be reduced, and the market price of rubber may eventually be so considerably lowered that, as with quinine, the synthetic production could not be profitably carried on. That is a question which involves many factors at present unknown, and only time can decide. Chemists may, however, confidently predict that before the British Association again meets at York the synthetic production of rubber will be a fully accomplished fact.

As I have said, our science is concerned with nearly every problem connected with the great rubber industry, and in concluding these few remarks I may allude to the production of vulcanised rubber depending on the formation of additive compounds of the hydrocarbon with sulphur. In this connection I should mention the recent experiments of Mr. Bamber in Ceylon, which appear to show that vulcanisation may be accomplished by acting on the uncoagulated latex with chloride of sulphur. If this proves to be practicable, it may mean the transference to the tropics of the subsidiary industry of vulcanisation, which is at present carried on in Europe.

Owing to the importance and interest which attach to the chemistry of rubber, it is to form an important feature in the work of this Section at the York Meeting. Papers will be contributed by some of the best known workers in this field, by Prof. Tilden, and by Prof. Harries, of Kiel, who will give an account of his recent work; whilst Mr. Pickles, of the Imperial Institute, will present a report summarising the whole of our chemical knowledge of the subject.

The chemical investigation of raw materials often raises, unexpectedly, problems of great scientific interest. The examination at the Imperial Institute of the seeds of the Para rubber tree (*Hevea brasiliensis*) has shown that they contain what proves to be a valuable drying oil, and in the course of the investigation it was ascertained that there is also present in the seeds an enzyme closely allied to, if not identical with, lipase, which is capable of splitting the oil by hydrolysis into glycerin and the free fatty acid. Subsequently, during the examination of other oil seeds similar enzymes have been detected, and it would appear probable that most oil seeds may prove to contain an enzyme capable of decomposing the fatty constituent.

Another subject of great chemical interest and botanical importance which has come into prominence in connection with the Indian and Colonial work of the Imperial Institute is to be included in a joint discussion which has been arranged with the Section of Botany. I refer to the production of prussic acid by plants, which, as I have elsewhere suggested, it is convenient to refer to as cyanogenesis. In this discussion we shall have the advantage of the cooperation of Prof. Van Romburgh and Dr. Greshoff, whose work with Dr. Treub of Java on this subject is known to chemists and botanists alike. The history of the origin of the several investigations in which Dr. Henry has been associated with me is not without interest in connection with the principal subject of this Address. During the first British expedition to the Sudan against the Mahdi a number of transport animals were poisoned through eating a small vetch which springs up in the Nile Valley during the fall of the river. The plant (*Lotus arabicus*) is well known to the Arabs, by whom it is cut when fully grown, and used as fodder for animals.

The results of the investigation of this matter which were communicated to the Royal Society proved that the young plant generated prussic acid when crushed with water. It was found to contain a new glucoside, lotusin, together with an enzyme capable of decomposing it into prussic acid, dextrose, and a yellow colouring matter, lotoflavin.

The glucoside is of special chemical interest, as being the only one known which contains the cyanogen group attached in the molecule to the sugar residue. Further investigation has shown that other fodder plants which are occasionally poisonous owe this character to the existence of other cyanogenetic glucosides. In a series of papers communicated to the Royal Society, Dr. Henry and I have described the properties and constitution of dhurrin from *Sorghum vulgare*, and of phaseolunatin, which we have shown to be responsible for the production of prussic acid by *Phaseolus lunatus* (Lima beans), *Manihot utilissima* (cassava or tapioca), and by linseed (the flax plant). Phaseolunatin is remarkable in furnishing acetone as one of its products of hydrolysis. The investigation, besides fulfilling the primary purpose for which it was carried out, has raised a host of problems;—as to the constitution of glucosides, the nature of the enzymes which accompany them in the plants, and also in relation to the fundamental question of plant metabolism.

Another subject of Imperial as well as National importance is to be the subject of a joint discussion with the Section of Physiology. I refer to the problem of diet. As chemists we are interested in this subject chiefly from the point of view of the composition of foods, and of the molecular structure which is associated with dietetic value. The first attempt to deal with the matter from the scientific side was made by a great chemist, Liebig. We are now in a position to investigate the problem more minutely, and the work of American physiologists has already led to important results. We have still to learn how materials such as rice and potatoes, which are nearly free from proteids, continue nevertheless to serve as the main diet of large numbers of people. It would seem that the best plan of operations will be for physiologists to settle by the accurate methods now available the precise value of typical foodstuffs, and for the chemist to deal with these in relation to their composition, and finally with reference to the constitution of their constituents. The time has come when an advance must be made from the chemical side in the analytical methods employed for gauging the value of food materials.

I feel that I have said much, but that I have left still more unsaid on many topics. I must leave almost untouched the entire subject of mineral chemistry, which is not only important in connection with the determination of the resources of India and the Colonies, but is also a subject somewhat neglected on its chemical side, which has been recently brought into prominence through the discovery of radio-activity.

The new radio-active mineral thorianite, from Ceylon, of which Mr. Blake and I have given an account to the Royal Society, brings me at once to a subject which raises the most fundamental of chemical questions, the nature of the elements and of the atom. The recent discussions of this subject have become so purely speculative that, whilst chemistry is bound to follow the lead of physics in this matter, chemists are inclined to consider that more well-ascertained facts are needed for any further discussion to be profitable from the chemical side.

In this Address I have ventured to urge the fuller recognition by Government of the scientific method as a powerful instrument in promoting the commercial development of the Colonies, and I have drawn attention to the important part the science of chemistry can play in the Imperial work of developing the resources of our Possessions.

No apology is needed in this place for directing attention to a subject which involves a most important practical application of our science, since one of the principal functions of the British Association is to bring science into close touch with the problems of our national life, and to interest the general public in the application of science to their solution.

I have, however, also shown that many problems of the highest scientific interest arise in connection with the investigation of these economic problems.

NOTES.

A DEPARTMENTAL committee has been appointed by the Home Secretary to inquire and report what diseases and injuries, other than injuries by accident, are due to industrial occupations, are distinguishable as such, and can properly be added to the diseases enumerated in the third schedule of the Workmen's Compensation Bill, 1906, so as to entitle to compensation persons who may be affected thereby. The chairman of the committee is Mr. Herbert Samuel, M.P., and the members are Prof. Clifford Allbutt, F.R.S., Mr. H. H. Cunynghame, C.B., and Dr. T. M. Legge.

The Paris correspondent of the *Times* states that a mission to investigate the subject of sleeping sickness is to leave Paris in October next for Brazzaville. The leader of the mission is to be Major Martin, of the French Medical Corps, who has worked at Saigon and at Lille in the Pasteur Institutes, and already had an opportunity in Guinea of studying sleeping sickness. He is to be assisted by Dr. Lebeuf, M. Roubaud, and M. Weiss. After establishing a permanent central laboratory the mission will begin the direct study of the malady up country. Special attention will be paid to the Upper Ubangi region. The mission also intends to combat the small-pox which is decimating French African possessions, but the main object is to fight the tsetse fly by every means that the resources of science can suggest.

In a letter to the *Times* of Tuesday last, Dr. Hamilton Wright, chairman of the late Port Swettenham Sanitary Commission, directs attention to the successful measures taken to stamp out malaria at Port Swettenham. The port was designed by the Government of the Federated Malay States to replace that of Klang, on the upper tidal reach of the river of the same name. It was jungle-covered, flooded daily by tides, and incident to an average of about 100 inches of rainfall a year. The railway station and bungalows for officials and coolies were on made ground. On the formal opening of the port, Klang was abandoned, and the river closed to sea-going vessels. Severe malaria immediately broke out amongst the officials and coolies employed on the railway and shipping. A commission was at once appointed, composed of medical men, railway and works officials, and instructed to devise measures for the suppression of malaria and otherwise to sanitise the port. The recommendations of the commission involved an outlay of from 10,000*l.* to 12,000*l.* The Government, without any hesitation, accepted the recommendations made by the commission; the new port was dyked, drained, levelled, and cleared, the result being that since these sanitary measures were initiated there has been scarcely a case of malaria at the port, and from being an unhealthy, shunned swamp, the port is now sought by officials as a desirable billet.

Information has reached the *British Medical Journal* that Dr. W. J. Goodhue, medical superintendent of the Molokai Leper Settlement, has, after several years of research, succeeded in demonstrating the bacillus of leprosy in the mosquito (*Culex pungens*) and the common bed-bug (*Cimex lectularius*). Dr. Goodhue expresses the opinion that the bed-bug is more of a factor in the spread of leprosy among the natives than the gnat, for the following reasons, that the bed-bug's invasion is noiseless and occurs during deep sleep of the victim, and secondly, the beds and bedding which have belonged to a leper are after his death or segregation used by his family without adequate disinfection.

We regret to have to announce the death of Sir Alexander Moncrieff, K.C.B., F.R.S. (the inventor of the "disappearing" gun which bears his name), which took place on Friday last at the age of seventy-seven years.

The *Athenaeum* announces the death, in his sixty-seventh year, of Prof. G. A. P. Rayet, director of the observatory at Floirac, Bordeaux.

A monument is to be erected at Brünn to the memory of Mendel, and an international committee has been formed at Vienna to further the object.

Mr. W. Eagle Clarke has been appointed by the Secretary for Scotland keeper of the natural history collections of the Museum of Science and Art, Edinburgh, in succession to Dr. R. H. Traquair, F.R.S., who is about to retire.

Mr. Henry Rew has been appointed an assistant-secretary to the Board of Agriculture and Fisheries in succession to Major P. G. Craigie, C.B., who has just retired.

Prof. A. Bergt has been appointed acting director of the Leipzig Museum of Ethnology in place of the late Prof. Obst.

The following telegram, dated August 2, respecting Dr. Sven Hedin's journey, has been received at Stockholm from the explorer at Leh (Kashmir):—"All well; our journey is most promising; our large, well-equipped caravan of 120 carriers is capital and our men are trustworthy."

According to the *Museums Journal*, the portrait of Dr. A. J. Evans, F.R.S., is to be painted by Sir W. B. Richmond, R.A., and deposited in the Ashmolean Museum, in commemoration of the services rendered to archæology by Dr. Evans. A general committee, representative not only of this country, but of Europe and the United States of America, has been formed to carry out the project.

The Moxon medal of the Royal College of Physicians of London, which is given every third year, has been awarded to Dr. Jonathan Hutchinson, F.R.S.

At the concluding meeting of the International Conference on Hybridisation and Plant Breeding on Thursday last, Veitch gold memorial medals were presented to Mr. W. Bateson, F.R.S., the president of the conference, Prof. Johannsen, Prof. Wittmack, and Prof. Maurice de Vilmorin, and silver-gilt Banksian medals to Miss E. R. Saunders, lecturer on botany at Newnham College, and Mr. R. H. Biffen, for eminent services rendered to scientific and practical horticulture. Prof. de Vilmorin, as the representative of the Horticultural Society and the Botanical Society of France, invited the society to hold its next conference at Paris.

The Bradshaw lecture will be delivered at the Royal College of Physicians, London, on November 6 by Dr. Sharkey, who will take as his subject "Rectal Alimentation"; the FitzPatrick lectures will be given by Dr. Norman Moore on November 8 and 13, and will deal with the "History of the Study of Clinical Medicine in the British Islands"; and the Horace Dobell lecture by Dr. F. W. Andrews, on November 15, will treat of the "Evolution of the Streptococci."

The following courses of lectures have been arranged for by the Royal Sanitary Institute:—one on "Hygiene in its bearing on School Life," beginning on September 17, and a special course on "Food and Meat Inspection," commencing on November 12.

The International Anti-Tuberculosis Conference will be held at the Hague from September 6–8 next, when the following questions will probably be discussed:—Ways of infection; specific therapeutics; compulsory notification; cost of sanatoria; dispensaries; tuberculosis in children; and education.

The annual meeting of the American Röntgen Ray Society will take place at Niagara Falls, New York, on August 29, 30, and 31.

An electrical manufacturers' exhibition is to be held at Bristol in November and December next. The object of the exhibition will be to afford to manufacturers an opportunity of bringing the latest improvements in their various specialities before the notice of electrical contractors and the public generally, and to demonstrate clearly the advantages of electricity for lighting, heating, and motor power purposes.

A disastrous fire broke out in the buildings of the Milan Exhibition on Friday last, causing the destruction of the Italian and Hungarian decorative art sections and of a pavilion of the Italian architecture section. The damage is estimated at 160,000*l*.

The recently issued annual Blue-book respecting the British Museum records a large falling off in the number of visits paid to the Bloomsbury Museum in 1905. In recent years the numbers have been steadily increasing, and in 1904 they reached the large total of 954,441. There has now been a reaction, with a loss of upwards of 140,000, the number for the year being 813,659. The visits paid to the Natural History Museum show, on the other hand, a considerable improvement; thus the total number of visitors last year was 566,313, an increase of 95,756 over the total in 1904 and of nearly 80,000 over that of any previous year. The number of visits recorded as having been made on Sunday afternoons was 70,084, as against 60,909 in 1904. The average daily attendance for all open days during the year was 1560·09; for weekdays only, 1600·73; and for Sunday afternoons, 1322·34. The total number of visits paid during the year to the department of zoology by students and other persons requiring assistance and information amounted to 11,811, as compared with 11,824 in 1904 and 11,627 in 1903.

As a result of the passage of the Bill allowing the production and utilisation of alcohol in America for industrial purposes, without the internal revenue tax, the U.S. Department of Agriculture has decided to publish a bulletin, from January 1 next, when this law is to take effect, placing before the public a collection of the best obtainable data on the use of alcohol in small engines. For this purpose Prof. Charles E. Lucke has been retained by the department as expert to conduct a protracted series of investigations in the laboratories of Columbia University. The bulletin, says the *Scientific American*, will contain all available information of the work done on the subject both at home and abroad. It is hoped that all those interested in this question will forward to Prof. Lucke at Columbia University any information of which they may be in possession, or inform him of the location of existing data. Possessors of patents covering inventions bearing upon the subject are invited to provide Prof. Lucke with copies of the same, and if possible to submit their apparatus intended for the utilisation of alcohol, such as vaporisers, carburetters, or complete engines. These will be tested in the most thorough manner, and the experiments will be conducted without any expense whatever to the public, save those entailed for the transportation of the apparatus. The reports of the tests will be published in the bulletin.

The *Electrician* states that an ordinance has been published constituting wireless telegraphy in the Sudan a Government monopoly by providing that no person shall instal or make use of any apparatus for wireless telegraphy, or transmit or receive messages by means of any such apparatus within the Sudan except the Department of Telegraphs or a duly authorised officer or official of the Sudan Government, unless such person is in possession of a special licence in writing from the Governor-General.

At the meeting of the Harvard College Chapter at Cambridge (Mass.) on June 28, the oration was delivered by Prof. E. C. Pickering, director of the college observatory. From the *Boston Evening Transcript* we learn that Prof. Pickering took as his subject "The Aims of an Astronomer," and dealt with it in vigorous style, pleading eloquently for the internationalisation of funds and aims. After describing the evolution of the individual astronomer from the time when his main object is to earn a living to the period when he arrives at the truer and broader aim of increasing the world's store of knowledge, Prof. Pickering outlined his international plan whereby the present overlapping of work and interests would be eliminated and the science of astronomy infinitely benefited. For instance, he suggests that rich men wishing to subsidise astronomical research should exercise as much discretion as they do in the businesses from which they derive their riches in order to place their gifts where the greatest need and the greatest facilities exist. This would entail an international advisory board to administer properly the accumulated fund without regard to nationality or personal interest. By such proceedings the young and ardent astronomer, the suitably situated observatory, and the men with ideas could be granted the financial help which they now so often lack, and with the assistance of which the progress of astronomical research could be greatly promoted.

The acoustical properties of buildings form the subject of two papers, one by Mr. Wallace C. Sabine in the Proceedings of the American Academy of Arts and Sciences, xlii., 2 (June), and the other by M. Marage in the *Comptes rendus* bearing the date April 9. Mr. Sabine states that the absorbing power of a room, its furniture and cushions, and of the clothing of the audience, are all capable of numerical determination, and that the time of reverberation of a given sound is also a calculable quantity. An important feature of the paper consisted in a series of experiments undertaken to determine the reverberation best suited to piano music. M. Marage's paper deals with the corresponding conditions with regard to speech. There appears to be a unanimous consensus of musical opinion that a reverberation of about 1·1 seconds is calculated to secure the best effect with a piano, while for speech M. Marage fixes the coefficient at from 0·5 second to 1 second for all parts of the room and all vowels. A second part of Mr. Sabine's paper—which, by the way, is a sequel to a previous one published in 1900—deals with the effect of pitch on reverberation. It is to be wished that attention were more commonly given to the study of acoustical effect; then we might get rid of the boxed-in piano, covered with highly absorbing draperies and jangling ornaments, of the conventional drawing-room. The sounds which this instrument is able to emit under the violent treatment commonly applied to its keyboard are a mere travesty of music.

The difficult problems in statistical mechanics associated with the kinetic theory of gases form the subject of a paper of thirty-five pages in the *Journal de Physique* for June, by Prof. H. Poincaré. The paper is largely a discussion of points suggested by the late Prof. Willard Gibbs. For simplification the author considers the case of a one-dimensional as well as that of a three-dimensional gas, and he is led to the distinction of two kinds of entropy, which he calls coarse and fine entropy (*entropie grossière, entropie fine*). Account is taken of rapid disturbances in which the gas has not time to assume a state of statistical equilibrium at every instant of the transformation. An allied subject is treated by Dr. W. Peddie in the Proceedings of the Royal Society of Edinburgh, xxvi., 3, in a paper on vibrating systems which are not subject to the Boltzmann-Maxwell law. Here again systems in one-dimension are considered, a kind of generalised Hooke's law of force being assumed in the test-case under discussion. The inference is drawn that equipartition of energy is not a general property of dynamical systems. It would not be unreasonable to infer that the Boltzmann-Maxwell distribution is characteristic of certain definable systems, and therefore is applicable to the explanation of definite phenomena only.

The meteorological reporter to the Government of India has issued a memorandum (dated June 9) on the abnormal features of the weather of the past half-year, with a forecast of the probable character of the south-west monsoon rains of 1906. Similar forecasts were first made by H. F. Blanford, and were based on the limited information of snowfall reports and the general character of the weather in India immediately preceding the rains. Sir J. Eliot realised that Indian conditions alone were insufficient, and in 1894 introduced information from other sources. This work is another instance of the useful application of statistics in attempting to trace the meteorological relations of widely distant regions to which we recently referred. Dr. Walker remarks that "it is certain that the influence of abnormal features over any large region spreads in every direction, and will after some months affect the conditions at very great distances"; he also instances the discovery by Sir Norman and Dr. Lockyer that the oscillations of annual pressure in South America are closely related to those of the Indian Ocean, but inverse in character. Dr. Walker has added considerably to the data employed, and gives very full particulars of the considerations upon which his forecast is framed, the most important features being the heavy and late snowfall, associated with excessive rain both at Zanzibar and Seychelles. On the whole, he thinks that there is reason to expect that the total rainfall will not be appreciably smaller in amount than that of last year, which was considerably below the normal value.

Heredity and evolution occupy an important position in the July issue of *Biologisches Centralblatt*, Mr. H. de Vries communicating an article entitled "Altere und neue Selektionsmethode," while Dr. J. Gross discusses the relation between heredity and variation, more especially in connection with the Mendelian theory. The former is largely devoted to the methods of plant-culture adopted by Nilsson and by Rimpau. In the course of the latter the author directs attention to the fact that while albinism among mammals is frequently "recessive," in the case of hybrids between species of which one parent is normally white (such as the Polar bear and the Arctic fox) and the other dark-coloured the offspring are frequently intermediate in point of colouring between their parents. The movements of the spermatozoa of the parasitic nematode worms of the genus Ascaris form the subject of an article by Dr. H. Marcus, while Dr. F. Samuely brings to a close his account of recent researches into the chemistry of albumen and their bearing on physiology.

Captain W. S. Patton, I.M.S., records the occurrence of a parasite in the white corpuscles of the blood of Indian palm squirrels (*Funambulus pennantii*) (Sc. Mem. Gov. of India, No. 24, 1906). The parasite, which in all probability belongs to the Hæmogregarinidæ, occurs as a long vermiform body, measuring 10 μ in length, lying in the substance of the large mononuclear leucocytes. The majority exhibit slow vermicular movements altering their position in the cells, sometimes lying close to the nucleus, sometimes at right-angles to the nucleus. The nucleus may be compressed or split by the parasite. In some cases free vermicules were seen in the plasma. The parasites were found in the peripheral blood, spleen, and liver. In the louse (an undescribed species of Hæmatopinus) infesting the animals vermicules were met with.

In the last number of the *Journal of Anatomy and Physiology* (vol. xl., part iv.) Dr. Gaskell gives a final paper on his views of the origin of vertebrates, which he believes are derived from arthropods. In the present paper, a study of ammocœtes, the origin of the notochord is discussed, and the suggestion is made that it has originated as an accessory digestive tube. The remaining articles are mostly anatomical in character.

According to the July issue of its Journal, the Marine Biological Association of the United Kingdom is extending the investigations which have already been instituted with regard to the distribution of the Channel fauna in the neighbourhood of Plymouth to deeper waters, and it is hoped during the present year to enlarge still further the area of survey. Special attention has been directed to improving the methods of rearing organisms in the laboratory, in regard to which a report is shortly promised. An investigation has also been commenced with regard to the nature of the food of mackerel and pilchard and other migratory fishes frequenting the mouth of the Channel in relation to seasonal changes.

In his report for 1905, Dr. Benham, the curator, states that the Otago University Museum has been enriched by a valuable collection of eggs of New Zealand birds presented by Dr. Fulton, and also by the gift of a large series of ethnological objects from Mr. and Mrs. James Mills. The latter, which are chiefly weapons, are mostly Polynesian, and were collected some five-and-twenty years ago.

"The Living and Fossil Species of Comptonia" is the title of one of the two articles in the July number of the *American Naturalist*. According to the author, Mr. E. W. Berry, the genus is represented at the present day only by a single species, which is a low shrub ranging from Nova Scotia to Manitoba, and southwards to Carolina and Tennessee, but the number of extinct forms which have been described is upwards of three score, with an almost cosmopolitan Tertiary distribution. In the second article Mr. C. S. Meads discusses the adaptive modifications of the occipital condyles in mammalian skulls. The basal connection between the two condyles in spiny anteaters is regarded as a direct reptilian inheritance. It is pointed out that there is a very marked difference between the carnivorous and ungulate type of condyles, the latter being much elongated inferiorly, so as to admit of great angulation of the head in relation to the vertebral column, and thereby, in the case of ruminants, presenting an armed front to the foe.

The Tertiary lake-basin of Florissant, Colorado, receives a large share of attention in the third number of vol. iii. of the University of Colorado Studies, Mr. J. Henderson dealing with the basin itself, while Mr. T. D. A. Cockerell discusses the fossil fauna and flora of the Florissant shales. A paper on the existing flora of the district, by Dr. F. Ramaley, may be regarded as supplemental to the other two. The Florissant shales, which contain a very rich series of fossils, are apparently later than the well-known Green Rover shales, and may probably be assigned to the Miocene period. "The plants and insects are wonderfully preserved in fine volcanic sand or ash, deposited in layers which readily split apart, revealing the specimens, just as they fell, in prodigious numbers. Green leaves and even branchlets were torn from the trees, and insects perished wholesale in a catastrophe that must have equalled that of Martinique."

Two new memoirs of the Geological Survey of England and Wales have been received, "The Geology of the Country near Sidmouth and Lyme Regis," by H. B. Woodward and W. A. E. Ussher, and "The Water Supply of Suffolk from Underground Sources," by W. Whitaker, with contributions by Dr. H. F. Parsons, Dr. H. R. Mill, and Dr. J. C. Thresh. The former memoir is explanatory of sheets 326 and 340 of the new series, colour printed, geological maps (1 inch to the mile). It embraces a district that is famous no less for the eminent pioneer geologists who have worked in it than for its intrinsic geological interest. The cliff sections, so well exposed along the coast, are represented by numerous diagrams; there are also some small black-and-white maps and a few time-honoured representations of common fossils; the frontispiece is a reproduction of one of Sir A. Geikie's vigorous sketches, depicting the Axmouth or Bindon landslip. A short chapter on the local economic geology is done with more care than is usual in these "sheet explanations," and is quite adequate for the purpose. No striking advance appears to have been made with the difficult problem of the correlation of the lower New Red Sandstone series. The "Water Supply of Suffolk" is the fourth of the series of county memoirs dealing with this subject. It comprises a brief introduction to the geology, with remarks on the more notable borings, as that at Stutton, and others which record a remarkable thickness of Glacial drift. There is a sketch of the county rainfall with a coloured rainfall map by Dr. H. R. Mill, a series of detailed records of wells and borings, and a number of analyses of Suffolk waters. These water-supply memoirs should be of the greatest value to engineers, builders, and others. We note, for the first time, the free use of the American "geologic" in an English survey memoir; it is to be hoped that in future numbers of the series the practice of inserting maps showing the depth of water-bearing strata may be imported from the same quarter—this would be a much more useful innovation.

The application of artificial manures to forest land has received some attention in Belgium and Germany, the results being sufficiently encouraging to induce Dr. Borthwick to bring the matter to the notice of the Royal Scottish Arboricultural Society. Besides showing an increase of growth, it has been found that trees on manured soil are stronger and less liable to disease. Dr. Borthwick's address is printed in the Transactions of the Society (vol. xix., part ii.), wherein there appear several papers by Dr. Nisbet, Mr. W. M. Stewart, and Mr. R. Galloway on the advisability and cost of establishing plantations in Great Britain, either as a cooperative undertaking or otherwise. A system is described of combating larch disease by thinning out the pure larch woods after sixteen or twenty years and planting up with other conifers or beech.

The Department of Agriculture in the Federated Malay States was initiated in June, 1905, so that the report of the director, Mr. J. B. Carruthers, refers to half a year's work. Mr. Carruthers is continuing his experimental trials, previously started in Ceylon, of protective jungle belts to prevent the spread of fungal and insect pests. Reference is made to the more important products of the States, *e.g.* rubber, cocoanuts, sugar, and rice. At present the acreage of land planted with cocoanut palms is three times as great as that planted in rubber, but the value of the latter is already greater. On swampy lands it is suggested that nipah and sago palms will yield profitable results.

Sir Dietrich Brandis contributes an account, with illustrations, of some bamboos collected in Martaban to the April and May numbers of the *Indian Forester*. Allusion is made to the transverse veins and the longitudinal bands of silica cells on bamboo leaves that are both well marked in *Pseudostachyum polymorphum*. The genera Oxytenanthera and Gigantochloa are characterised by the connate arrangement of the anthers, forming a transparent membranous tube. The rhizomes of a Phyllostachys and *Thyrostachys siamensis* are converted into walking-sticks and umbrella handles.

A new photographic paper has recently been put on the market by the Falla-Gray Photo Paper Co., Ltd., and samples have been submitted to us for trial. The special feature of the paper is that by some preparation of the emulsion it has been found possible to give a film which can be satisfactorily fixed by an immersion of only one minute in the hypo bath, and as satisfactorily washed in five minutes after fixing. It is claimed that this great saving of time is not obtained at any expense of the permanency of the prints. In actual working the paper is similar to the general type of gaslight paper, the image appearing quickly and rapidly acquiring full density. With the developer recommended, a rather strong combination of metol and hydroquinone, excellent toned greys and blacks appear to be easily obtained, while the semi-glossy surface is well adapted to give all the detail that may be required for reproduction purposes. The paper should prove useful for Press purposes, where fine gradation and speed of production are specially necessary, while to the ordinary worker it will be recommended by its full range of tones and adaptability to most kinds of negatives by variations of exposure.

The eleventh "Annual" of the British School at Athens has been issued by Messrs. Macmillan and Co., Ltd; it describes the work accomplished during the session 1904–5. Dr. A. J. Evans, F.R.S., contributes a provisional report on the excavations during the year at the palace of Knossos and its dependencies; there are five articles on Laconia concerned respectively with the excavations near Angelona, the excavations, sculptures and inscriptions of Geraki, the excavations and inscriptions of Thalamae, a note on the Ἑρμαῖον on the north-east frontier, and the Frankish sculptures at Parori and Geraki. The assistant-director of the school, Mr. M. N. Tod, describes inscriptions from Eumeneia, and there are in addition nearly a dozen other well-illustrated contributions, making up with the sixteen plates an admirable and interesting volume.

An interesting pamphlet on the development of the Bristol Museum and Art Gallery has been written by Mr. W. R. Barker, chairman of the Museum and Art Gallery committee, and issued by Mr. Arrowsmith, of Bristol. In it is traced the institution from its inception (as the Bristol Library Society) in 1772 to the present day. The pamphlet, which is well worth perusal, is illustrated by some excellent process engravings.

THE Journal of the Royal Sanitary Institute for August contains the inaugural address delivered by Sir Edward Fry, president of the congress held last month; it contains also the lecture by Prof. C. Lloyd Morgan on "The Relation of Heredity to Physical Deterioration," and that on "The Wastage of Human Life" by W. Fleming Anderson.

THE July issue of the *Museums Journal* contains, in addition to its General Notes, the address on "The Education of a Curator," delivered at the Bristol conference of the Museums Association by Dr. W. E. Hoyle, the president of the conference.

A NEW book on the microscope, by Sir A. E. Wright, F.R.S., is announced for early publication by Messrs. Archibald Constable and Co., Ltd. The work will contain a complete vocabulary of technical terms relating to the microscope.

OUR ASTRONOMICAL COLUMN.

FINLAY'S COMET (1906*d*).—The results of a number of observations of Finlay's comet (1906*d*) are published in No. 4108 of the *Astronomische Nachrichten*.

At the Utrecht Observatory the comet was seen on July 21, and recorded as very faint; the observation showed that corrections of −12m. 58s. and −1° 51′ were necessary to the ephemeris published by M. Fayet.

The magnitude of this object was found to be 9·0 when observed at Strassburg on July 17, its diameter being recorded as 12′.

In No. 4109 of the *Astronomische Nachrichten* M. L. Schulhof states that the ephemeris derived from his elements shows a greater error than he had foreseen, an error which a superficial revision of his calculations for the perturbations has failed to discover. The comet appears to have suffered a retardation which as yet is unexplained.

Applying, provisionally, the corrections shown to be necessary by the Strassburg observation, he has calculated another ephemeris, from which the following is taken:—

Ephemeris 12h. (M.T. Paris).

1906	α (app.) h. m. s.	δ (app.) ° ′	log Δ	$1 : r^2\Delta^2$
Aug. 8	2 47 36	+2 40	9·40344	13·72
10	3 5 35	+4 23	9·40744	13·78
12	3 23 6	+6 2	9·41390	13·67
14	3 40 2	+7 35	9·42253	13·41
16	3 56 17	+9 1	9·43301	13·03
18	4 11 49	+10 21	9·44499	12·56

OBSERVATION OF A BRIGHT METEOR.—A communication by Herr Ph. Fauth in No. 4109 of the *Astronomische Nachrichten* states that a bright meteor was observed at Landstuhl on July 16.

The time of observation was 11h. 39m. (local M.T.), and the object appeared in the N.N.W. Its brightness was greater than that of the full moon, and its path was between 12 Canum Venaticorum and γ Virginis. The duration of the light was about 1·5 seconds, and no detonation was noted.

DOUBLE-STAR MEASURES.—The results of the micrometer measures of double stars made with the 28-inch refractor at Greenwich during the year 1905 appear in No. 8, vol. lxvi., of the *Monthly Notices* (R.A.S.).

In addition to a large number of stars contained in the ordinary working list, and for which the name, position, position-angle, distance, magnitudes, and epoch of observation are given, a number of Struve stars which have been neglected, or for which periodical observations are required, were observed. Only the names of the latter are now published, the results of the measures being reserved for the *Greenwich observations* for 1905.

The measures now published are, in general, confined to stars of which the separation does not exceed 4″ or which show orbital movement.

In Nos. 4107–8 of the *Astronomische Nachrichten* Dr. G. van Biesbroeck publishes the results of the measures of 177 Struve stars made with the 12-inch refractor of the Heidelberg Astronomical Institute. The measures of twenty-nine comparison double stars are also given.

INTERNATIONAL CONFERENCE ON HYBRIDISATION AND PLANT-BREEDING.

THE Royal Horticultural Society held high festival in its new hall and elsewhere from July 30 to August 3. The occasion was the third conference on plant-breeding, previous gatherings having been held at Chiswick and in New York. Mr. William Bateson presided, and was so thoroughly imbued with his subject that the visitors found it difficult which to admire most, his grasp of difficult and complex problems, his able management, or his powers of endurance. The programme was a very long one, although some of the papers were, in the absence of their authors, taken as read. All the memoirs will be printed in full in the journal of the society. The speakers included, besides our own countrymen, Danes, Swedes, Germans, Austrians, French, and Americans.

"Mendelism" was naturally to the fore, and the numerous exhibits in illustration of the phenomena did more to secure general acceptance for the theory than did the elaborate disquisitions. Some of these, especially those of a mathematical character, evoked from the chairman the remark that we had reached the limits of our comprehension. In his introductory address Mr. Bateson gave a very interesting summary showing the advances that had been made since the first conference in 1898. The predominant note then was mystery—in 1906 we speak less of mystery and more of order.

Mr. Bateson suggests the adoption of the term "genetics" to indicate the nature of our researches into the phenomena of heredity and variation, in other words, the physiology of descent. He showed that we had already arrived at a clear conception of the true meaning of "pure-bred," pointing out that an individual is pure-bred when the two cells, male and female, from which it develops are alike in composition, containing identical elements or characters. Instead of regarding genetic purity as a vague state which may or may not be attainable by a long course of selection or fixation, we now know exactly what it is and how it is produced.

Similar explanations were given as to the significance of "reversion"; the reappearance of the ancient characters is brought about by the meeting together of distinct elements long parted, but how this is effected is still unexplained. Conversely, "variation" is often due to the separation or elimination of factors, and sometimes probably to the addition of new factors. Heredity is now known to be a regular phenomenon less or more amenable to experimental methods of research. When someone says, "But can't you breed a Derby winner or do something useful?" Mr. Bateson replies that "though in the attempt to discriminate among animals all good enough to win science may be as much at fault as common sense, yet it would not surprise me if science were to devise a way of breeding even racehorses which would not produce about a hundred 'wasters' for one fit to win—and yet I understand that common sense remains content with that rather modest attainment after two centuries and a half of steady trying." Mr. Bateson concluded by pointing out that the great advances in the application of science have generally become possible through discoveries made in the search for pure knowledge. In no other spirit can natural knowledge be more profitably pursued.

Other papers were contributed by Prof. Johannsen, of Copenhagen, whose views did not meet with universal acceptance, Messrs. Hurst, Darbishire, Yule, Dr. Wilson, of St. Andrews. Mr. de Barri Crawshay, Mr. Rolfe, and Prof. Pfitzer spoke on orchids; Mr. Chittenden and Dr. Tschermak dilated on questions of heredity. Prof. Rosenberg, of Stockholm, had a most important paper showing the behaviour of the chromosomes in hybrid plants. M. Noel Bernard spoke of the symbiosis existing between the roots of orchids and the hyphæ of certain fungi.

Miss Saunders, in a very lucid manner, explained the complex results she had obtained in crossing stocks, a paper the comprehension of which was much facilitated by the numerous specimens exhibited in the hall. Mr. Biffen contributed a remarkable paper on the application of Mendel's laws to the improvement of cultivated wheats, and various communications from raisers of carnations, potatoes, bulbs, roses, amaryllids, and other plants were read. The entire programme, with very few exceptions, was worked through under trying conditions of heat and street noises, and those who participated in the hard work honestly earned the recreation that was furnished them by garden-parties at Burford and Gunnersbury, to say nothing of the banquets offered to the foreign guests and other visitors by the Royal Horticultural Society and the Horticultural Club. The success of the conference was marked, and congratulations may be tendered to all who took part in its organisation.

MAN AND THE GLACIAL PERIOD.[1]

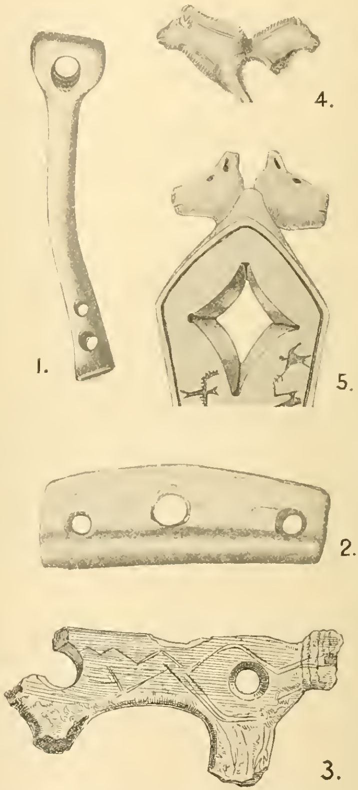
THE correlation of the successive occupation of Europe by various races of mankind with the successive events of the Glacial period has been greatly facilitated by the successful investigations of Prof. Albrecht Penck into the Quaternary history of the eastern Alps. Four well-defined terraces can be traced up the valleys of this region, each of them taking its origin in a terminal moraine. They represent the deposits of rivers issuing from the front of the ice during a glacial episode. Between the terraces the valleys show evidence of deepening by erosion during periods which correspond to genial intervals, the last of which, in order of time, is represented by the breccia of Hötting, when the temperature at Innsbruck, as shown by the included leaves and bracts of *Rhododendron ponticum*, was 3° C. higher than the average at the present day.

The earliest remains of the human family are afforded by *Pithecanthropus erectus* of Upper Pliocene age; the skull of this creature, while singularly simian in form, is shown to be human by its capacity (850 c.c.). Evidence supposed to indicate an even earlier existence of man-like species is afforded by the so-called "eoliths," but these it is now scarcely necessary to consider seriously, especially after the observations recently made on the eolithic forms which occur as a by-product in the manufacture of cement at Mantes. Probably 99 per cent. of the supposed implements obtained from the plateau gravels of southern England are of a doubtful character, but there is a small remainder, comprising forms distinguished by a notch, almost semi-circular in outline, which so closely resemble the scrapers once used among the Tasmanians for making their wooden spears that it seems most natural to regard them as of human origin.

The Tasmanians were the most unprogressive race in the world, and probably the oldest within the Australian region; their cranial capacity was 1160 c.c., and they were ulotrichous. It would hence appear that the cleavage between the Ulotrichi and the rest of the human species must have occurred at a very remote period.

The Chelléan stage of culture is represented by stone implements, which occur in the third fluvio-glacial terrace of southern France at the foot of the Pyrenees, and in possibly corresponding gravels in the valley of the Thames. The numerous skulls of Chelléan age which have been met with in cave deposits (Neanderthal, Spy, Krapina) agree in all essential features, and evidently belonged to a single race (*Homo primigenius* of Schwalbe), now most nearly represented by the Australians. In cranial capacity there is a close agreement between the recent and extinct races (1250 c.c.).

The Solutrian stage follows upon the Chelléan, and implements representing it are found in the löss of the Danube, which occurs between the third and fourth fluvio-glacial terraces, and thus occupies an horizon corresponding to that of the Höttinger breccia. The Solutrian, or löss man, as the Germans sometimes call him, lived in a warm or genial climate. To the artists of this race are to be ascribed the drawings and paintings left upon the walls of numerous caves in France and Spain, which recall by their spirit and technique the work of the Bushmen in South Africa. The associated figurines carved in various material present two remarkable anatomical features (steatopygy and elongated labia minora) which are peculiar to South African races, so that, even without the evidence afforded by the Grimaldi skeletons in the Grotte des Enfants, Mentone, we might safely regard the Solutrian race as ancestral to the Bushmen or some allied



1 and 2. Arrow straighteners used by Eskimos of Baffin Bay, after Boas. 3. Arrow straightener of Magdalenian age, from the Kesslerloch, near Thayngen, after Merk, from Hoernes. 4 Head of a Magdalenian arrow straightener, after Lartet. 5. Head of an Eskimo arrow straightener, after Dawkins.

[1] An abstract of three lectures delivered at the Royal Institution on May 24, 31, June 7, by Prof. Sollas, F.R.S.

race. Stow, in his excellent account of the South African races, has furnished the key to much of Solutrian history, and it is of particular interest to observe that this author was led by independent evidence to conclude that the original home of the Bushmen lay far to the north of the area they occupied at the time we first became acquainted with them. The cranial capacity of the Bushmen was 1330 c.c.; that of the Grimaldi skeletons has not yet been made known.

The Magdalenian race, or the reindeer hunters, the last of the definitely Palaeolithic tribes, evidently lived under somewhat severe conditions of climate. A study of their implements and mode of life certainly suggests, as Prof. Boyd Dawkins first pointed out, some connection with the Eskimos, but this is a view which has not commended itself to the majority of investigators. The so-called "batons de commandement" may be selected as affording the crux of the problem; these have been compared by Prof. Dawkins with the Eskimo arrow straighteners, an explanation rejected by Hoernes and others on the ground that the Magdalenian people were unacquainted with the use of the bow. This, however, is a pure assumption, unsupported by facts. A stronger objection may be found in the shape of the perforation which characterises the Eskimo straightener as represented by Prof. Dawkins; this is lozenge-shaped, as it is in all the examples I have seen preserved in our museums; in the "baton," on the other hand, the form is invariably circular. Some of my archaeological friends have gone so far as to assert that this form is incompatible with use as an arrow straightener, though I have myself made perforated "batons" out of deer's horn which serve to straighten a crooked stick very effectually. But, what is more to the point, Dr. Boas has figured recently an arrow straightener actually used by the Eskimos of Baffin Bay, which not only resembles many "batons de commandement" in general form, but more particularly in the shape of the aperture, since it is drilled with a round hole. These two implements, the arrow straightener of the Eskimos and the "baton" of Magdalenian man, are in this case so nearly identical that no manner of doubt can exist as to the truth of Prof. Dawkins's explanation. Additional interest is thus acquired by a curious resemblance in detail which characterises the arrow straighteners of the two races, otherwise very different both in form of the perforation and in certain artistic qualities; this is to be found in the carved end, which sometimes represents two heads placed back to back, an unusual design, repeated, curiously enough, among a tribe of American Indians in their "topos" or hair-pins, which are similarly terminated by two heads (llamas') *adossé*. These facts, taken in conjunction with numerous other resemblances in detail between the implements at present used by the Eskimos and those of Magdalenian man, cannot fail to suggest some ethnic connection.

As regards the skeletal remains of the period, attention may first be directed to those of the Cro-Magnon type, including the skeleton of the seventh interment in the Grotte des Enfants; the skulls of this type, while resembling those of the Eskimos in some respects, especially in the narrowness of the nose, differ widely in others, such as the length of the face and the height of the orbits; the limb bones indicate a race of tall stature (1800 mm. or 1900 mm.), very different in this respect to the short Eskimos (1646 mm.). In the skeleton of La Chancelade these differences disappear; the skull is remarkably Eskimo-like, the stature deficient (1500 mm.). The osteological evidence would seem to point to the contemporaneous existence of two allied races during the Magdalenian age, one now represented by the Eskimos and the other by neighbouring North American tribes, both possibly inhabiting a large part of Europe and Asia, whence they overflowed into North America either by the Icelandic or the Alaskan route, perhaps by both. The existing Eskimo cult has to a large extent been evolved since the race entered North America. The distribution of Magdalenian remains suggests that the occupation of Europe occurred during the closing phases of the last glacial episode.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—The committee for the study of special diseases announces that Dr. R. C. Brown, of Preston, Lancashire, has promised the sum of 150*l.* per annum for two years for a pathological scholarship in connection with the investigations being carried out by the committee on rheumatoid arthritis and allied diseases. This scholarship will be known as the R. C. Brown Scholarship in Special Pathology, and will be open to all recently qualified men. The scholar will be required to work under the direction of the Huddersfield lecturer in special pathology at Cambridge, and to assist in the research the committee have undertaken on the pathology and bacteriology of the above diseases.

The Frank Smart studentship in botany will be awarded during the present month. The studentship (the yearly value of which is about 100*l.*) is ordinarily tenable for two years, and the student is in special cases eligible for reappointment for a third year. The successful candidate must devote himself to research in botany under the direction of the professor of botany, who shall determine the conditions under which the research is to be conducted and the place or places in which it is to be carried on. Applications must reach the Vice-Chancellor, Trinity Hall Lodge, on or before Saturday, August 25.

Prof. Uhlenhuth, of Greifswald, has been appointed director of the newly established department of bacteriology in connection with the Imperial Bureau of Health, Berlin.

Dr. G. D. Harris, of Cornell University, has been appointed to the chair of geology in the Louisiana State University; he will also direct the Geological Survey of Louisiana.

Prof. E. A. Minchin, professor of protozoology to the University of London, will deliver his inaugural lecture on "The Scope and Problems of Protozoology" on November 15.

Miss Ethel Hurlbatt, principal of Bedford College for Women, London, has accepted the post of warden of the Royal Victoria College, McGill University, Montreal. Her successor will shortly be appointed, and will, it is hoped, go into residence at the beginning of the Lent term.

Mr. R. L. Wills has been appointed by the Kent Education Committee director of technical instruction in the Chatham, Rochester, and Gillingham district, and Mr. J. Quick has been appointed by the same committee director of technical instruction in the Folkestone, Ashford, and Hythe district.

On Saturday last Prof. T. Clifford Allbutt, F.R.S., and Prof. H. H. Turner, F.R.S., had the degree of D.Sc. conferred upon them by the University of Leeds; the degrees in connection with the British Association meeting and the celebration of the jubilee of the coal-tar industry, to which attention was directed in our last number, were also conferred.

Thanks to the aid afforded by the Drapers' Company, the work of the statistical laboratory at University College, London, under Prof. Karl Pearson, has been considerably extended. The laboratory, which possesses a large collection of statistical models and diagrams and of mechanical integrators and calculators, provides a complete course of training in the theory and practice of statistics, and instruction is given in exhibition calculation (mechanical and arithmetical) and the use of statistical quantities.

The Senate of the University of London has accepted from Mr. Martin White two further donations, one to provide a salary of 200*l.* a year for Dr. Edward Westermarck, university lecturer in sociology, for a further period of five years, the other an additional sum of 700*l.* for the establishment for five years of two scholarships a year each of the annual value of 35*l.* and tenable for two years. In connection with Mr. White's benefaction, special courses will be delivered during the session 1906–7 on ethnology, by Dr. A. C. Haddon, F.R.S., and on psychology, by Dr. J. W. Slaughter.

ACCORDING to *Science*, the investigation at Cornell University of problems in fresh-water biology the year through is made possible by a recent provision for a division of limnology in the department of invertebrate zoology in the University. Dr. James G. Needham, of Lake Forest College, has been appointed assistant professor of limnology to take charge of that work. He will enter upon his duties at Ithaca in February of next year. A site for a biological field station has just been selected on the Renwick Lagoon at the head of Cayuga Lake. The necessary station building and equipment will be provided in the spring.

THE calendar of Tokyo Imperial University for 1905–6, a copy of which has just been received, shows that the total number of students enrolled in September, 1905, was 4517 as compared with 3771 in 1903. These students were divided among the constituent colleges as follows:—University Hall, 680; College of Law, 1545; College of Medicine, 641; College of Engineering, 540; College of Literature, 511; College of Science, 122; and College of Agriculture, 469. The number of students at the College of Science is small, probably because all scientific work of an applied kind seems to be apportioned to the colleges of engineering and agriculture, where such subjects as applied chemistry, mining and metallurgy, and agricultural chemistry are studied. The list of original scientific papers published by professors and students of the University is an imposing one, and fills more than forty pages of the calendar.

A COPY of the prospectus of the agricultural department of Armstrong College, Newcastle-upon-Tyne, for the session 1906–7 has been received. Complete courses of work are provided in all departments of agriculture and forestry. The department is subsidised by the Board of Agriculture and by the education committees of the four northern county councils. The Northumberland County Council Experimental Station is worked in connection with the department under the supervision of Prof. D. A. Gilchrist. A special laboratory and the entire use of a byre for ten cows are available, at the Durham County Council Dairy Station, for daily research work. By an arrangement with H.M. Office of Woods, the Chopwell Woods, which extend to about 900 acres, are now placed under the control of the department, and are of great value in connection with the courses in forestry. Intending students will thus see that the college possesses every facility for the practical study of agricultural science.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, June 27.—Sir Archibald Geikie, Sec.R.S., president, in the chair.—Interference-phenomena in the Alps: Dr. Maria M. **Ogilvie Gordon**. The present paper, so far as it deals with the general structure of the Alps, was completed in April, 1905, but the author has since endeavoured to strengthen her line of argument by taking as a type the series of structural changes undergone in the largely igneous mountain-massive of Bufaure in the dolomites. After describing in detail the geology of the Bufaure Massive, the structural relation of the Western Alps and the Engadine to one another and to the whole mountain-system are discussed. From the arrangement of overthrusts, as well as from the distribution of the igneous intrusions in the Western Alps and in the Engadine, it is concluded that these were areas where leading cross-faults intersected the east-and-west Central Alpine band, and shows how the coalescence of these cross-faults with E.N.E.–W.S.W. faults on the north side and W.N.W.–E.S.E. faults on the south side defined two leading fault-curves, the one passing through the Engadine, the other passing through the Western Alps. The cross-segment comprising the Rhine-Ticino district between the Western Alps and the Engadine is regarded as anticlinal in character, segments having been down-thrown from it both towards the west and east, and overthrust masses have crept E. and S.E. from the Western Alps and westward from the Engadine. The relation of the French Jura Mountains to the Alpine system is then discussed, and it is pointed out that the Swiss-French plain flanking the Western Alps presents the same essential features of structure in relation to the Western Alps on its east side and the French Jura Mountains on its west as those elucidated for the Rhine-Ticino cross-segment. The strike-curve round the west formed by the Jura Mountains and the ranges of Dauphiné is interpreted as the peripheral plicational system in the Alps, showing that the region between the Hungarian basin and the mountain-groups of Central France has been under the influence of the westward thrust. The general principle of structure is the sagging of crust-blocks by means of normal faults towards bands or localities of crust-weakness or subsidence, and the reverse or overthrust-movements which may take place from within these bands or localities. The paper affords evidence of differential rates of movement in different parts of a thrust-mass or fault-block undergoing horizontal displacement, both in respect of the laterally-adjacent parts of a thrust-mass and also of the subjacent layers. The maps and sections show that the actual deformations which characterise a thrust-mass have a different direction of strike on either side of an axial band of maximum horizontal displacement. Several examples in the dolomites are described where there has apparently been a local reversal of the regional westward movement. While each individual case demands special examination, an explanation that satisfies certain cases is provided. At localities where the base of the thrust-mass is open to inflows of igneous rock, the igneous material may ascend and be carried onward with the gliding mass. After consolidation of such igneous inflows, they present resisting bodies within the thrust-mass, which, in the same way as any massive developments of sedimentary material, impede the advance of rock-material in the same direction as before. The tendency is for the material of the thrust-mass to be plicated and faulted as it is driven against a resisting body, widening out in a direction parallel with the resisting mass, and piling up the material to such an extent that local reversal of the direction of overlapping is produced.—The influence of pressure and porosity on the motion of subsurface water: W. R. **Baldwin-Wiseman**. The author commences the paper with a brief historical summary of the researches which have been conducted since 1830 on the motion and behaviour of underground water. In discussing the influence of the porosity of a rock on the rate of flow of water through it, he describes the variations in porosity which may occur in restricted areas of the same rock, due to superincumbent pressure, faulting, and the intrusion of dykes. He describes experiments on the rate of desiccation and soakage of rocks. A lengthy series of laboratory experiments, conducted with specially devised apparatus to afford a constant pressure and to eliminate all errors due to lateral flow, are explained, and it is demonstrated that there is not a uniform relation between flow and pressure in rocks over a considerable range of pressure. Various attempts at determining the range of the cone of depletion in strata are passed in review, and a method based upon an experimental determination of the variation of internal pressure in a rock-mass when charged with water and subjected to a considerable difference of pressure on the two faces is outlined. In the concluding portion of the paper data collected during various hydrological surveys are discussed, and the influence of surface-configuration and stratigraphical sequence on the subsurface water-contours are pointed out.

DUBLIN.

Royal Irish Academy, June 25.—Dr. F. A. Tarleton, president, in the chair.—Note on the action of emulsine on β-glycosides: Prof. Hugh **Ryan** and G. **Ebrill**. This paper shows that emulsine hydrolyses the galactoside of α-naphthol in aqueous solution, but is inactive towards the arabinosides of cresol, β-naphthol, and carvacrol, as well as the tetracetyl derivatives of the glucosides of β-naphthol and cresol.—The composition of a nitrogen mineral water at St. Edmundsbury, Lucan, co. Dublin: Dr. W. E. **Adeney**. The mineral water which forms the subject of this paper flows from a spring which is situated in the demesne of St. Edmundsbury, Lucan. The water is supersaturated with nitrogen, and as it rises to the surface of the spring large bubbles of that gas mixed with small quantities of carbon dioxide are constantly evolved, giving it the appearance somewhat of ebullition; hence the name of the "Boiling Well" by which it is marked on the Ordnance maps. The dissolved gases were found to be as follows, expressed in volumes at 0° C., and 760 mm. bar., per 1000 volumes of the water: carbon dioxide, 140·77; oxygen, 0·0; nitrogen, 27·13. The water contains about ninety grains of mineral matter per gallon. The chief constituents are:—calcium bicarbonate, 35·2 grains; sodium chloride, 41·24 grains; magnesium chloride, 9·4 grains; and magnesium sulphate, 3·24 grains, per gallon. It also contains small quantities of ferrous bicarbonate, potassium chloride, and traces of lithium chloride and of barium sulphate. It is probable that the excess of nitrogen which this water holds in solution was derived from the fermentative decomposition of nitrates; 1·8 parts nitric nitrogen per 100,000 parts of the water would, on decomposition, yield 14 c.c. nitrogen, at 0° C., and 760 mm. bar., which represents about the quantity in excess of the gas in solution. The fact that after several days of strong frost, and at a time when the temperature of the air was 32° F., that of the water, as it rose to the surface of the spring, was 60°·5 F., shows that the water must rise from a considerable depth below the surface of the ground, and this suggests an explanation as to how the water holds so large an excess of nitrogen in solution. A careful examination was also made of the water to ascertain whether it contained any matters which would render it unfit to be drunk, but with negative results.

Edinburgh.

Royal Society, July 2.—Prof. Crum Brown, vice-president, in the chair.—The use of soluble Prussian blue in investigating the reducing power of animal tissue: Dr. D. Fraser **Harris**. The method of experiment was to inject the blood vessels of either decerebrate cats and rabbits or the isolated surviving kidney or liver of pig or sheep. In the latter cases the blue of the potassio-ferric-ferrocyanide is in the capillaries reduced to the pale green or colourless compound, the di-potassio-ferrous-ferrocyanide—a vital reduction expressed, *not* by a deoxidation, but by change of trivalent iron into divalent iron. Irrigation with H_2O_2 restored the blue colour. In the experiments on the kidney, when the pressure of injection rose to 100 mm. of mercury, a colourless, gelatinous artificial urine dropped from the ureter, and the pelvis of the kidney was filled with colourless gelatin; this leuco material at once became blue on irrigation with H_2O_2. Various considerations showed that the green or leuco condition resulted neither from the action of the alkaline salts of blood and tissues nor from putrefaction, but proved the existence within the blood of "reducing substances." The leuco compound ten years after formation within capillaries can still be, by the H_2O_2, restored to the blue condition. The least perfect reduction is in the great vessels, the most perfect in the thin-walled capillaries, *i.e.* in those vessels which are supplying material for anabolism to the living cells endowed with a high reducing capacity.—The viscosity of solutions, part i.: C. **Ranken** and Dr. W. W. **Taylor**. The paper contained an account of the apparatus, and also the measurements of aqueous solutions of electrolytes and non-electrolytes at various temperatures and concentrations. Of the substances examined, mercuric cyanide is the only one with a temperature coefficient smaller than that of water. Dilute solutions of carbamide at low temperatures have "negative relative viscosity," being probably the first example of a non-electrolyte in water which is known to exhibit it.—Two lecture experiments in illustration of the theory of ionisation: Dr. W. W. **Taylor**. (1) To show that the ionisation of an acid is diminished by addition of salts of an acid; addition of dilute nitric acid or of strong solution of potassium nitrate does not coagulate albumen; together they do so immediately. (2) To show that a weak acid turns out a strong acid from its salts; acetic acid solution or strong solution of potassium nitrate does not coagulate albumen; together they do so. This can be shown not to be due to potassium acetate.

July 13.—Dr. R. H. Traquair, vice-president, in the chair.—Obituary notice of S. P. Langley: Dr. W. **Peddie**.—The recent epidemic of trypanosomiasis in Mauritius; its cause and progress: Dr. Alex. **Edington** and Dr. J. M. **Coutts**. The authors believe that the infection did not come from India with a cargo of cattle, as has been stated, but that it had been already in the island in a latent form. This belief is further strengthened by information recently obtained that a case of trypanosomiasis actually existed on the adjacent French island of Réunion in August, 1901, which antedated the earliest date in Mauritius. Cattle which had been made immune to the trypanosome were found to be still susceptible to the *Trypanosoma brucei*—the parasite of the tsetse-fly, which is thus proved to be specifically distinct. The parasites totally disappear in the blood of immunised cattle. In goats the infection is evinced by progressive emaciation and death after about two months; but although their blood is virulent and produces trypanosomes in susceptible animals, no trypanosomes could be detected in the blood fluids or tissues of the goats. According to the report for 1904 of the director of the Health Department of Mauritius, the epidemic is slowly but surely diminishing. The importation of mules, which are very susceptible to the disease, tends more than anything else to maintain the disease in an active form.—Note on the smolt to grilse stage of the salmon, with exhibition of a marked fish recaptured: W. L. **Calderwood**. In 1905 the Tay Fisheries Company marked about 6500 smolts by the attachment of a small piece of silver wire to the dorsal fin. On June 1, 1906, the first grilse marked with a wire was taken in the Tay. Since then four other fish had been recaptured. The one exhibited was 24 inches long; fully a year before, when marked with the wire, it was about 5 inches long. Its growth during its residence in the salt water was estimated at from three to six ounces per month.—The effect of precipitation films on the conductivity of electrolytes, part i.: W. S. **Millar** and Dr. W. W. **Taylor**. The paper contained an account of results obtained by use of the alternating current and telephone method with films of aluminium hydroxide, chromic hydroxide, and cupric ferrocyanide. The solutions compared were the chlorides, bromides, and sulphates of potassium, sodium, and ammonium; sodium ammonium tartrate, and sodium ammonium racemate.—The theory of alternants in the historical order of development up to 1860, and the theory of circulants in the historical order of development up to 1860: Dr. Thomas **Muir**.—The length of a pair of tangents to a conic: Prof. **Anglin**.

Paris.

Academy of Sciences, July 25.—M. H. Poincaré in the chair.—The president announced the death of M. Brouardel.—The toxic action and localisation of the radium emanation: Ch. **Bouchard** and V. **Balthazard**. The presence in the peritoneum of the guinea-pig of 2 grams of barium sulphate containing about 5 mgr. of radium sulphate proved fatal to the animal. In a control experiment with the same quantity of barium sulphate free from radium, the animal suffered no inconvenience. The distribution of the radium emanation in the various organs of the animal after death was determined by an electrical method. The suprarenal capsules showed the largest proportion of the emanation, the lungs, skin, liver, and kidneys showing decreasing amounts. The author points out that from the chemical inertness of the emanation this selective action of the organs of the body is unexpected.—The results of two deep borings in Picardy: J. **Gosselet**. The boring at Saigneville was carried to a depth of 425·95 metres, the Devonian being encountered at a depth of 408 metres. The strata met with are compared with those encountered in the boring at Péronne, the latter having a depth of 500 metres. The extension of vectorial algebra with the aid of the theory of binary forms, with applications to the theory of elasticity: Emile **Waelsch**.—A class of integral series: Michel **Pétrovitch**.—Lagrange's projection applied to the map of European

Russia: N. **de Zinger.**—The mobility of the ions produced by the Nernst lamp: L. **Bloch.**—The experimental study of telegraphic transmission: M. **Devaux-Charbonnel.**—The relation existing between electrical resistance and the viscosity of electrolytic solutions: P. **Massoulier.** The conductivity of solutions of potassium chloride in glycerol has been measured for varying concentrations of glycerol. The resistance was not found to be strictly proportional to the viscosity, but there is obviously a relation between the two magnitudes, since while the viscosity varied from 1 to 5·6, the product of conductivity and viscosity only changed from 1 to 1·3. Similar results were obtained on measuring the conductivity and viscosity of potassium chloride in sugar solutions.—The influence of pressure and form of discharge on the formation of ozone: A. **Chassy.** At pressures below 6 cm. no ozone is formed, no matter how long the experiment is prolonged. This effect would appear to be due to a change in the nature of the discharge at this pressure.—Contribution to the study of ultramarine: C. **Chabrié** and F. **Levallois.** The prolonged action of an aqueous solution of silver nitrate at 140° C. upon ultramarine gives sulphuric acid and silver nitrite, together with nitric oxide.—Zirconium silicide ($ZrSi_2$) and titanium silicide ($TiSi_2$): Otto **Hönigschmid.** The reduction of zirconium oxide and the double fluorides of zirconium and titanium by the alumino-thermal method in presence of a large excess of silicon gives the silicides $TiSi_2$ and $ZrSi_2$.—The alloys of lead and calcium: L. **Hackspill.** The best method of preparing these alloys is the electrolysis of fused calcium salts with a molten lead kathode. Alloys containing from 7 per cent. to 21 per cent. of calcium were heated in a vacuum to about 1000° C.; lead distilled off, and the alloy remaining had the composition Pb_3Ca_2 in each case.—Kathode phosphorescence spectra of terbium and dysprosium diluted with lime: G. **Urbain.**—Radio-active lead extracted from pitchblende: Jean **Danysz,** jun.—The constitution of hordenine: E. **Léger.** Hordenine gives picric acid when treated with nitric acid, and trimethylamine on the dry distillation of its iodomethylate. The formula $(OH)C_6H_4.CH_2.CH_2.N(CH_3)_2$ is suggested as the most probable.—The action of phenylmagnesium bromide on the esters of the dialkylamidobenzoyl-benzoic acids: J. **Pérard.**—The introduction of the dinaphthopyryl and xanthyl radicals into electronegative molecules: R. **Fosse** and A. **Robyn.**—The diamino-acids derived from uvalbumen: L. **Hugounenq** and J. **Galimard.** Egg-albumin has furnished 2·14 per cent. of arginine and 2·15 per cent. of lysine.—The mixed crystals of barium chloride and bromide: Jean **Herbette.**—The production of a new elementary species of maize by traumatism: L. **Blaringhem.**—The disease of wine known as "la graisse": E. **Kayser** and E. **Manceau.**—New observations on the retrocerebral apparatus of rotifers: P. Marais **de Beauchamp.**—A new method of obtaining crystals of hæmatin in the medico-legal diagnosis of blood spots: MM. **Sarda** and **Caffart.**—The Gault and Genomanian of the Seybouse basin: J. **Blayac.**—The liquefaction of volcanic carbonic acid in Auvergne. The poison spring of Montpensier: Ph. **Glangeaud.**—The resistivity of mineral waters, their coefficient of variation with temperature, and the differentiation of natural mineral waters from similar waters made artificially: D. **Negreano.**—The structure of the Fusilinideæ: Henri **Douvillé.**—The formation of ground ice: J. **de Schokalsky.** A detailed account of observations on the formation of ground ice in Lake Ladoga, near St. Petersburg.

CAPE TOWN.

South African Philosophical Society. June 27.—Dr. J. D. F. Gilchrist in the chair.—Opisthobranchiata of South Africa: Prof. **Berg.** Forty new species are described, of which several represent new genera. Both tectibranchs and nudibranchs are well represented. Among the former are eight new species of Aplysia. The difference between the fauna of the east and west coast is marked in these marine animals, the region west of the Cape Peninsula having forms of northern character; the region to the east of the Cape of Good Hope has more of a tropical Indian character.—Dr. R. **Broom** communicated five papers:—(1) The early development of the appendicular skeleton of the ostrich, with remarks on the origin of birds. In the early embryo there are three well-developed toes and two others rudimentary. In the pelvis the pubis and ischium are directed downwards and united by pro-cartilage. In the wing there are evidences of four digits. The author holds that birds are descended from bipedal reptiles intermediate between the Pterosaurs and the carnivorous Dinosaurs. (2) Note on the lacertilian shoulder girdle. It is held that all the various cartilaginous and bony bars found in front of the shoulder girdle are merely parts of the true scapula and coracoid. (3) Some little-known bones in the mammalian skull. A number of bones typically present in the reptilian skull, but not generally recognised as occurring among mammals, are shown to be present occasionally. (4) A new cynodont reptile from the Molteno beds of Aliwal North. A description is given of a new cynodont, the first reptile that has been discovered in the Molteno beds. (5) A new rhynchocephalian reptile from the Upper Beaufort beds of South Africa. A description of a lower jaw of a small reptile allied to Homœosaurus. This is the oldest true rhynchocephalian known.—Notes on South African cycads: Prof. H. H. W. **Pearson.** Field observations upon *Encephalartos Friderici-Guilielmi*, Lehm., *E. Villosus*, Lem., *E. Altensteinii*, Lehm., and a species of Stangeria. Evidence in support of the insect pollination of *E. Villosus* is adduced. In *E. Friderici-Guilielmi* and *E. Altensteinii* the cones are laterally placed, and the growth of the stem is therefore monopodial. The importance of subterranean branching as a means of vegetative reproduction in Stangeria and in *E. Friderici-Guilielmi* is discussed.

CONTENTS.

THURSDAY, AUGUST 16, 1906.

ANTHROPOLOGICAL ETHICS.

The Origin and Development of the Moral Ideas. By Dr. Edward Westermarck. Vol. i. Pp. xxi+716. (London: Macmillan and Co., Ltd., 1906.) Price 14*s.* net.

IN one engaging paragraph of this work, its author describes how, whilst living in the North of Morocco—where he spent four years studying folklore—he was described as a person with "propitious ankles," because the village where he stayed was frequently visited by favoured and distinguished guests. Propitiousness is not with us the most familiar term in such a context, but the ankles of Dr. Westermarck's intellectual endeavour are certainly sturdy. The readers of his "History of Human Marriage"—all of them his debtors—were doubtless prepared for the vast array of footnotes, the excellent way in which long series of facts are arranged, the clearness of the style, the sanity and reasonableness of a work which certainly was needed to keep ethical theory abreast of anthropological research, and which will add greatly to its author's reputation.

This first volume divides itself into two parts. In the earlier the author states his theory of moral judgments, and discusses generally the nature of the phenomena which tend to evoke moral blame or moral praise. In the later part he examines the particular modes of conduct which are subject to moral valuation, and considers how these are judged by different peoples and in different ages.

The chief topics dealt with in the later part are homicide, human sacrifice, hospitality, the subjection of children, and the subjection of wives. It is certainly a great benefit to have the facts so clearly stated on which inductions may be based, and to discover, too, how far generalisations are possible; to be told, for example, that there does exist a moral rule among mankind forbidding people to kill members of their own society, but "that the stringency of this rule is subject to variations, depending on the special relationship in which persons stand to one another, or on their social status, and that there are cases to which it does not apply at all." It is profitable, too, to have certain lingering prejudices corrected. The subjection of wives is a case in point. Dr. Westermarck discusses the apparently cruel custom which ordains (*e.g.* among the Panama Indians) that

"the woman should be burdened with a heavy load, while the man walks before her carrying nothing but his weapons. But a little reflection will make it plain that the man has good reason for keeping himself free and mobile. The little caravan is surrounded with dangers: the man must be on the alert and ready in an instant to catch his arms to defend himself and his family against the aggressor."

Or, again, he contests the frequently repeated statement that a people's civilisation may be measured by the position held by the women.

"So far at least as the earlier stages of culture are concerned, this opinion is not supported by facts. Among several of the lowest races, including peoples like the Veddahs, Andaman Islanders, and Bushmans, the female sex is treated with far higher consideration than among many of the higher savages and barbarians. Travellers have not seldom noticed that of two neighbouring tribes the less cultured one sets, in this respect, an example to the other."

The theoretical part of the work calls for a more detailed criticism. Dr. Westermarck interprets his subject—the origin of moral ideas—very literally, and steadily refuses to discuss validity; in fact, he does not even suggest that there is room or need for a larger investigation, a metaphysic of some sort, such as a work on so-called scientific ethics may perhaps be allowed to omit. His theory is that the moral judgments are based entirely on emotions either of indignation or approval. Consequently there is no objective standard; neither the utilitarian principle that actions are right in proportion as they tend to promote happiness, nor the "practical" or "moral" reason, nor any other standard that may be suggested. "If moral judgments differ from any others that are rooted in the subjective sphere of experience, it is largely a difference in degree rather than in kind." No doubt morality may be in a much greater degree than beauty a subject of instruction and of profitable discussion, but the emotional constitution of man is not so uniform as the human intellect. Such uniformity as there is certainly suggests objectivity; and we are further tempted to objectivise our moral judgments by the fact that authority is so widely ascribed to moral rules. But all this presumed objectivity of moral judgments is a chimæra: for the moral concepts are based upon emotions, and the contents of an emotion fall entirely outside the category of truth. All that can come under the category of truth, all that can be stated as a proposition objectively valid, is that a given mode of conduct has a tendency to evoke in us moral indignation or moral approval.

To all this there are very serious objections. Our author's position is, of course, very natural for one to occupy who is able from the serene heights of anthropology to survey the many contradictions that exist among moral judgments, and to doubt the possibility of unity and objectivity among them. But is *moral* judgment the only sphere in which such difficulty is found? Truth is objective, says Dr. Westermarck. But, not to out-Pilate Pilate, when have we got truth? and has the long labour of science revealed no astonishing contrariety of judgments even in matters where emotions, moral or other, have no place? Man constructs one aspect of experience into knowledge and science: is this intellectual system less liable to error, is it more certainly correct and true than his construction of another aspect into morality and ethics?

Some sentences of Dr. Westermarck seem an elaborate parrying of the point. The best treatment of objectivity in morals is probably that of the late Professor Sidgwick, who argued that there would be general agreement in morals, if only the moral consciousness of men were sufficiently developed. But our author replies, "We may speak of an intellect as sufficiently developed to grasp a certain truth, because truth is objective; but it is not proved to be objective by the fact that it is recognised as true by a 'sufficiently developed' intellect. The objectivity of truth lies in the recognition of facts as true by all who understand them fully, whilst the appeal to a sufficient knowledge assumes their objectivity." How anyone can understand facts fully without sufficient knowledge it will puzzle the plain man to discover. And in another passage he writes: "Far above the vulgar idea that the right is a settled something to which everybody has to adjust his opinions, rises the conviction that it has existence in each individual mind, capable of any expansion, proclaiming its own right to exist, if needs be, venturing to make a stand against the whole world." This sentence seems to the writer of this notice a huge mis-statement, or, if true, true only in the sense in which the same sentence must be understood with the words "the truth" substituted for the words "the right."

But to linger over the more controversial aspects of such a book is always an ungrateful task. With the rest of the work there is little fault to be found. The account of the moral emotions, the treatment of punishment (in which subtle arguments are offered against determent as a sufficient guiding principle), the discussion of the various distinctions suggested by terms like act, agent, motive, intention, the detailed examination of the facts advanced by such authorities as Lord Avebury, Dr. J. G. Frazer, Dr. Steinmetz, are all excellent. On the whole, Dr. Westermarck's view of the condition of savage races is one flattering to humanity if not to civilisation. He points out how much more brutal punishment has often been among the civilised than among the uncivilised. He believes in the "noble savage," and thinks that many accounts of "savagery" among savage races come from a time when they have been affected by a "higher culture," a culture "which almost universally has proved to exercise a deteriorating influence on the character of the lower races." One would like to see a monograph devoted to this subject, and learn what the best missionaries have to say.

JOSEPH PRIESTLEY.

Joseph Priestley. By T. E. Thorpe, F.R.S. English Men of Science. Edited by Dr. J. Reynolds Green. Pp. viii + 228. (London: J. M. Dent and Co., 1906.) Price 2*s.* 6*d.* net.

IT is a curious and unaccountable fact that whilst for more than fifty years we have been in possession of a biography of Cavendish, whose solitary and uneventful existence was chiefly passed within the four walls of his laboratory, a whole century has elapsed without the appearance of any worthy record of Priestley's life, which was so full of human interest and dramatic incident. Following closely upon the centenary commemoration of Priestley's death, the new volume in the series of English Men of Science comes as a fitting and welcome memorial.

That the task should have fallen to Dr. Thorpe seems perfectly natural and appropriate, and one might feel assured beforehand that the writer of the charming little biography of Humphry Davy, poet and philosopher, would be equally happy in his treatment of the present subject. These anticipations have not been disappointed. The book is not for chemists only. It will attract a wider circle of readers, and will not fail to add to the literary reputation of its distinguished author.

No one has perhaps portrayed his own character in his writings more graphically than Priestley. We know the main events of his life from his own pen; we can study his opinions, religious, political and social, in his numerous brochures; the records of his chemical experiments vividly reflect his scientific habit of thought. All his writings express the same candour and simplicity, the same virile honesty, which were the keynotes of his character.

Priestley has happily been allowed to tell his story as far as possible in his own words, and the abstracts from his memoirs, supplemented by others, notably Miss Aikin's account of the life at the Warrington Academy and Miss Russell's thrilling description of the Birmingham riots, are skilfully woven into a continuous and delightful narrative.

Chemists will naturally turn with special interest to the account of Priestley's scientific labours, and here it must be confessed that the small space, unavoidably, no doubt, allotted to this section is the least satisfying part of the volume.

The vast accumulation of experiments from their discursive treatment and confused arrangement would have repaid careful editing. But if we have not everything, we have at least a substantial record of what is most valuable among Priestley's discoveries.

Priestley was in a sense a follower of Hales. The musket-barrel, the trough for collecting gases, the burning-glass for heating substances in vessels standing over water, are described in the "Vegetable Staticks." Hales, moreover, obtained oxygen, like Priestley, by heating red lead in a gun-barrel, but he never knew that the gas he so carefully collected and measured differed from ordinary air. But if Priestley's experiments were suggested by those of Hales they served only as a foundation to build upon. The improvement introduced by Priestley into pneumatic apparatus would alone have earned for him a lasting reputation and the gratitude of subsequent generations of chemists; but his great discovery was, of course, the recognition of different kinds of air.

As a theorist Priestley's claims are insignificant, for he was particularly unfortunate in interpreting his own observations. Dr. Thorpe says very truly:

"The contrast between Priestley the social, political and theological reformer, always in advance of his times, receptive, fearless and insistent, and Priestley the man of science—timorous and halting when he might well be bold, conservative and orthodox when almost every other active worker was heterodox and progressive—is most striking."

Equally striking is the absence of any well-considered plan in his method of experimenting when his work is contrasted with that of his three great contemporaries, Cavendish, Scheele and Lavoisier.

One explanation of these defects may be found in the fact that he was not, as he said, "a practical chemist," or, as we should say, a trained chemist. This was perfectly true. That he knew little about the substances which he employed in his experiments is evident from his habit of applying to his chemical friends for such materials as a man like Scheele would never have hesitated to prepare himself, and, moreover, the absorbing interest of his laboratory seems to have obliterated any inclination towards the study of text-books.

Priestley, in both his social and scientific life, seems to have been pursued by an ironical fate. On the one hand his honest zeal in the cause of reform was turned against him to his undoing; on the other, his experiments which were founded on his cherished theory of phlogiston became the weapon which demolished it. Priestley was fortunately endowed with a serene disposition, and in spite of his many misfortunes it would be incorrect to suppose that his life was not a source of real happiness and satisfaction. Such at least may be gathered from the perusal of the volume before us.

J. B. C.

SPHERICAL ASTRONOMY.

A Compendium of Spherical Astronomy with its Applications to the Determination and Reduction of Positions of the Fixed Stars. By Prof. Simon Newcomb. Pp. xviii+444. (London: Macmillan and Co., Ltd., 1906.) Price 12*s.* 6*d.* net.

AS Prof. Newcomb has been in close touch with all branches of the astronomy of position during the last forty years, and as so much of the progress that has been made is his work, a text-book by him on spherical astronomy will be eagerly examined by all who are interested in the subject.

With such qualifications we may be sure, before opening his book, that we shall be conducted to the various points on the frontiers of the subject, some of which it is necessary to occupy before an advance can be made in any direction; and we are also certain to be spared those tiresome digressions into problems such as "To find the season of the year, when twilight is shortest in a given latitude," which serve to degrade astronomy into a mere examination subject.

Let us examine Prof. Newcomb's arrangements. His first three chapters, forming part i., are introductory. They serve to equip the reader with a competent knowledge of spherical trigonometry, interpolation, and least squares. A pleasing feature at the end of each chapter is a page or two of bibliography.

Part ii. opens with a chapter on spherical coordinates. Practical illustration is given of the problem, so simple in theory and so laborious in practice, of turning latitude and longitude into right ascension and declination; and here we find a striking feature differentiating Prof. Newcomb's book from one that would be written by a mere lecturer on astronomy. The lecturer, if he gave an example at all, would probably work to the nearest tenth of a degree with four-figure logarithms, and tell the reader that that sufficiently illustrates the method. Prof. Newcomb's book is for those who may want to carry out actually calculations of the kind. He therefore places before the reader two different computations of the same problem each with seven-figure logarithms, and knowing that the difficulty is the practical one of keeping out numerical blunders, and not in the last degree the theoretical one of understanding the formulæ, he adds a test computation, thus forcibly insisting upon the superior value of checks by test equations over checks by duplicate computation.

The fifth chapter of the book, the second of part ii., is on time, solar and sidereal, mean and apparent, Greenwich and local, the Besselian and Julian year, with numerical examples.

The sixth chapter is on parallax, naturally subdivided into figure of the earth, and formulæ for parallax in right ascension and so on.

The seventh chapter is a very short one on aberration.

The next chapter is on refraction. "There is perhaps," says the author, "no branch of practical astronomy on which so much has been written . . . . and which is still in so unsatisfactory a state." Prof. Newcomb gives an excellent account of the various hypotheses as to the state of the upper regions of the atmosphere. We have not found any allusion to the way in which observed refractions are mixed up with division error, and R–D discordance. The question of systematic corrections has been reserved for a later chapter.

The ninth chapter, the last of part ii., is devoted to precession and nutation. This chapter, in particular, is full of formulæ and data for practical use, and, like the previous chapter, it concludes with an excellent bibliography.

Part iii. is devoted to the "reduction and determination of positions of the fixed stars." It is the part of the book where the author at length closes with the observations, and to which the previous parts are in fact merely introductory. But even now two more chapters of an introductory kind still remain, chapter x., on the application of precession and proper motion, chapter xi., on star corrections. In chapter xii. we come to a description of the methods of observation and allusion to the systematic errors to which observation is liable.

Chapter xiii. may be regarded as the real purpose of the book. It describes how individual catalogues are corrected so as to reduce them to an adopted system, and thus render them comparable with one another. At the end of the chapter is given a list of star catalogues.

The book concludes with an appendix giving tables and precepts for their use. We are inclined to consider some of these tables a mistake, or, at least, their inclusion in this book a mistake. The fact is that tables in constant use wear out very fast, and we are none of us rich enough to care to throw aside a copy of a three-dollar book when four or five pages of it have become too dirty or too tattered to please our fastidiousness.

We do not know a more excellent book on its subject. P. H. C.

OUR BOOK SHELF.

Die neueren Wandlungen der elektrischen Theorien einschiesslich der Elektronentheorie zwei Vortrage. By Dr. Gustave Holzmüller. Pp. viii+119. (Berlin: Julius Springer, 1906.)

In this little book the author publishes some lectures delivered before a society of German engineers. The subjects for discussion do not seem to have been selected on any principle, and are inadequately represented by the title. The first chapter deals with Newtonian potential, the second with logarithmic potential; neither of these topics can be described as "neueren Wandlungen." We then proceed to the theories of electromagnetism based on "action at a distance," and are informed at the conclusion that these developments are also not new, having been superseded by the Faraday-Maxwell theory, to which the next chapter is devoted. The author devotes a considerable amount of space to analogical representations of the electric field, but the electromagnetic theory of light is considered beyond his scope.

No doubt the author knows best what is likely to interest his hearers; it is sufficient for our purpose to note that his treatment is undeniably accurate. But it should be pointed out that the information which he assumes that his readers possess is rather heterogeneous. The training of German engineers must be very different from that of their English colleagues if they require a lengthy proof that the conservation of mechanical energy is a consequence of the Newtonian law of attraction, and yet are ready to plunge, on the next page, into a discussion of the dimensions of electrical units.

The final chapter deals with the theory of electrons; it is really a description of some of the more important properties of kathode and Becquerel rays. The mathematical aspects are hardly mentioned, so that the term "electromagnetic mass" is used without a word of explanation as to its meaning. It is to be regretted that in this part of his work, where accuracy is especially desirable in the absence of complete text-books, there are to be found many statements which require considerable revision. In fact, when we find the author stating that the diameter of an electron has been determined by the application of the kinetic theory of gases, and accounting for the ionisation of a gas by the adherence of a slow-moving electron to the neutral molecule, we begin to doubt his competency to lecture or write at all on these subjects. N. R. C.

The Unity of Will. Studies of an Irrationalist. By George Ainslie Hight. Pp. xv+244. (London: Chapman and Hall, Ltd., 1906.) Price 10s. 6d. net.

Even if the thinking of this book were of the best, it would seem a somewhat expensive morsel at half the price; and its thinking is not of the best. It professes to be an exposition of the leading doctrine of Schopenhauer, that in self-consciousness the primacy belongs to will. The author is at the same time careful to explain that he is a Vedântist while Schopenhauer is a Buddhist, but we doubt if the ordinary man will appreciate these fine distinctions. We rather fear that the ordinary man will be repelled by a certain lack of unity, coherence, systematic statement, and logical proof. Thus, for example, we have a chapter full of irrelevancy on "hysteria and sophistry, the deadly evils of civilisation." Thus, too, we have a small appendix on the notion of life, which explains that everything in the world is in a certain sense alive, and seems to regard it as a valid argument that "the language of the skilled artisan is full of anthropomorphic expressions." A five-page statement of first principles at the end has certain of the merits that are so conspicuously lacking in the main body of the volume.

Diet and Dietetics. By A. Gautier. Edited and translated by Dr. A. J. Rice-Oxley. Pp. xii+552. (London: A. Constable and Co., Ltd., 1906.) Price 18s. net.

This is a translation of the second edition of Prof. Gautier's book published in Paris in 1904. It contains a vast mass of useful information, and is a laudable attempt to be an exhaustive treatise on diet. It deals with the individual articles of food, animal, vegetable, and mineral; with the combinations of these that constitute dietaries; it contains (*inter alia*) discussions, lightened by homely phrases and apt illustrations, on the dietaries of different races, on vegetarianism, on the part played by food as a source of heat and energy, on the alcohol question; and finally treats of the part played by diet in the cure and alleviation of disease. Prof. Gautier's large experience would lead one to anticipate a useful book; the arrangement of subjects appears, however, to be rather confusing, and the translator, although as a rule he has done his work ably, is not always happy in rendering the original into acceptable English.

German Grammar for Science Students. By Prof. W. A. Osborne and Ethel E. Osborne. Pp. viii+106. (London: Whittaker and Co.) Price 2s. 6d. net.

Science students who have not been taught German in schools will find this volume very useful in enabling them to read scientific papers published in that language. The essential parts of German grammar are described in sixteen lessons, and the exercises, instead of being of the "Have-you-seen-the-hat-of-my-uncle?" type, deal with scientific work and phrases—chiefly relating to chemistry—from the beginning to the end. Lists of words commonly met with in scientific German, and terms of frequent occurrence in papers on anatomical, botanical, chemical, physical, mathematical, and physiological subjects are given in an appendix. The book should be particularly valuable to private students.

LETTER 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.]*

Colour Phenomena in "Boletus cœrulescens."

In reply to the query by Edgar Trevithick respecting the blue coloration in Boletus, Bourquelot and Bertrand (Bull. Soc. Myc., 1896, p. 18) have recently investigated the subject, and consider the action due to the presence of an oxidising ferment they have named tyrosinase. This ferment acts on certain chromogenous materials present in the fungus when exposed to the air.

Geo. Massee.

Royal Botanic Gardens, Kew.

THE EARLY HISTORY OF SPITSBERGEN.[1]

"INASMUCH as industrie and diligence are two principall steps to atchieve great enterprises, and negligence and idlenesse are enemies to the same; we would have you in this charge committed unto you, to embrace the one, and to avoide the other." Such were the instructions of the Muscovy Company to Thomas Edge, the commander of its third expedition to Spitsbergen, in 1610. By these same steps to success Sir Martin Conway has collected the widely-scattered materials of Spitsbergen history, and by wise selection and with high literary skill has wrought them into an addition to Arctic literature of unusual interest. The volume tells us in greater detail than has ever before been possible the history of Spitsbergen from its discovery by Barents in 1596, to the beginning of its scientific exploration by the expedition of Sven Loven in 1837. It is, on its own lines, an ideal geographical monograph, from its bibliographic thoroughness, its sound literary judgment, and its evidence of exhaustive research in British and Continental libraries. It contains much of interest to naturalists, with its fresh information regarding the early whale fishery in the Greenland seas.

Geographical exploration in the Spitsbergen area was begun as a business enterprise, and the keen commercial competition led to serious political complications. Though discovered by a Dutchman, Spitsbergen was formally annexed by England in 1614; but we were forced to agree to a partition of the territory with the Dutch, and after 1670 both nations abandoned it. Though now the only ownerless piece of Europe, it is claimed as being within the Russian sphere of influence, owing to its occupation by Russian trappers in the nineteenth century. The main part of the history is political; but the adventures of the whalers and walrus-hunters, and the tragic fate of various parties left to winter there contribute the most stirring incidents in the narrative.

The chapters of most scientific interest are those dealing with the fishery for *Balaena mysticetus*, the Greenland right whale, which was begun by some Biscay whalers in the employment of the Muscovy Company of London in 1611. The European whaling industry was founded by the Basques, and, as the author tells us, the British and Dutch whalers retained many Basque methods, regulations and terms, as, *e.g.*, harpoon. The Dutch, having established their claim to join in the whale fishery, founded Smeerenburg, or Blubbertown, in 1614, on Amsterdam Island, off the north-eastern corner of Spitsbergen. This, the most northern town on record, flourished from 1633 to 1643. The whale oil was prepared on shore, and, according to Sir Martin Conway's estimate, the town was occupied in the season by from 1000 to 2000 people—a number far below the exaggerated reports of 20,000 which are so often quoted. The book includes some interesting contemporary accounts of the whaling industry, of which perhaps the most valuable is Fotherby's description, written in 1615, of the method of whale capture adopted at that period.

The Spitsbergen settlements declined after 1644, as the whales abandoned the fiords and had to be followed into the Greenland Sea, and there killed and treated. The Dutch kept up the fishing somewhat later than the English whalers, who abandoned the industry in 1670, and only resumed it, and then not from Spitsbergen, after 1770.

The land animals on Spitsbergen must have been very abundant on its first discovery, for in 1613 Fotherby's party, in addition to as many whales as he could use, secured a bag of "400 deare," and "also good store of wild fowle" and "manie young foxes, which wee made as tame and familiar as spaniell-whelpes."

The walrus has shared in the same reduction in range and numbers as the rest of the fauna. It has now abandoned the western coast of Spitsbergen, but, as the author reminds us, a walrus was killed in the "Netherlandish Sea," as recorded by the drawing of it, now in the British Museum, by Dürer in 1521.

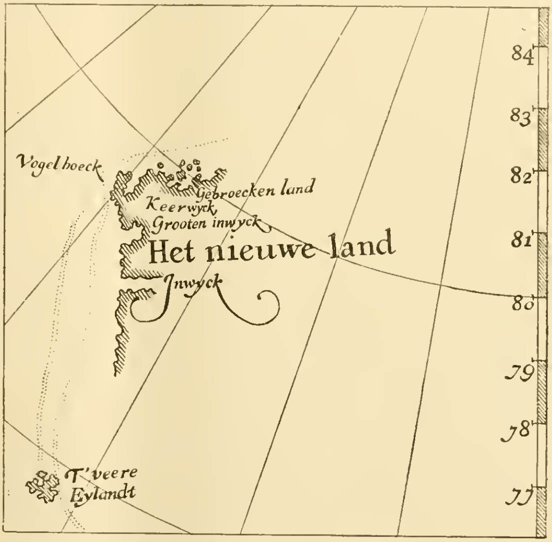


Fig. 1.—Spitsbergen from Barents' Chart (1598). From "No Man's Land."

The early narratives say little about the interior of Spitsbergen, but the records are of value in reference to the reported emergence of land during the past three centuries. Sir M. Conway remarks that Poole's record of 1611 shows that there has been no change since then in the level of the shallow bar off "Bear Island."

The value of the book as a permanent work of reference is enhanced by its full bibliography of the history and geography of Spitsbergen (pp. 305-327), a chronological list of the maps (pp. 342-346), and a history of the geographical nomenclature. There is also a valuable series of reprints of the early maps, from Barents in 1598 to that after Edge in 1662, and that after Doncker in 1663, which was the first of the series which "really begins to resemble the form of the country it professes to depict." The volume is accompanied by a map, of which the outline is taken from the Admiralty chart, and the names are given according to the results of Sir Martin Conway's study of the nomenclature.

J. W. G.

[1] "No Man's Land: a History of Spitsbergen from its Discovery in 1596 to the beginning of the Scientific Exploration of the Country." By Sir Martin Conway. Pp. xii+378. (Cambridge: University Press, 1906.)

PROF. GEORGE RAYET.

TO the long list of astronomers recently deceased, with the greatest regret we have to add the name of Prof. George Rayet, who for five-and-twenty years directed the Observatory of Bordeaux with equal vigour and success. Born in 1839, and entering the Paris Observatory in the early 'sixties, the name of Rayet not only recalls to us the ancient history of that establishment, when its fortunes were guided by Le Verrier and Delaunay, but the forty years that separate us from that period embrace the new departures that have been made, in more than one of which Rayet may be said to have assisted. For example, at that time Le Verrier was engaged in the creation of an international bureau for the furtherance of meteorological study. The subject of weather forecasting was then in its infancy, and Le Verrier was endeavouring to give scientific accuracy and precision to the method. Into this department and the allied subject of storm warnings Rayet was early initiated. Similarly his astronomical career coincides very approximately with the time in which spectroscopic studies have been vigorously prosecuted, and in this department he laboured strenuously. It may be recalled that he was one of the observers of the famous solar eclipse of 1868, when the characteristic light of hydrogen was first perceived in the solar prominences, and we were further led to the study of the helium ray. In another direction Prof. Rayet was again a pioneer, when, in conjunction with M. Wolf, he detected that peculiar variety of gaseous star with which his name has been particularly associated. The three typical representatives found in the constellation Cygnus are now members of a tolerably large class, the spectroscopic examination of which has done much to widen our conceptions of stellar chemistry.

As professor of astronomy Rayet was much engaged in teaching, and as occupant of the chair of physical astronomy at Bordeaux he was naturally pointed out as the most appropriate director of the new observatory it was proposed to construct in that town. Since 1881 this observatory has been in full activity, and a valuable series of volumes has been issued containing the work of the director and staff. These volumes can generally be divided into two sections, one giving the results of observations, the other the details of mathematical researches. Among the observations are given the coordinates of stars, the position of comets, and nebulæ and measures of double stars. In the memoirs there are signs that Prof. Rayet still retained his old fervour for meteorological study, but we have, in addition, inquiries connected with problems arising out of the construction of the International Star Chart.

In his conduct of the observatory Prof. Rayet was indefatigable; its interests he defended with energy, and his administration was able and judicious. While French science will regret his removal, his immediate associates will mourn his loss as that of a friend whose sympathy, knowledge, and experience were ever at their command. W. E. P.

NOTES.

THE annual meeting of the British Medical Association will next year be held at Exeter; the president-elect is Dr. H. Davy.

THE appointment of Prof. Hermann Thoms as director of the Pharmaceutical Institute of the University of Berlin at Dahlem is announced.

THE death is announced of Dr. Adolf Voss, director of the prehistoric section of the Royal Berlin Museum.

WE regret to have to record the death, on July 27, of Mr. Richard Glascott Symes, who retired from service on the Geological Survey in 1900. Mr. Symes was born at Kingston, Dublin, in 1840; he joined the survey as assistant-geologist in 1863, and in 1869 was made geologist. After a long period of useful work in Ireland, he was transferred to Scotland in 1890. Most of his work will be found recorded in the Memoirs of the Geological Survey.

WITH reference to the recent correspondence in our columns concerning the Geological Survey of Canada (see NATURE, June 21, p. 175, and July 12, p. 245), Mr. A. P. Low has sent us a certified copy of a report of a committee of the Privy Council, approved by the Governor-General in Council on January 5, 1892, which reads as follows:—

"Geological Survey.

"That in accordance with the provisions of 53 Victoria, chap. 11, an act respecting the Geological Survey. . . . 2. Bell, Robert, LL.D., M.D., F.R.S.C., Assistant Director and Chief Geologist—$2,250.00 . . . .

"(Signed) JOHN J. MCGEE,
"Clerk of the Privy Council."

A PARTY of French medical men is about to visit Germany for the purpose of inspecting the medical institutions of the country. Three days will be spent in Berlin, and other cities and towns visited will include Cologne, Frankfort, Leipzig, Munich, Bonn, Heidelberg, and Marburg. A committee of entertainment has been formed under the presidency of Prof. von Bergmann.

STEPS are being taken by the German Government to encourage sea fisheries in view of the national importance of this industry in furnishing a recruiting ground for the navy and the mercantile marine. A fishing cutter having an auxiliary engine of twenty horse-power and every modern equipment has, says the *Cologne Gazette*, been constructed at the Government expense, and after being tested in practice, and if necessary improved, will be adopted as a model for further fishing craft which are to be built, with the assistance of grants from the Imperial Treasury.

CAPTAIN LENFANT, the French explorer, is, according to the *Siècle*, about to leave on another expedition to West Africa in order to discover, if possible, a navigable waterway connecting Lake Chad with the coast of the Atlantic. It will be remembered that in his expedition of 1903–4 Captain Lenfant ascertained that a through waterway existed along the Niger, the Benue, the Mayo-Kebbi, the Logone, and the Shari, but he was unable to follow it from beginning to end by boat, as the Mayo-Kebbi was found to be obstructed by rapids, round which it was necessary to travel by land.

ACCORDING to a Reuter telegram from St. Petersburg, violent earthquake shocks were felt on August 13 in the districts of Jarkent and Kopal, in the government of Semirechensk, Central Asia.

THE *Pioneer Mail* for July 27 states that earthquake shocks were felt at Mussoorie, Lahore, Delhi, and Naggar (Kangra) on the morning of July 21.

DR. H. W. WILEY, chemist to the U.S. Department of Agriculture, has been elected president of the commission appointed by the Secretary of the Treasury, the Secretary of Commerce and Labour, and the Secretary of Agriculture to formulate rules and regulations for the enforcement in America of the pure food law. The public hearings by the commission are to begin in New York on September 17.

According to the *Electrical Review*, the working of the electric tramways on the overhead trolley system in the neighbourhood of Berlin, and of the electric haulage system on the Teltow Canal, has interfered with the work of the magnetic observatory at Potsdam, and in consequence the Meteorological Institute recently addressed a request to the Ministry for Home Affairs asking for sanction to establish an auxiliary station for delicate magnetic registrations, while at the same time ameliorating the protective regulations for the principal institute at Potsdam. The proposal, it is stated, has now received the approval of the authorities, and preparations have been made in regard to the realisation of the scheme. It has been possible to secure a site eight miles to the south of the Potsdam Observatory, and on the northern bank of the Seddin Lake, near Kunersdorf. The exact spot selected is in a wood, and the cost of the building and instruments is estimated at 2200*l*. In order that the work may be completed as rapidly as possible, and without waiting for an estimate to be inserted in the next Budget statement, the Teltow Canal Construction Board has advanced the necessary funds unconditionally.

The Canadian Government is still further extending the organisation of Marconi stations which it has established for communication with ships and from point to point along the coast. One of the new stations is to be at Father Point and one at Seven Islands, in the Province of Quebec. The station at Cape Race, in Newfoundland, is being enlarged. When the two new stations are completed, there will be a continuous Marconi system from Quebec to Labrador on the one side and to Cape Race on the other.

It is stated in *Science* that the Indiana University has had granted to it by the legislature of the State the management of a tract of timber land of 182 acres, on which are the openings to extensive caves and the richest blind-fish localities known. The University is in search of a graduate able and willing to conduct research work on cave animals for twelve months, beginning on September 1 next.

A preliminary report of the archæological mission which went to Abyssinia last spring has been received by the Berlin Academy of Sciences. The mission, the intention of which was to explore the ruins of the ancient city of Aksum, has made, it is stated, a plan of the site, collated inscriptions already known, and copied others discovered in the course of its researches; it has also accumulated information of great interest from an architectural as well as from an ethnical point of view.

An exhibition of india-rubber is to be held next month in the Royal Botanic Gardens, Peradeniya, Ceylon, the object being to encourage further the growth of rubber in the island. It is thought that both Ceylon and the Malay States may soon become important sources of supply of rubber.

The fifth biennial congress of the International Committee on Aeronautics will be held at Milan under the presidency of M. Palazzo in September next.

The sixteenth meeting of the Italian Congress of Internal Medicine will take place in Rome in October next. The subjects proposed for discussion are:—arterio-sclerosis; fevers resembling typhoid and Malta fever; and arthritism. A report on the progress in diagnosis will be presented by Prof. Ferrannini, of Naples, and one on advances in therapeutics by Prof. Michelazzi, of Pisa.

An International Maritime Exhibition, in celebration of a century of steam navigation, is being organised under the auspices of the League Maritime Française. It will be opened in Bordeaux on May 1 next, and remain open until the following November. A section will be devoted to colonial products which are intimately connected with the commerce of Bordeaux, and there will be pavilions devoted to ocean geography, nautical automobilism, and aërial navigation. Congresses, competitions, and lectures on maritime affairs, science, art, industry, &c., are being arranged for. The exhibition will be divided into the following groups: marine history and fine arts; instruction; charts and instruments; navigation and commerce; navy; materials for construction; motor machines and propellers; fittings and apparatus; automobile navigation and boats of all types; aëronautics; port and harbour works; sea and river fishing; hygiene, salvage, and sports; ship's provisions, food; various industries: interior decoration of passenger steamers and yachts; mariners' and passengers' clothing, sporting attire; special furniture for passengers' steamers and yachts, &c.; travelling articles, &c.; commercial relations of Bordeaux with the colonies; social economy; and works of mutuality and charity.

The fourteenth meeting of the International Congress of Hygiene and Demography will be held in Berlin from September 23 to September 29 of next year. The congress will be divided into eight sections, devoted to the following subjects: hygienic microbiology and parasitology; hygiene of nutrition and hygienic physiology; hygiene of childhood and school life; industrial hygiene; the prevention of infectious diseases and the cure of patients suffering therefrom; hygiene of the dwelling and the community; hygiene of traffic; military, colonial, and marine hygiene; and demography. The general secretary of the congress is Dr. Nietner, 9 Eichhornstrasse, Berlin, W.

According to the *Pioneer Mail*, Allahabad, the programmes of work of the various Indian scientific departments for 1906–7 have been issued by the Board of Scientific Advice. Our contemporary states that the principal questions to be taken up by the director of the Imperial Institute and reporter of economic products are the produce of *Ficus elastica* and the developments of rubber planting in India, tanning extracts from barks, the improved preparation of agave fibre, and manganese ores. The Meteorological Department will undertake the preparation of an atlas showing the normal monthly conditions for the Indian Ocean, and the study of the upper atmosphere by kites and balloons, and of atmospheric electricity and earthquakes. The Survey Department, it is proposed, shall compile a paper summarising the geographical position of our knowledge of the Himalayas and Tibet. The Botanical Survey will conduct economic investigations regarding Indian cottons and fibre-yielding plants. The Agricultural Department will investigate remedies for injurious crop pests, and conduct investigations into the improvement of cotton, wheat, tobacco, tea, indigo, and jute. The Forest Department will examine tanning extracts.

The report of a subcommittee of the Board of Scientific Advice on the consumption of mineral fertilisers in India has been issued by the Government of India Revenue Department. The director of the Geological Survey having reported on the possible consumption in India of sulphuric acid, and the large supply of rich phosphate of lime on Christmas Island, and the officiating inspector-general of agriculture having directed attention to the scope for the use of mineral fertilisers in Indian agriculture, the sub-committee recommends that experiments should be made to test the results of the use of the principal mineral fertilisers. In particular, it urges that special attention should be given to the trial of sulphate of ammonia in sugar-cane cultivation. Arrangements are being made for prospecting the copper-sulphide deposits of Chota Nagpur, and if the deposits prove as valuable as is asserted by some authorities, it is thought that a large chemical and metallurgical industry may be started, the by-products of which will include sulphuric acid and ammonium sulphate.

Mr. William Cole, of Buckhurst Hill, the honorary secretary of the Essex Field Club, is endeavouring by the aid of a phonographic apparatus to perpetuate the record of Essex folk-songs and peculiarities of dialect and intonation, and solicits the assistance of residents in Essex in discovering and enlisting the services of singers of the ancient folk or cradle-songs or quaint harvest-home ballads who will not fear to face the recording-horn of the phonograph. Mr. Cole will be pleased to correspond with anyone willing to cooperate.

According to *L'Aviculteur*, the wholesale destruction, for purposes of millinery, of certain species of birds threatens at no distant date to bring about the extermination of some of the rarer and more beautiful kinds which the world possesses. How real this danger is may be estimated by the fact that in one market alone were sold lately at one time 12,000 humming-birds, 28,000 parrakeets, 15,000 kingfishers, 20,000 aigrettes, and thousands of other gorgeous southern birds of different kinds, as well as doves and even sparrows. France receives every year from America, Tonkin, and India millions of birds, which are exchanged for millions of pounds. The number of small birds annually imported into England and France may be computed at 1,500,000. Germany exports yearly twenty million feathers which are worked up in England into hat trimmings. In London there are held every month sales of birds' skins and feathers, India alone supplying some thirty millions of feathers. The South American Republics have awakened to the danger of the extermination of their most ornamental species of birds, and have passed laws regulating their slaughter. A league has been formed in America the members of which forswear the wearing of feathers; as the demand creates the supply, it is to be hoped more leagues of this kind will be formed elsewhere, and that it will be some day considered bad form for a woman to adorn her headgear or clothing with the bodies and feathers of wild birds.

M. Lancaster, director of the Belgian Meteorological Service, states that henceforward the results of the international balloon ascents organised by that service will be published in *Ciel et Terre*. Tandem "sounding" balloons made of india-rubber are used, one of which bursts at a certain height; thermometers of two kinds are employed—Teisserenc de Bort's bimetallic instrument and Hergesell's German-silver cylindrical thermometer. In the ascents of April 5 and May 3 altitudes of 15,140 metres and 16,970 metres were attained, temperature $-52°.5$ C. and $-38°.0$ C., respectively. In the first experiment the lowest temperature recorded was $-57°.4$, at 13,500 metres, during the descent; an inversion occurred at 13,940 metres during the ascent. In the second experiment the lowest temperatures were $-62°.6$, at 10,160 metres, during the ascent, and $-61°.9$, at 9800 metres, during the descent. A large inversion commenced at 10,160 metres, and increased to 16,970 metres, when the upper balloon burst. Both ascents were made in the morning.

We have received from the director of the Central Meteorological Observatory at Tokio, Japan, complete observations made every four hours, and results for 1904–5, at the Corean stations at Fusan, Chemulpo, Wonsan, and Yongampo, also for part of the year at Josin. We quote the following statistics for Wonsan (lat. 39° 9′ N., long. 127° 26′ E.), 1905, as the station having the greatest annual range of temperature. The mean of the daily maxima in July was 80°.1 F., and of the minima in February 17°.6 F.; the absolute maximum was 94°.8 F. in August and 2°.1 in January. The annual rainfall was 73.3 inches, of which 20.9 inches fell in July and about 0.2 inch in February.

Museum curators should study attentively certain statements by Mr. F. A. Lucas in the report for 1905 of the Museums of the Brooklyn Institute. On the south side of the building the windows are reported to have been "sand-blasted," with the view of diffusing the light, and thus helping to protect the specimens from its ravages. The results are held to have been worth the heavy expense. The second point relates to descriptive labels, on which the author writes as follows:—"As a rule, the visitor wishes to know first the name of an animal or an object, next where it is to be found, and then what it does or is used for; and the effort is made to supply this information and not discourage the visitor with statements regarding matters of which he knows little and cares less. The technical label is the easiest to prepare, but it is the one that most visitors do not care for, while the student can get such information from text-books." If these views be sound, many of the labels in museums in this country require drastic amendment.

The contents of *Biologisches Centralblatt* for August 1 emphasise the extent to which the problems of hybridisation and variation are occupying the attention of Continental naturalists at the present time. In the first article Dr. K. Goebel describes a double-flowered wild race of *Cardamine pratensis* which is to be found in abundance in spring on the mountains of Upper Bavaria, and discusses its bearings on the development and infertility of double flowers in general. The sexual and asexual reproduction of fresh-water polyps (Hydra) forms the subject of the second article, in the course of which the author, Dr. R. Hertwig, records the remarkable circumstance that while in one winter all his specimens—some thousands in number—developed ovaries and eggs, in the following season the whole series produced spermatozoa. Dr. J. Gross, in the third article, continues the discussion of the problems of modification and variation. Albinism and melanism in relation to the Mendelian theory are first discussed, after which the author takes into consideration the case of the interbreeding of black and grey crows, De Vries's mutation theory being subsequently contrasted with the Mendelian doctrine. The fourth article, by Mr. L. Plate, is devoted to a review of Hatschek's new theory of modification.

A collection of fishes—both fresh-water and marine—from Argentina forms the subject of a paper by Messrs. Evermann and Kendall, published as No. 1482 of the Proceedings of the U.S. National Museum. Three species—among them one of the exclusively southern and chiefly fresh-water genus Galaxias—are described as new. The physical features of the fresh-waters of the country are noted.

We have been favoured by the author, Mr. H. R. Watkin, with copies of two papers published by the Torquay Natural History Society. One, which was read in 1905, is a translation of the original account of the discovery and transport to St. Petersburg of the now well-known Berezovka mammoth. In discussing whiteness in animals in the second paper, the author takes occasion to dissent from the view that British park-cattle are albinos, urging as a reason that they have been white for centuries an argument which has, of course, no value at a'

ACCORDING to the *Irish Naturalist* for August, the bog-slide at Ballycumber, King's County, in June last, of which much was made in the Dublin papers, was a very insignificant affair. To the same issue Mr. R. Southern contributes notes on Irish oligochætous worms of the genus Enchytræus, recording three species new to the Irish fauna, one of which appears to be also new to science.

PART vii. of the "Fauna of New England," issued as an Occasional Paper of the Boston Society of Natural History, consists of a list of the ants (Formicidæ), by Mr. W. M. Wheeler.

THE vexed question of the chemical nature of thorium and the origin of its radio-activity forms the subject of a series of papers in the *American Journal of Science* (vol. xxi., No. 126). Dr. Bertram Boltwood has determined the amount of α-ray activity due to thorium in different minerals, containing, in addition to thorium, other radio-active constituents. The values obtained clearly indicate that this activity per gram of thorium is a constant independent of the nature of the mineral. The total activity of minerals containing thorium and uranium can, indeed, be calculated from the proportions in the mineral of these elements. The constancy of the "specific activity" of thorium in different minerals is in support of the view that Hahn's radio-thorium is a degradation product of thorium itself; the transformation of thorium into radio-thorium is probably rayless. It is a remarkable fact, however, that the specific activity of thorium in samples of thorium nitrate and oxide prepared on the commercial scale for the Welsbach mantles is only about half that of thorium in the same substances prepared directly from the minerals worked with. This is explained by assuming that the commercial method of purifying thorium salts is remarkably efficient in separating radio-thorium, the change of thorium into radio-thorium occurring only very slowly. Similar conclusions were arrived at by Mr. H. M. Dadourian and by Messrs. McCoy and Ross from experiments of a somewhat different character described in the same number. The question whether thorium can be obtained entirely free from radio-thorium and completely inactive is, however, still unsettled.

THE July number of the Journal of the Röntgen Society contains an address by Mr. Frederick Soddy on the nature of the α ray. A clear account of recent investigations and hypotheses is given with regard to this problem, and the author, in addition, briefly refers to some experiments he has made to ascertain whether the α particle is capable of deviation in a magnetic field under conditions in which it has not suffered impact with a single gas molecule; but the results would indicate that in the highest vacuum obtainable the α rays are deflected as readily as in ordinary air. In the *American Journal of Science* for July Mr. M. Levin shows that polonium is a homogeneous source of α rays, and that the range of the α particle in air is 3·86 cm., being slightly greater than that of the α particle of radium (3·50 cm.), but less than that of the α rays of radium C (range 7·06 cm.).

AN interesting note on the fluorescence of anthracene vapour is published by Mr. T. S. Elston in No. 4 of the Johns Hopkins University Circular. It is concluded that the light exciting the fluorescence has a wave-length of about 390 $\mu\mu$, and that the fluorescence spectrum extends continuously from $\lambda = 365$ $\mu\mu$ to $\lambda = 470$ $\mu\mu$, showing three distinct bands at wave-lengths 390, 415, and 432 $\mu\mu$. It is clear that for anthracene vapour Stokes's law, which states that fluorescence lies entirely on the red side of the exciting light, does not hold.

A SCIENTIFIC and not too technical exposition of the present position of certain problems connected with heredity will be found in *Naturwissenschaftliche Wochenschrift* (July 1) in an article written by Dr. E. Teichmann. The first part of the article is devoted to a review of the hypotheses and facts adduced in recent papers by Heider, Correns, and Strasburger in favour of regarding the chromosomes as bearers of hereditary characters, and showing how the chromosome divisions fit in with Mendelian principles; this part is illustrated with useful explanatory diagrammatic figures. Dr. Teichmann then gives a short account of the hypothesis advanced by Dr. Hatschek, who interprets heredity as a chemical process. Hatschek postulates generative molecules occurring in the nuclei, and energy molecules in the cells; it is by changes in the generative molecules of the reproductive cells that variations are produced. Reference is also made to Loeb's latest expression of opinion, in which he also favours a chemico-physical explanation.

IN the course of a lecture addressed to the Field Naturalists' Club of Victoria, and published in the *Victorian Naturalist* (June), Mr. D. McAlpine summarises a few of the interesting points observed in studying the plant rusts in Victoria. The geographical distribution of some of the species furnishes curious facts. The genus Uromycladium causing "witches-broom," and characterised by the production of a colourless cyst along with one or two spores, is only known from Java outside Australia. An æcidium on wallaby grass has only been found elsewhere on a species of Stipa in the Argentine, Chili, and California. The absence of any native barberry plants would suggest that wheat rusts in Australia forgo a heterœcious existence, and it was found that the spores would not even infect imported plants.

THE third and concluding portion of Sir Joseph Hooker's enumeration of British Indian species of Impatiens, published as vol. iv., No. 3, of the Records of the Botanical Survey of India, contains the list of known species for the Western Peninsula, also for Ceylon and Malaya. The Peninsular balsams differ in sectional characters from the Himalayan and Burmese; they all fall into the short-capsuled group, and none possesses the two additional lateral sepals; many are endemic, only three being found in northern or eastern India, and one of these is the polymorphic *Impatiens balsamina*. There is some affinity between the Malabar and Ceylon species, although the majority of the latter are endemic. In marked contrast to the large number of balsams from Burma, only seven Malayan species are recorded, and none of these is found in Burma. *Impatiens mirabilis*, that is only known from one island, is a remarkable species, as it produces a branching stem 5 feet high and 22 inches in diameter, bearing leaves 6 inches to 10 inches in length.

AS recent research has led to the transference of many of the so-called fossil ferns of the Carboniferous period to the pteridosperms, and has thrown doubt on others, it is a matter of considerable interest to have a new fern recorded from the Coal-measures. The plant, consisting of axis, petioles, and root, is described by Miss M. C. Stopes in the Memoirs of the Manchester Literary and Philosophical Society, vol. l., part x.; associated with these fossil remains are small annulate sporangia which, there is every reason to believe, belong to the same plant. The plant is referred to Tubicaulis, a fern genus, formerly monotypic, that is probably one of the simpler Botryopterideæ.

The Field Naturalists' Club of Victoria, which has been in existence twenty-six years, appears to be in a very satisfactory condition, financially, numerically, and in the interest shown in the monthly meetings. During the year which ended in April last, eight papers relating to zoology were read; eleven papers dealt with botany, two with geology, and one with palæontology. The president (Mr. F. G. A. Barnard) at the annual meeting took as the subject of his address "The First Quarter of a Century of the Field Naturalists' Club of Victoria," from which we notice there are still thirteen of the original members in association with the institution.

The *National Geographic Magazine* (the organ of the National Geographic Society of Washington) maintains its high standard of excellence, and the August issue—devoted mainly to South America—contains many articles of interest, notably one by Prof. A. Heilprin on the shattered obelisk of Mont Pelée, which is illustrated by reproductions of several striking photographs of the peculiar cone of rock which was thrown up during the volcanic activity of the mountain a few years ago, and which at the time of its greatest development attained the height of more than a thousand feet. To-day the obelisk is in ruins, consisting of boulders ranging from 2 feet or 3 feet in diameter to 30 feet, and it was to view these and to endeavour to understand the geological riddle of the mountain that Prof. Heilprin in February last paid his fourth visit to Martinique.

A fifth edition has been published by Messrs. Swan Sonnenschein and Co., Ltd., of "Through the Wordsworth Country: A Companion to the Lake District," by Prof. William Knight, with sixteen full-page illustrations by Mr. Harry Goodwin. In an explanatory preface Prof. Knight explains his aim as having been to be as terse and simple as possible, and not to traverse precisely the same ground as that covered in one of his earlier works. He modestly insists more than once that the merit of the book rests on Mr. Goodwin's drawings and certainly these are delightful, but lovers of Wordsworth visiting the Lake District will also find Prof. Knight an interesting and inspiring guide.

OUR ASTRONOMICAL COLUMN.

Comet 1906*d* (Finlay).—A further extract from M. Schulhof's ephemeris for Finlay's comet, as published in No. 4109 of the *Astronomische Nachrichten*, is given below:—

Ephemeris (12*h*. *M.T. Paris*).

1906	α (app.) h. m. s.	δ (app.) ° ′	log Δ	$1 : r^2\Delta^2$
Aug. 18	4 11 49	+10 21	9·44499	12·56
20	4 26 35	+11 33	9·45816	12·02
22	4 40 34	+12 39	9·47221	11·44
24	4 53 48	+13 38	9·48689	10·85
26	5 6 19	+14 31	9·50197	10·25

From this it will be seen that the comet is now apparently travelling through Taurus towards the northernmost extremity of Orion, and will be about 4° south of Aldebaran on August 21, on which date it will rise a little north of east at about 12 o'clock (midnight).

Planets and Planetary Observations.—In the second of the series of articles which he is writing for the *Observatory*, Mr. Denning discusses the powers best suited for planetary observations, the best times for making the observations, and the *modus operandi* most suitable for observers with moderate equipments.

In this he emphasises the importance of noting every detail very carefully, and of keeping any one object under regular observation for as long a period as possible.

In a discussion as to the relative values of eye-estimates and instrumental observations of transit times, Mr. Denning supports the former method (the *Observatory*, No. 373).

A New Form of Spectroheliograph.—A new form of spectroheliograph, in which it is hoped that the effects of instrumental vibrations will be materially reduced, is proposed by MM. G. Millochau and M. Stefánik in No. 1, vol. xxiv., of the *Astrophysical Journal*.

This instrument may be fed from a cœlostat or siderostat, or attached directly to a telescope. It is moved about a horizontal axis perpendicular to the plane containing the optical axes of the spectrograph by a Brashear clepsydra mounted vertically.

By widening the primary slit at its two extremities, a photograph of a portion of the spectrum of the diffuse skylight may be obtained, thus giving an indication of the exact radiation which is being employed.

THE RELATIONS BETWEEN SCIENCE AND INDUSTRY.

THIS year's meeting of the Association française pour l'avancement des Sciences was held at Lyons, and opened on the same day as the meeting of the British Association at York. On August 1, Prof. G. Lippmann, the president of the French association, delivered his presidential address,[1] and by a significant coincidence dealt with the want of respect accorded to scientific research by French manufacturers and merchants on the same day that Prof. E. Ray Lankester was directing the attention of the visitors to York to the "less widespread interest than formerly in natural history and general science, outside the strictly professional arena of the school and university."

Prof. Lippmann found the text of his discourse in the success which has followed the attempts of the manufacturers of Lyons to benefit fully by the work accomplished by men of science. At Lyons, he said, "science and industry live together in harmony." In this district scientifically organised factories are to be found, in which it is recognised that science can give daily assistance to industrial development—a truth other parts of France are, said Prof. Lippmann, far from understanding. The mistake is too common that industry only has need of technicists, or, at least, that she need trouble only about "applied" science, taught specifically with a view to the various manufactures; and this tendency the president described as the fatal error which had caused the total production of French industries to fall from the first to the fourth rank. It is the duty of every man of science, he continued, to wage war on such false ideas, wherever met, and to substitute for them the salutary truth that success in industry is founded upon a proper regard for the methods of science. For this reason, he explained, he had decided to speak on the relations between science and industry.

It is easy to define the bond which unites science to industry. There is only one nature. The forces which mould the material world are those also which inspire the apparatus of the laboratory, which are utilised in industry, and in the arts of peace and of war. There is one science only, which is neither professorial, industrial, civil, nor military. Experimental science is the art of wielding the forces of nature—and industry and science are developed along parallel lines.

During an unknown number of centuries science was empirical and industry mere fumbling and groping. In the last hundred years science has developed more than in thousands of years previously, and industry has advanced with giant's strides. Prof. Lippmann exemplified his statements by reference to the chemical and industrial industries, and paid eloquent tributes to the creator of the

[1] The address is printed in the *Revue Scientifique* for August 11, 1906.

first wheel and the discoverer of fire. These examples prepared the way for a consideration of the conditions, other than those of the researches of the laboratory, to which industrial work is subject. The burden of the president's remarks was that nothing is too insignificant for careful attention, and that qualified workmen require long training.

A well-instructed technical staff is indispensable to every works; the men may be prepared in special schools, but their work must be learnt in the shop itself, for it can be learnt properly nowhere else. It is equally important that the managers of the factory be properly trained and be provided with research laboratories where trials should be made with an automatic regularity.

But even when all these things have been provided there should be no standing still. In industry, said Prof. Lippmann, one is never tranquil. When everything has been provided for, there is still the unforeseen, and the rivalry of other producers at home and abroad has always to be reckoned with. "Industry is a struggle without end and without truce."

The president then went on to show how, as science made new discoveries, technical experience became insufficient, and without scientific assistance an industry must fall behind. He insisted upon the value of mathematics, and explained that all the resources of mathematical analysis can be brought into requisition in industrial undertakings, instancing the way in which Lord Kelvin found by analysis the cause of the remarkable slowness with which electric signals traversed the Transatlantic cable at the time it was being laid. He then gave other instances of how men of science have provided new resources to the industrial expert, and concluded by again urging the need at every factory for a scientific staff provided with research laboratories.

Such a procedure, Prof. Lippmann went on to point out, is common in Germany and in America; and Austria and Switzerland are, he added, adopting the same method. But no mention was made of Great Britain. Evidently the president felt that French disregard of the value of science was reflected across the Channel, and no instance of British enterprise seems to have presented itself to him. Germany, however, has had the good sense to set an example to the nations. The great German manufacturing houses know the value of the man of science. In the Zeiss works at Jena, fourteen Doctors of Science are employed, and these include mathematicians as well as physicists. The great German aniline colour works employ more "scientific" than "technical" chemists. At one of them, for instance, fifty-five scientific and thirty-one technical chemists are engaged; at a second, 145 scientific chemists and 175 technologists; at a third 148 scientific chemists for 75 technicists. The research laboratories of these works are lavishly equipped; one of them possesses a library of 14,000 volumes; a second spends 150,000 francs a year on glass-ware. These things are no doubt expensive, but these great factories still manage to pay a dividend of from 20 to 30 per cent.

Every newly-discovered substance which is usable is patented, and in this way Germany has managed to establish a monopoly. The house of Baeyer possesses a thousand patents at home and 1200 in foreign countries. Germany exported, in 1904, 195 times as much aniline colours as France. The German plan, said Prof. Lippmann, is a good one; the French method is bad.

American procedure was then described, and a word or two said about the methods being adopted in Austria and Switzerland.

French shortcomings were next passed in review and condemned unreservedly. French manufacturers, said the president, consider mathematicians, physicists, and chemists as expensive luxuries, and engage very few of them. They do not recognise the value and significance of the discoveries of French men of science. The instance of Carnot's researches on heat-engines was cited, and the value they had been in England as compared with the extent to which they had been utilised in France was traced. The scientific spirit, continued the president, is less developed in France than in other European countries, less developed than in America and Japan. The national industries have suffered profoundly from this weakness, and the lack of scientific spirit is felt in other directions. The cause of this deficiency is in no sense due to a want of national ability. Prof. Lippmann put it down to an antiquated system of public education. French education, he assured his audience, is Chinese in origin as well as in character.

The president in directing attention to higher education in France saw in this direction cause for hope and the remedy for the shortcomings he had previously enumerated. In countries where the conditions of culture are normal, every young man to whom it is desired to give a liberal education is sent to a university, not for reasons of vanity, but because it is necessary for the youth's professional future. This necessity is not, Prof. Lippmann maintained, sufficiently understood in France. The young man should go to the university not only to learn law or medicine, but in order to become a cultured man.

The chief business of the university is to teach the art of research, that is to say, science, for science is the art of research and nothing else; and research is indispensable to industry. At the same time, the university must put men with no scientific ambitions, but who wish to acquire a general culture worthy of the name, in touch with science at first hand, for science in the making is alone attractive and fruitful. The French universities are at present too much under the influence of a bureaucratic pedantry to accomplish this double function, and the sooner they are liberated from the yoke of the executive power the better according to the president. So far as unfettered universities are concerned, France is, in Prof. Lippmann's view, behind the rest of the world except Spain.

Prof. Lippmann concluded by expressing the devout hope, in the name of industry and of national development, that the teaching of science in France may be delivered soon from all ancient fetters.

THE BRITISH ASSOCIATION.

SECTION C.

GEOLOGY.

Opening Address by G. W. Lamplugh, F.R.S., President of the Section.

On British Drifts and the Interglacial Problem.

If a personal reminiscence be pardonable, let me first recall that twenty-five years ago, at a meeting of this Section in this same room, I ventured, while still a youth, to contribute my mite towards the right understanding of the Yorkshire drifts. The occasion will always remain memorable to me, for it was my first introduction to a scientific audience, and the encouraging words spoken by Ramsay from this chair impressed themselves upon me and gave me confidence to persevere in the path of investigation.

Finding myself again in these surroundings, it seems fitting that with fuller experience and less diffidence I should resume the subject by bringing before you some further results of my study of the drifts. But it is with just a sigh that I recollect how on the former occasion I was able to reach a definite conclusion on a simple problem from direct observation, and had confidence that all problems might be solved by the same method; whereas now I find confronting me an intractable mass of facts and opinions, of my own and other people, terribly entangled, out of which it seems to grow ever more difficult to extract the true interpretation.

That the glacial deposits possess some quality peculiarly stimulating to the imagination will, I am sure, be recognised by everyone who has acquaintance with glacialists or with glacial literature. The diversity and strongly localised characters of these deposits, together with their aspect of superficial simplicity, offer boundless opportunity to the ingenious interpreter; and therefore it is not surprising that along with the rapid accumulation of facts relating to bygone glaciation there should have arisen much divergent opinion on questions of interpretation. Nor need we regret this result, since these differences of opinion have again and again afforded the stimulus for research that would not otherwise have been undertaken.

The Interglacial Problem.

One of the most important points on which there has been, and still is, wide difference of opinion among glacial geologists, both in this country and abroad, is with regard to the value of the evidence for interglacial periods; and it will be my aim, in bringing before you some general conclusions regarding the drifts, to concentrate attention principally upon this evidence.

To keep the discussion within practicable limits I must perforce assume the former extension of ice-fields over the glaciated areas; for although I know that there are still dissentients from this fundamental proposition, the cumulative evidence in its favour has been so frequently recapitulated that it would not be justifiable for me to detain you by repeating the arguments.

It is now, I think, agreed by all who accept this proposition that the ice-sheets of the Glacial Period, though of vast extent, had their northern as well as their southern limits; the original idea, that they represented the outer portion of a polar ice-cap, having been disproved by more extended researches in the more northerly part of our hemisphere. Moreover, it has been found that these ice-sheets had their origin in the coalescence of masses which spread outward from separate areas of accumulation, acting more or less independently, so that the individual sheets did not all attain their farthest bounds at the same time. But this recognition of independent centres of glaciation has given sharper prominence to the question whether the glacial deposits are to be regarded as the product of a single epoch of glaciation, or whether they represent successive epochs of this kind, separated by intervals during which the great ice-sheets temporarily vanished.

As opinion stands at present, probably most geologists lean to the idea that the glaciation was interrupted by at least one interglacial epoch, during which the climate of any particular latitude became not less warm, and perhaps warmer, than it now is. This is the Interglacial hypothesis in its simplest form. But it has been frequently pointed out that the criteria depended upon in the recognition of warm interglacial conditions cannot be all assigned to the same horizon, since they recur at different positions in the drift series. Hence it has been claimed that two, three, four, or even five interglacial epochs, with a corresponding number of separate epochs of glaciation, may be recognised in the glacial sequence. In respect to the number, relative importance, and correlation of these epochs or stages in different countries, or in different parts of the same country, there has been, however, no pretence to agreement among the upholders of the Interglacial idea.

In opposition to these views of every degree, a smaller number of glacialists have urged that there is no proof of even a single absolute interruption of the glacial conditions from the beginning to the end of the period; and that the evidence indicates only one great glaciation, during which there were wide oscillations of the margins of the ice-sheets in different places, due probably to more or less local circumstances.

This radical difference of interpretation respecting the constitution of the Glacial Period assumes the greater consequence in that it bears directly upon many questions other than those which are strictly geological. Thus, the antecedents and distribution of our present fauna and flora, and the time and conditions of that momentous event, the appearance of man in Northern Europe, are deeply involved in the issue.

Moreover, until we can tell whether it is one or several periods of glaciation that we require, how can we approach the other sciences for aid in our search for the cause of the Ice Age? It is, indeed, essential that, before seeking counsel's opinion of this kind, the geologist should have all his evidence at command and well marshalled, so that he can say such and such are the facts, and this the order of them. Otherwise he may receive, not the desired interpretation, but advice as to what he ought to have found and instructions to go and find it. And that such instructions may be detrimental rather than helpful to our progress is, I think, shown by the history of the Interglacial hypothesis. In this matter the glacial geologists, having some evidence for the alternate extension and recession of ancient glaciers, fell readily under the influence of the fascinating theory brought forward by James Croll to explain the Great Ice Age, whose interpretation, however, reached far beyond the facts that were placed before him.

I need hardly remind you that, according to Croll, a sufficient explanation of the Glacial Period could be found in certain astronomical conditions, which were shown by his calculations to have recurred at definite intervals, and were supposed to have produced repeated alternations of cold and warm climate at the opposite hemispheres during the course of the period. It is not my purpose to discuss this or any other theory regarding the cause of the Great Ice Age, but only to direct your attention to the influence of Croll's views upon the work of observation. If the theory could have been sustained, it would have given into the hands of the geologist a first instalment of that absolute measure of geological time which he so ardently desires; and with this allurement it is no wonder that the theory was welcomed and hopefully put to the test. Foremost among its exponents was Prof. James Geikie; and we must all recognise that its main importance to the field-geologist arose from his powerful support and masterly arrangement of the evidence favourable to the hypothesis.

It is not surprising that, amid the complicated mass of facts confronting us in the glacial deposits and among the voluminous literature wherein these facts are more or less skilfully enwrapped, there should have been found some material to support the idea of a recurrent succession of glacial and interglacial stages. But the glamour of the astronomical hypothesis has waned, and it is recognised that there are flaws in the physical aspect of the theory and in its geological application that render it untrustworthy. I think, therefore, that the time has come when we should reconsider the matter in critical mood, uninfluenced by the early glow of the theory, after the wise example of that ancient people who debated all matters of import in two opposite frames of mind.

On the present occasion it would be impossible adequately to discuss the whole subject, and I propose to deal principally with my own experience in attempting to apply the Interglacial hypothesis to my field-work. I hope also to be able briefly to review the evidence from other parts of our islands in the light of this experience.

And here I may remind you of the important part which this Section of the British Association has taken in the study of the subject by organising Committees of Research, provided with funds for carrying out excavation and other necessary work. During the twenty-five years since we last met at York I find that, including the work in certain bone-caves, there have been fourteen such committees; and in many cases their operations have extended over several years, so that more than thirty separate reports have been published in the Annual Reports of the Association.[1] The precise information embodied in these reports is of high scientific value, and I am sure that these results are very creditable to the Section.

Classification of the Drifts.

I have mentioned the influence of Prof. J. Geikie in the establishment of the Interglacial hypothesis; and before proceeding further it is necessary that we should recapitulate the scheme of classification which he has proposed for the drifts on the basis of this hypothesis. This elaborate scheme has been built up by a skilful combination of evidence gleaned from various parts of Europe, and represents the hypothesis in its extreme form. Stated in downward succession it stands, in its latest development,[2] as follows:—

[1] Viz., Reports on "Raygill Fissure" (1883–1886); "Manure Gravels of Wexford," &c. (1887–1890); "Welsh Caves" (1886 and 1898); "Sewerby Raised Beach" (1888–1890); "Elbolton Cave" (1891–1894); "Scottish Marine Drifts" (1893–1896); "Calf Hole, Skipton" (1894); "Hoxne Plant Beds" (1896); "Irish Elk in the Isle of Man" (1897–1900); "Pleistocene Beds near Toronto" (1898–1900); "Moel Tryfaen Drift" (1898); "Uphill Cave" (1899–1901); "Irish Caves" (1901–1904); "Kirmington and other Fossiliferous Drifts" (1903–1905). During the same period there have also been twenty three reports of the "Erratic Blocks" Committee, which bear indirectly upon the problem.

[2] "The Classification of European Glacial Deposits," *Journ. Geol.* (Chicago), vol. iii. (1895), pp. 241–269.

European Glacial and Interglacial Stages (Prof. J. Geikie).

XI.	Upper Turbarian	= Sixth Glacial Period[1]
X.	Upper Forestian	= Fifth Interglacial Period[1]
IX.	Lower Turbarian	= Fifth Glacial Epoch
VIII.	Lower Forestian	= Fourth Interglacial Epoch
VII.	Mecklenburgian	= Fourth Glacial Epoch
VI.	Neudeckian	= Third Interglacial Epoch
V.	Polandian	= Third Glacial Epoch
IV.	Helvetian	= Second Interglacial Epoch
III.	Saxonian	= Second Glacial Epoch
II.	Norfolkian	= First Interglacial Epoch
I.	Scanian	= First Glacial Epoch

But although, as already mentioned, the Interglacial hypothesis in its simpler form has many supporters in this country, I do not think that the above scheme in its entirety has yet found any adherents among British glacialists. Usually, when beds supposed to be of interglacial age have been described by other workers, it has been implied that only a single interval of milder conditions was in mind; and even in the exceptional cases where several different boulder-clays separated by sand and gravel have been held to represent as many different epochs of glaciation, it is rare that any attempt has been made, except by Prof. Geikie himself, to classify the supposed events in accordance with the scheme. I suppose that most field-workers have felt, like myself, that while some part of the classification might possibly be sustained, this finished arrangement of the admittedly imperfect evidence was too artificial to be accepted with confidence, and that it was inadvisable to allow one's self to be hampered, in an inherently difficult task, with further difficulties that, after all, might, like "the word Bear-baiting," be "carnal and of man's creating."

On the other hand, partly, no doubt, from the persuasive manner in which its author has presented his case and his courteous readiness to meet objections, but still more from the vast extent of the field drawn upon for the argument, the scheme has aroused less active criticism than it has, in my opinion, deserved. The critic has shrunk from the magnitude of the task of testing it in all its parts, while to pick out the local flaws in any particular part has seemed invidious.

In taking this scheme as the basis of my examination into the evidence, I am aware that the local limitations which I have set myself will be held to impair the validity of my conclusions. But as there is at present in every glaciated country the same confusion of opinion on the Interglacial problem as in our own, and the same discussion upon the fundamental value of the evidence, it appears to me that we can find strong justification for considering our own problem on its separate merits. And the necessity for a re-sifting of the British evidence is the more urgent since it is frequently taken for granted in the discussions abroad that there is a well-established glacial sequence in Britain, which can be called in to support the argument for other lands.

The Interglacial Problem in Other Countries.

It will serve to illustrate the condition of the problem in other countries if I refer briefly to some of the literature which happens to have come under my notice, though I can rarely claim sufficient knowledge of the foreign work to discuss its value.

Norway.—In Norway there appears to be no direct evidence for interglacial epochs, though the existence of one such epoch is supposed to be indicated by a change in the direction of ice-flow, and by the presence of an arctic flora at the base of the Danish peat-mosses which is absent in Norway. By Dr. A. M. Hansen[2] the superficial deposits are classed as follows:—preglacial: proteroglacial: interglacial: deuteroglacial: and postglacial.

Sweden.—In Sweden, and, I believe, also in Denmark, the Interglacial hypothesis is generally accepted, at least to the extent of one epoch of deglaciation, but is strenuously opposed by Dr. N. O. Holst, who states his conviction, based on the result of his observations in Greenland, that the so-called interglacial sands and gravels and the "upper moraine" of Sweden represent the residual products of the ice-sheet that laid down the "lower moraine" as a ground-moraine. He also embraced the drifts of North Germany in this explanation.[1]

Germany.—In Germany, the discussion on the "Interglacialismus" is still in active progress. The idea of one interglacial epoch, corresponding to the "Helvetian" of Prof. J. Geikie's scheme, is widely entertained; and some geologists, influenced largely by evidence in the Alps, think that an earlier interglacial stage (="Norfolkian"), preceded by a stage of glaciation (="Scanian"), may have to be admitted, though the German evidence is acknowledged to be imperfect. But Prof. Geikie's interpretation of the North German drifts, on which he seeks to establish the "Neudeckian Interglacial" and the "Mecklenburgian Glacial" epochs, is strongly and authoritatively opposed. In a searching criticism of these views Dr. K. Keilhack, of the Prussian Geological Survey,[2] states that no reason has been found, by himself or his colleagues, for the proposed separation of the upper drifts into these separate epochs; and he remarks that, on similar grounds, "the so-called 'last glacial epoch' would have to be divided into four if not five epochs, so that even the most fanatical advocate for as many glacial periods as possible would be terrified." Prof. Geikie, in his reply to this criticism,[3] brings forward the British evidence to establish the case in Germany. But, as we shall see, this evidence is especially weak, and we in this country had expected that the stronger proof lay in Germany.

While the supporters of the "Interglacialismus" are thus uncertain how much of the scheme they will accept, there are other geologists in Germany who repudiate the hypothesis in its entirety, and hold for the "singleness of the Ice-Age." Among these I may mention Prof. E. Geinitz,[4] whose vigorous attack has been supported by Dr. W. Wolff, in a useful summary of the discussion, which contains many references to the literature.[5]

Russia.—In Russia, again, opinion is divided, and the evidence brought forward in favour of the Interglacial idea has been adversely criticised by Mr. S. Nikitin, of the Russian Geological Survey,[6] who considered that, whatever may have been the conditions farther westward, oscillations of the ice-margin would suffice to explain the facts observed in this outer portion of the glaciated area.

The Alps.—In the Alps there appears to be definite evidence for several periods of advance of enormous glaciers from the mountain valleys, with intervening periods of great recession, and these are supposed to correspond to glacial and interglacial epochs in Northern Europe; but there has been much difference of opinion respecting this evidence and its interpretation. By Profs. A. Penck and E. Brückner, who have systematically investigated the phenomena, the ice-movements are held to indicate four separate epochs of glaciation, with three, or perhaps four, warm interglacial epochs.[7] Not having yet found an opportunity to make myself sufficiently acquainted with the evidence, I may not fully recognise its importance; but it appears to me that the factors governing the glaciation of this Alpine region may have been very different from those that controlled the lowland

1 "Period" in original; *op. cit.*; probably misprints for "Epoch."

2 A. M. Hansen, "The Glacial Succession in Norway." *Journ. Geol.*, vol. ii. (1894), pp. 123–144.

1 "Har det fannits mera än en istid i Sverige." *Sveriges Geologiska Undersökning*, Ser. C., No. 151 (1895); and "On the Relations of the 'Writing Chalk' of Tullstorp (Sweden) to the Drift Deposits, with Reference to the Interglacial Question." *Geol. Mag.*, dec. v., vol. i. (1904), pp. 56–59.

2 Prof. Geikie's Classification of the North European Glacial Deposits," *Journ. Geol.*, vol. v. (1897), pp 113–125. See also discussion by H. Munthe: "Studien über ältere Quartärablagerungen im südbaltischen Gebiete." *Bull. Geol. Instit. Upsala.* vol. iii. No. 5 (1896), pp. 27–114.

3 "The Last Great Baltic Glacier." *Journ. Geol.*, vol. v. (1897), pp. 324–339.

4 "Die Einheitlichkeit der quartären Eiszeit." *Neues Jahrb. f. Mineralogie*, &c., xvi. (1902), pp. 1–98. and other papers.

5 "Zur Kritik der Interglacial-Hypothese." *Naturwiss. Wochenschrift.* Neue Folge, Bd. ii. No. 26 (1903), 14 pp.

6 "Sur la constitution des dépôts quaternaires en Russie, &c." *Rep. Congrès Internat. d'Archéologie*," Moscou. 1892.

7 Die Alpen im Eiszeitalter." Leipzig (1901–5), not yet complete; for convenient summary see "Glazialexkursion in die Ostalpen." No. 12 of "Guides to Excursions of the Geological Congress," Vienna, 1903.

glaciation. And although it is certain that the great extension of the Alpine glaciers was due to the same glacial conditions that gave rise to the lowland ice-sheets of Northern Europe, I do not regard it as a necessary consequence that advances and retreats of the ice should occur simultaneously in both regions. Variation in the relative amount of snowfall over the glaciated areas during the course of the Glacial Period, for which there is much evidence, would be likely to produce great effects in the high-lying reservoirs of the Alps; and at the latitude of this region we should expect rapid recession of the low-level glaciers in response to diminished supply. To distinguish between the effects of oscillations in precipitation and of oscillations in temperature under such conditions must be peculiarly difficult.

North America.—In North America, where both the drifts and their literature attain gigantic proportions, the state of opinion is closely analogous to that among ourselves. It is agreed by all that during the Glacial Period there were very extensive oscillations in the borders of the ice-sheets; and by some geologists some of the stages of recession are supposed to represent mild epochs of actual "deglaciation"; while others, fewer in number, among whom Mr. Warren Upham and Dr. G. F. Wright have been the most active, regard these stages as of minor consequence, and advocate the essential unity of the glaciation. And between the two extremes stand the great majority of the workers in American glacial geology, who refrain from expressing positive opinions, but mostly lean toward the idea of at least one great interruption in the glaciation. Some of the suggested schemes of classification [1] are fully as elaborate and complex as that proposed for Europe, but it seems to be recognised that these are only of local value. Prof. T. C. Chamberlin and his fellow-workers in the North-Central States have, however, adopted a sequence based on the successive advance of different ice-lobes, which is believed to be of wider application; and Prof. Chamberlin has tentatively suggested that some of these divisions may have their counterpart in the European scheme, but is careful to show that the correlation must at present remain entirely hypothetical,[2] especially as the proposed American grouping may itself require modification.

It is well established that the American ice-sheets, like their European equivalents, radiated from several distinct centres that attained their maximum influence consecutively, and not simultaneously. Of these the "Laurentide" and the "Keewatin" sheets had their radiants over comparatively low ground east and west of Hudson Bay, while the "Cordilleran" sheet spread outward from the Western Mountains. In his general discussion of the glacial phenomena of North-Western Canada, Mr. J. B. Tyrrell[3] concludes that the Cordilleran sheet had reached its greatest extent and had retired before the boulder-clay of the Keewatin sheet was laid down; and that the Keewatin sheet, in turn, had gone south to its farthest limit, and had retired for many hundreds of miles—more than half-way to its gathering ground—before the Laurentide sheet had reached its greatest extension.

If these conclusions be accepted, they must imply that at least in some cases the recession of the ice-lobes was due to causes acting locally, and not to mild interglacial periods affecting the whole hemisphere. The phenomena of invasion by successive ice-lobes in the peripheral regions might thus be readily explained without recourse to the Interglacial hypothesis.

Most of the detailed evidence brought forward in America to support the Interglacial idea is as fragmentary and unconvincing as that of our own country. But there is one notable exception, to which I must particularly refer, as it has been investigated by a Research Committee of the Association, and has, moreover, come under my personal observation. In this case the interglacial deposits, first described by Dr. G. J. Hinde, are magnificently exposed in cliff sections at Scarboro' Heights, on the shores of Lake Ontario, near Toronto. When I visited these sections under the guidance of my friend Prof. A. P. Coleman, in 1897, they impressed me strongly, inasmuch as they afforded the kind of evidence for which one had sought in vain in Britain. The section around Scarboro' Heights reveals a great mass of fossiliferous stratified deposits, more than 180 feet thick, consisting in the lower part of slightly peaty clays, and in the upper part of sands; and these deposits are overlain by a complex series of boulder-clays, with intercalated beds of sand and gravel, attaining a thickness of at least 200 feet. The fossiliferous clays are the lowest beds seen in the cliff section, but beds belonging to the same series, that are exposed in the Don Valley, on the outskirts of Toronto, are underlain by a few feet of boulder-clay, so that it seems to be beyond question that the Scarboro' beds were deposited in an interval between two epochs of glaciation.[1] In their upper part these beds contain a flora and fauna indicating a cool climate, but in their lower portion some of the plants and freshwater shells no longer exist so far north as Canada, and are therefore considered to denote a climate warmer than that of the present day. On this and other evidence it is clear that during the course of the Glacial Period the whole of the district was for a considerable time released from the ice-sheets which previously and afterwards covered it. Moreover, in the opinion of Prof. Coleman, some of the plants and shells of the warm-climate beds denote conditions that would be incompatible with the persistence of ice-sheets anywhere in Canada[2]: and if this be so, then we here have proof for at least one interglacial epoch. But I still permit myself to feel doubt regarding this last-mentioned deduction, as the shells and plants in question, which have their present habitat in the Middle United States, even yet endure winters of considerable severity; and there are certain factors in the composition of the beds and their altitude above Lake Ontario that justify caution. It is, however, mainly from my knowledge of this "Toronto formation," and of the Kirmington section in England, presently to be discussed, that I still maintain an undecided attitude in respect to the Interglacial hypothesis in its simpler form.

Further support to the probability of an interglacial epoch has been adduced from the history of the great lakes which formerly existed in the Interior Basin of the Western States. It has been shown by the researches of G. K. Gilbert in the "Lake Bonneville" basin[3] and of I. C. Russell in that of "Lake Lahontan,"[4] that there were two separate epochs, during which these enormous basins were filled with water, and an intervening arid epoch, during which they were dried up. The region is one in which the actual glacial phenomena are restricted to the mountain valleys; but as it seems evident that the lakes were associated in some way with the Glacial Period, the two stages of extension are supposed to represent two distinct epochs of glaciation, separated by a long interglacial drought. The correlation, however, has difficulties, which are very impartially discussed by Gilbert and Russell; and it will not admit of more than one interglacial episode.

The Interglacial Problem in the British Islands.

Let us now consider the application of the Interglacial hypothesis to our own land.

The task of following up the evolution of Prof. Geikie's scheme through its various phases, though instructive, is very confusing—one might even say irritating—by reason of the continual changes of correlation which its author has suggested in sorting out the British drift deposits into this orderly sequence. Our East Coast boulder-clays, for example, were at one time held to cover four glacial epochs,

[1] *e.g.*, "The Diversity of the Glacial Period in Long Island," by A. C. Veatch. *Journ. Geol.*, vol. xi. (1903), pp. 762–776.
[2] "Classification of American Glacial Deposits." *Journ. Geol.*, vol. iii. (1895), pp. 270–277, and in J. Geikie's "Great Ice Age," 3rd. ed., chap. xli. See also Chamberlin and Salisbury's recent text-book, "Geology: Earth History," vol. iii. chap. xix (London, 1906).
[3] "The Glaciation of North-Central Canada." *Journ. Geol.*, vol. vi. (1898), pp. 147–161; and "The Genesis of Lake Agassiz," *ibid.*, vol. iv. (1896), pp. 811–815.

[1] Prof. A. P. Coleman, Reps. British Assoc. for 1898, pp. 522–29; for 1899, pp. 411–414; for 1900, pp. 328–40; also (summary and discussion) "Glacial and Interglacial Beds near Toronto." *Journ. Geol.* vol. ix. (1901), pp. 285–310.
[2] "The Duration of the Toronto Interglacial Period." *American Geologist*, vol. xxix. (1902), p. 79.
[3] "Lake Bonneville." *Monogr. U.S. Geol. Survey*, vol. i. (1890).
[4] "Lake Lahontan." *Monogr. U.S. Geol. Survey*, vol. xi. (1885).

and their associated gravels to mark three mild interglacial epochs; and all except the first glaciation were supposed to be represented in the boulder-clays of Lancashire and Cheshire.[1] Then, somewhat vaguely, it was allowed that perhaps there were only three separate glaciations on the east coast, with a minor episode of recession of the ice-margin; and the Lancashire and Cheshire boulder-clays were correlated with the two later of these glacial epochs.[2] But subsequently we are reduced in the eastern district to two epochs of glaciation, with one mild interval, of which the equivalents are all recognised also in the north-west of England.[3]

While these and other similar changes may show a laudable desire of their author to keep pace with the growth of definite information, I cannot help feeling that they also show the premature character of the whole scheme, and a flexibility in it that justifies suspicion. Moreover, in spite of these frequent changes in the correlation and this local lopping off of glacial and interglacial episodes, we find, with surprise, that the number of separate epochs in the classification has not diminished, but has actually increased, by regrowth in fresh places. This, again, may betoken the inherent vitality of the scheme, in which case it will gain strength from every readjustment; but it must certainly also denote the weakness of its original basis. In considering its application to this country we will begin by glancing at the evidence for the two earliest epochs of the classification.

"*Scanian*" (*First Glacial*) *and* "*Norfolkian*" (*First Interglacial*) *Epochs.*

It is acknowledged that the First Glacial Epoch is not represented in Britain by any boulder-clay or other evidence of land glaciation, but is based mainly upon the supposed existence of a great Baltic glacier which overflowed the southern part of the Scandinavian peninsula from south-east to north-west, a direction differing widely from that of the later ice-sheets. This glaciation of Scania is supposed to have been contemporaneous with the deposition of the Chillesford Clay and Weybourn Crag of Norfolk, which contain a marine fauna indicative of cold conditions. The Forest Bed series of Norfolk, with its temperate land fauna and flora, is then interpreted as the product of a mild interglacial epoch ("Norfolkian") intercalated between the "Scanian" glaciation and the more severe "Saxonian" glaciation which followed; and it is implied that during this mild stage the earlier ice-sheet vanished.

So far as I can gather, the recognition of the "Scanian" ice-sheet rests on dubious grounds, being based chiefly on the disputed supposition that the lower boulder-clay of North Germany is not the equivalent of the lower boulder-clay of Sweden, but of a subsequent Swedish boulder-clay. For the "Norfolkian" disappearance of the first Swedish ice-sheet no direct evidence is forthcoming, since it is acknowledged that no interglacial deposits representing this stage have been found in Sweden. But the Norfolk Forest Bed is here brought into the argument to prove the "deglaciation" so that the Scandinavian geologist is invited to accept the "First Interglacial Epoch" mainly on the supposed strength of the British evidence, while the British geologist is expected to acknowledge the "First Glacial Epoch" on the supposed strength of the Swedish evidence. This method of argument might have weight if the evidence afforded by either region were perfectly definite. But in the present instance the conclusion that the Forest Bed represents an interglacial episode is not acceptable to the observers who have the fullest knowledge of the Norfolk sections, Mr. Clement Reid pointing out that the enclosing of the North Sea by the union of Britain with the southward continental land affords an adequate explanation of the apparent climatal discrepancy between the fauna of the sea and that of land[4]; while Mr. F. W. Harmer shows the probability of the transport of southern relics into this old estuarine deposit by river-drifting.[1]

[1] "Great Ice Age," 2nd ed (1877), p. 393.
[2] "Prehistoric Europe" (1881), pp. 263–266.
[3] "Great Ice Age," 3rd. ed. (1894), chaps. xxv. and xxvi., and *Journ. Geol.* (*supra cit.*).
[4] "The Pliocene Deposits of Britain." *Mem. Geol. Survey* (1890), pp. 186–190.

It has, indeed, been long recognised that the marine Pliocene deposits of eastern England present us with an intelligible chain of evidence for the gradual and uninterrupted approach of the Glacial Period; and to break this chain will require stronger reasons than have yet been adduced. From the Coralline Crag, with seas warmer than at present, to the Red Crag and Norwich Crag, with a northern element steadily gaining ground in the fauna, we pass upward to the Chillesford Clay and Weybourn Crag, wherein this element becomes predominant. Then follows the period of slight elevation indicated by the Forest Bed, wherein, along with its temperate-climate fauna, such northern forms as the musk ox and glutton are associated; and finally we gain just a glimpse of truly arctic conditions in the *Leda myalis* bed and the Arctic freshwater bed, immediately before the advent of the great ice-sheet that relentlessly blotted out both land and sea.

"*Saxonian*" (*Second Glacial*), "*Helvetian*" (*Second Interglacial*), *and* "*Polandian*" (*Third Glacial*) *Epochs.*

Regarding the glacial severity of the ensuing stage the "Saxonian Epoch" of Prof. Geikie's scheme—all are agreed; and from this stage onward to the close of the "Glacial Period" as usually understood, or to the close of the "Polandian Epoch" of the proposed classification, our difficulties of interpretation arise not from lack of evidence, but rather from its superabundance and local intricacies.

It happens, fortunately, that the great bulk of our British drifts, with the exception only of those in certain mountainous districts, are now included by Prof. Geikie within the two above-mentioned glacial epochs and the intervening "Helvetian Interglacial Epoch." Therefore, in dealing more particularly with the deposits assigned to these three epochs in certain typically glaciated districts, we shall bring under consideration a considerable portion of the drifts of our islands, and shall obtain results which can be applied to many other areas in which the structure of the glacial deposits is essentially similar. The first district to be considered shall be that which lies nearest us; and in discussing the drifts of East Yorkshire I propose to interweave some personal opinions that I have deduced from the facts, which will afterwards be given wider application.

East Yorkshire Drifts.—The long cliff-sections between the Humber and the Tees constitute one of the best exposures of lowland drifts in Britain, or even in Europe. They fortunately include some deposits which reveal the conditions prevailing in the neighbouring part of the North Sea basin just before the great glaciation; and they therefore enable us without interruption to continue the history begun in East Anglia.

The old cliff of chalk and the marine beach at its foot which lie buried at Sewerby, on the southern side of Flamborough Head, under sheets of boulder-clay and gravel, prove to us that at the very beginning of glacial times the North Sea still held possession of its basin, and with a surprisingly slight difference from its present level. A few far-transported stones in the old beach denote that ice-floes sometimes drifted southward into Holderness Bay; while the bones of animals in the shingle, and in the blown sand which overlies it, prove that among the denizens of the neighbouring land were the elephant (*E. antiquus*), rhinoceros (*R. leptorhinus*), hippopotamus (*H. amphibius*), and bison. This fauna is frequently considered to be proof of mild conditions of climate; but from the mode of its occurrence in this and other places, I can find no reason to doubt that these animals inhabited the country, perhaps as seasonal migrants, until the time that it was actually covered by the encroaching ice-sheets.

And here I may note my opinion, that throughout the discussion of our glacial deposits too much weight has been allowed to the deductions regarding climate based upon scanty indications afforded by the ancient fauna and flora.

[1] "The Later Tertiary History of East Anglia." *Proc. Geol. Assoc.*, vol. xvii. (1902), p. 449.

We know little regarding the range of adaptability possessed by the forms in the past, and can judge only from their present habitat, which is generally governed by many other factors besides climate; moreover, it is granted that species already established, when subjected to gradual change, will persist for long in circumstances that would have effectively barred their introduction. In the Upper Zambesi Valley last year I was more impressed with the cold of the nights than with the heat of the days; and even at that latitude the sturdy hippopotamus in his nocturnal raids must experience a temperature occasionally descending below freezing-point.

It took us long to break away from the established conviction that the fossil elephant and rhinoceros could not have existed in a cold climate; and the same conviction still lingers with respect to their companion, the hippopotamus. But the far-travelled stones in the Sewerby beach and in the beaches of the same age in the south of Ireland are evidence that the British seas were already cold enough to carry ice-floes while these large mammals still tenanted the land.

The next event indicated by the Sewerby section is a slight elevation of the land. Then the traces of an increasingly rigorous climate become conspicuous, for the sand-dunes which had been banked against the old cliff are covered by chalky rubble containing a few land shells [1]; and this material, like the corresponding "head" which covers the ancient beaches of the south of Ireland and the south-west of England, appears to represent the frost-splintered rock washed down from the rock slopes during the season of thaw.

According to my reading of the evidence, it was during this time that the bed of the North Sea was gradually filled by a great ice-lobe that spread southward and outward along the basin, slowly but irresistibly churning up and dragging forward the old sea-floor as part of its ground-moraine. When it impinged upon the rising ground of eastern Britain the progress of this sheet was arrested and part of its burden left in the form of the lowest boulder-clay—the "Basement Clay" of Yorkshire and the "Cromer Till" of Norfolk. In Yorkshire this boulder-clay frequently includes huge transported masses of Secondary strata, which still maintain their identity, in some cases even to their bedding planes; and along with these we sometimes find patches of the material of the old sea-floor which have similarly escaped destruction. More frequently the preexisting deposits from which the boulder-clay has been derived have been thoroughly kneaded together, and fragments of Pleistocene shells are then scattered through its mass, along with fossils derived from the Secondary and older rocks.

In adopting the hypothesis that the Basement boulder-clay represents the ground-moraine of an ice-sheet we may consider briefly the probable conditions under which this "East British ice-lobe" was accumulated. Whether the elevation subsequent to the stage represented by the infra-glacial beaches was sufficient to drain off the shallow seas around our islands is uncertain, but it must, at any rate, have restricted their area and rendered them still shallower; and it is unlikely that there was then any southward connection of the North Sea with the English Channel. The climate by this time had become such that permanent snow-caps could accumulate in the northern parts of our country at elevations not much above present sea-level. Indeed, I am inclined to think that the climate may have been actually colder at this time than during any of the later phases of the Glacial Period, and that the stage of maximum glaciation lagged considerably behind the stage of minimum temperature. Under these conditions, with the snowfall on the uplands always slowly drawing away in ice-streams to the basins, and there accumulating, it is inevitable that the enclosed basins would eventually become ice-covered, any open water within them being in time obliterated, either directly by the encroaching glaciers, or indirectly by the packing of bergs and floes, until the basins themselves possessed a surface upon which the snowfall could accumulate. Thus the basins became great reservoirs of ice, in which the supplies from the surrounding uplands received important augmentation by direct accretion of snowfall;—reservoirs, moreover, containing a substance sufficiently rigid not to require retaining walls; so that, in time, the surface of the ice within the basins rose higher than many parts of the rim. The general movement of the mass within its reservoir then became dependent mainly upon its own configuration, and only secondarily upon the shape of the solid ground.

These conditions in the North Sea basin had their parallel in the basin of the Irish Sea, in which the "West British ice-lobe" was developed; and on the low interior plain of Ireland, where the similar though smaller "Ivernian" sheet held possession.

Now, the crux of the Interglacial problem, so far as the British Islands are concerned, lies in the question whether these huge reservoirs, after their first filling, were completely emptied during the supposed interglacial epoch of warmth named by Prof. Geikie the "Helvetian," and were afterwards refilled for the later "Polandian" glaciation, in which, on the evidence of the upper boulder-clays, it is generally agreed that ice-sheets from the basins again closed in upon the land. It is this one interglacial or "middle glacial" epoch only that most of the British supporters of the hypothesis have demanded, and have attempted to establish in the East Yorkshire sections.

For my own part, although I have sought long and carefully for evidence of this great interglacial episode in the Yorkshire drifts, and at first with the belief that such evidence must surely be somewhere forthcoming, my search has not only failed to bring to light any adequate proof of its reality, but has yielded many facts which I cannot explain otherwise than by recognising that the ice-lobe continued to occupy the basin of the North Sea during the deposition of the beds claimed as interglacial, though its margin had for a time shrunk considerably within its earlier limits.

The "Purple" Boulder-Clays and Stratified Drifts.—The drifts overlying the Basement Clay in East Yorkshire consist of a complex and very variable series, in which bands of boulder-clay predominate in some places and lenticular sheets of well-stratified material in others. In the cliff-sections of the Holderness plain certain bands of boulder-clay, known as the Upper and Lower Purple Clays, are persistent for many miles; but when the series approaches the rising ground of the Wolds the individuality of the beds is lost, and they are often replaced entirely by irregular mounds of sand and gravel.

I began work on these sections with the then-prevalent idea that every separate band of boulder-clay above the Basement Clay might indicate a separate glacial epoch, and that warm interglacial epochs might be represented by the partings of sand and gravel between these boulder-clays; and the object of one of my early papers [1] was to show that more of these divisions were present than had found place in the scheme of classification then in vogue. But after struggling for a time under an ever-increasing load of epochs I was compelled, in tracing the separate bands northwards, to recognise, as my friend Mr. J. R. Dakyns had previously recognised,[2] that the whole series underwent protean changes, the boulder-clays sometimes splitting into numerous shreds amid thick sheets of sand and gravel, at other times merging into a single mass to the exclusion of all stratified material, and not rarely presenting a passage from uncompromising "till" to stratified gravel, sand, and clay. Hence I was driven to conclude that stratified and unstratified drift must often have been forming simultaneously at places very little distance apart; and on finding, also, that the whole of the deposits between the Basement Clay and the Upper or "Hessle" Clay were not only knit together in this fashion, but were similarly interwoven with the top and bottom of these boulder-clays, I had finally to abandon the Interglacial hypothesis altogether so far as the coast-sections were concerned. I mention this experience in order to show that my present

[1] Lamplugh, *Proc. Yorks. Geol. Soc.*, vol. xv. (1903), pp. 91-95.

[1] "On the Divisions of the Glacial Beds in Filey Bay." *Proc. Yorks. Geol. Soc.*, vol. vii. (1879), pp. 167-177.

[2] "Glacial Beds at Bridlington." *Ibid.*, vol. vii. (1879), pp. 123-128.

scepticism respecting the Helvetian Interglacial Epoch is based, not upon any preconceived objection to the idea, but upon the failure of the hypothesis when I have put it to the test in this and other districts; and I find also that my experience in this particular runs parallel with that of many other investigators of the so-called "middle glacial" deposits of England.

Marine Detritus in Glacial Gravels.—From certain characters of the moundy gravels on Flamborough Head and in Holderness, such as their rudely linear arrangement, their indifference to the contours, and their relation to the middle or Purple boulder-clays, it appears most probable that they represent the material deposited along the margin of the ice-sheet by the surface-waters flowing from it and from the adjacent land.[1] From the occurrence of more or less fragmentary marine shells in them, the gravels were, however, originally supposed to be of marine origin, and this view is still upheld by some geologists. It is the same question in which so many of the so-called "middle glacial" sands and gravels of the British Islands are involved, and upon which there has been so much discussion. If it be permissible for me to reiterate the well-known argument by which the presence of marine shells in gravels of glacial origin is explained it may be outlined as follows.

Since the basins around our islands are known to have been occupied by the sea at the beginning of the Glacial Period, and since these basins were afterwards filled by ice-lobes, which, as we have seen, moved outward in many places upon the land, dragging with them much of the material of the old sea-floor, it is inevitable that a certain amount of marine detritus will occur in the deposits formed by the ice or derived from its melting. Just as we find shells, and sometimes even transported masses of marine deposits, intact in the Basement Clay, so we find marine relics likewise, though usually more scattered and less perfect, in the gravels derived from the same ice-sheet. This deduction is consistent with our knowledge of existing glaciers and ice-sheets; thus, Sir Archibald Geikie has recorded the presence of sea-shells in the moraine of a Norwegian glacier[2]; Profs. E. J. Garwood and J. W. Gregory have found an excellent illustration of the same phenomenon in one of the Spitzbergen glaciers[3]; and Prof. R. D. Salisbury, in describing the characteristic upturning of the layers of ice at the end of one of the glacial lobes which descends into a shallow bay in North Greenland, gives the following instructive note on the conditions which he observed: "Here the upturning of the layers brought up *shells from the bottom of the bay*, and left them in marginal belts where the upturned layers outcropped. These shells were mingled with other sorts of débris. In one case their quantity could have been measured by some such unit as the wagon-load."[4]

In our islands, as Prof. P. F. Kendall has clearly shown in discussing the drifts of Western England,[5] it is only where the ice-lobes have passed over portions of the pre-existing sea-floors that we find marine remains in the drift deposits; while in other places, at the same or lower elevations, where there is proof that the ice-flow was from the land, such remains are invariably absent.

The occurrence of these shells in a few places at high elevations, all explicable by consideration of the geographical circumstances, gave rise to the idea of a great mid-glacial submergence, and upon this idea the hypothesis of a mild interglacial epoch has mainly hinged. In Prof. Geikie's latest scheme this supposed submergence is, indeed, reduced to moderate limits, but it is still the essential factor in the argument.

The same idea of a moderate degree of submergence, accompanied by temperate conditions of climate, has been applied by Mr. Clement Reid[1] to the shelly gravels of Holderness. Mr. Reid has also proposed to include the buried cliff-beds of Sewerby in the same interglacial stage; but as the gravels rise to nearly 100 feet above the level of the old beach in northern Holderness, and are separated from it by the Basement boulder-clay, I am sure that this correlation cannot be sustained.

These Holderness gravels are supposed to be absent from the coast sections, and it is suggested that they may lie below sea-level in this quarter; but this is not very probable, as they are found at an elevation of 50 feet within a few miles of the coast in southern Holderness, and the Basement boulder-clay rises well above sea-level in the cliffs at Dimlington. It is true that the gravels of the coast sections afford no support to the idea of a mild interglacial submergence, and are evidently of similar origin with the rest of the glacial deposits, but I can see no other reason against their correlation with the gravels of the neighbouring interior. Except in two or three limited tracts, the shells in the Holderness gravels are as fragmentary, and nearly as scanty, as in the moundy gravels of Flamborough Head, which from their character and position cannot be of marine origin. Even at the exceptional places referred to, where the fossils are more plentiful, there is a mixture of forms, including an abundance of the freshwater shell *Corbicula fluminalis*, which seems to denote their derivation from preexisting local deposits; and in the new section at Burstwick, described by Mr. T. Sheppard,[2] these shelly gravels revealed the same close association with the boulder-clay that is so frequently displayed in the glacial gravels of the coast sections.

The Kirmington Section.—There is, however, one case known to me in the east of England, and only one, in which an undoubtedly contemporaneous fauna occurs in beds intercalated with the boulder-clay series.[3] At Kirmington, in North Lincolnshire, a brickyard is worked in a deposit of estuarine clay lying in the middle of a broad shallow valley which cuts across the Chalk Wolds about eight miles south of the Humber. Recent investigation by a Research Committee of the Association, in which I took an active share, has shown, somewhat unexpectedly, that the surface of the chalk at this place descends to present sea-level, and that the estuarine warp is underlain by more than 60 feet of drift, consisting of sand and chalky gravel, with two thick bands of tough clay containing far-travelled stones.[4] The boring in which these beds were proved was insufficient to show precisely whether the stony clays possessed the distinguishing features of true till, but there can be no doubt as to their glacial character, since we know of no deposits of this kind in the east of England except those of glacial age. At the base of the estuarine warp, at 65 feet above Ordnance datum, we found a thin seam of silt and peat containing a few freshwater shells and plant remains, which, like the very scanty fauna of the overlying warp, give no precise indication of climatal conditions, though suggesting that the climate was cooler than at present. The estuarine bed is overlain by a coarse gravel of rolled flints, and in one part of the section this gravel is covered by 3 or 4 feet of red clay with far-travelled stones, resembling the Upper boulder-clay or Hessle Clay of Holderness. The character and fauna of the warp show that it must have been laid down between tide-marks, and we therefore gain an exact measure of the sea-level at the time of its accumulation, and also, I think, of the highest limit of marine submergence in this part of England during any stage of the Glacial Period.

The position of the deposit, at the fringe of the great sheet of drift which covers the lowland east of the Wolds

[1] Lamplugh. "Drifts of Flamborough Head." *Quart. Journ. Geol. Soc.*, vol. xlvii. (1891), pp. 384–431.

[2] "Geological Sketches at Home and Abroad" (London, 1882), pp. 145–6.

[3] "Contributions to the Glacial Geology of Spitzbergen." *Quart. Journ. Geol. Soc.*, vol. liv. (1898), p. 210.

[4] "Glacial Geology of New Jersey." *Rep. Geol. Survey of New Jersey*, vol. v. (1902), p. 81. (The quoted italics are in the original.)

[5] In the late Prof. H. Carvill Lewis's "Glacial Geology of Great Britain and Ireland" (London, 1894), Appendix A, pp. 425–431.

[1] "The Geology of Holderness." *Mem. Geol. Survey* (1885).

[2] "On another Section in the so-called Interglacial Gravels of Holderness." *Proc. Yorks. Geol. and Polytech. Soc.*, vol. xiii. (1895), pp. 1–14.

[3] The freshwater deposit which I found some years ago at Bridlington, and at first thought to be probably intercalated with the boulder-clay, proved on fuller exposure to lie above the boulder-clay, with which it had become entangled by later disturbance. See *Geol. Mag.*, dec. ii., vol. vi. (1879), p. 393; and *Proc. Yorks. Geol. and Polytech. Soc.*, vol. vii. (1881), p. 380.

[4] *Rep. British Assoc.* for 1904, pp. 272–4.

and on the edge of an area west of the Wolds which appears to have escaped glaciation, sustains me in the opinion that it was accumulated during that temporary recession of the East British ice-lobe of which we have other evidence. Its proposed correlation with the Holderness gravels seems hardly tenable in the light of the fuller information which we now possess regarding the section. That the East British ice-lobe, during one of its phases, had the sea at its margin, has always appeared to me to be probable,[1] and, I think, supplies an adequate explanation of the facts.

Under this interpretation the complex drifts between the Basement Clay and the Hessle Clay are regarded as the marginal products of the ice-lobe which filled the North Sea Basin during a stage when its eastern border began to lose ground by rapid wasting. By this recession a broad hollow was left between the hills and the ice-sheet, and into this hollow were swept the abundant washings from the glacier on the one side and from the bare land on the other, thus forming the irregular mounds and broad fans of stratified material which run parallel with the receding ice-border. The sea at this time encircled the southern end of the ice-lobe, but its waters were restricted, in the area under consideration, to narrow estuarine inlets between the ice and the land.

The Upper Boulder-Clay.—Concurrently with this shrinkage of the East British ice-lobe there appears to have been a steady increase in the ice-caps which covered the broader upland tracks of the northern English counties. But all the evidence tends to show that the tongues descending eastward from these caps, from the time of the Basement Clay onward to the close of the glaciation, were persistently prevented from passing freely outward by the presence of the main lobe in the North Sea Basin. Upon the shrinkage of the main lobe they were deflected southward along the hollow between it and the hilly land, which, in time, they filled again to a somewhat higher level than before, the inosculation of the upper and lower Purple boulder-clays with the stratified drifts marking the gradual stages in this process. The magnificent cliff-sections of the Yorkshire coast north of Flamborough reveal the continuous character of this glaciation, and there is no room anywhere to wedge an interglacial period into these sections. South of Flamborough, the interval between the withdrawal of the one mass and the advance of the other was longer, because the passage of the new invader to the eastward of the Oolitic hills was only gradually effected; and consequently it is in the interior of the Holderness recess that we find the greatest development of the stratified drifts. To imagine, with the interglacialists, that the North Sea Basin was emptied of its ice-sheet, and was then filled again just far enough to influence the flow of the local ice, without extraneous re-invasion of our coast, seems to me an unwarranted sacrifice of the evidence to the idea.

Local Shrinkage in the Ice-sheets.—There are many indications, especially in the Midland Counties and along the southern margin of the glaciated region, that the several lobes and tongues of ice of the Glacial Period in Britain did not all attain their maximum development at the same time, but that while some were creeping forward, others were shrinking back. To a certain extent this result may have been brought about simply by changes in the currents as the ice-sheets overwhelmed their erstwhile confining rims of bare land and opened up fresh avenues of discharge.

It appears to me, however, that the prime factor lay in the displacement of the areas of greatest precipitation during the course of the Glacial Period.[2] As the plateaus of ice rose higher in the path of the moisture-laden air-currents they must have gained increased effectiveness as condensers, thereby not only augmenting the snowfall in one quarter, but also diminishing the precipitation in the region to leeward. Hence I imagine that there would be a persistent tendency for the great ice-sheets of Western Europe to thicken and spread more rapidly toward the west than toward the east, until finally the eastern portions were shrunken for want of sustenance, while the westerly lobes were still waxing thicker and stronger. The recent researches of Mr. F. W. Harmer into the probable meteorological conditions of the Glacial Period[1] are full of suggestion in their bearing upon the changes which must have been brought about by the expansion of the ice-sheets. The subject is one of peculiar difficulty, but I believe that the solution of many of the problems connected with the Glacial Period is to be found along the lines of Mr. Harmer's investigations.

In considering this factor it is also especially interesting to find that Captain R. F. Scott is of opinion that the great shrinkage in the Antarctic land ice, of which he obtained such convincing evidence during the recent expedition, is due to the present excessive coldness, and consequent dryness, of the climate; and he assigns the former extension of the southern ice-sheets to a period of warmer and moister conditions.[2] It would have been easy, had time permitted, to bring together numerous illustrations from Polar lands to show how strongly localised in many places are the conditions of existing glaciation; and such conditions must have been still more effective at lower latitudes. Hence we can readily imagine that, during the Glacial Period, differential growth and shrinkage might be brought about concurrently in areas not very wide apart, by local circumstances.

Waning Ice-sheets. So far as the eastern side of England is concerned, I think that the epoch of maximum glaciation was reached, not when the East British lobe pressed farthest westward, but when the Pennine and North British ice advanced southward along its receding flank; and this stage is, I presume, equivalent to the "Polandian Glacial Epoch" of Prof. Geikie's classification. It was at this time that the ice lapped highest around the slopes of the Jurassic and Cretaceous uplands of Yorkshire, causing that radical diversion of the surface-drainage which produced the remarkable effects first made known to us by the brilliant researches of Prof. P. F. Kendall in Cleveland,[3] and since traced by him and his fellow-workers at intervals wherever the margins of the ice-sheets have abutted against the slope of the land.

Farther southward this ice, augmented by the snowfall on its own broad surface, appears to have spread over the lower ground far beyond the bounds of the former invasion, covering most of East Anglia and the East Midland counties with a moving ice-cap, beneath which the Chalky boulder-clay was accumulated. The Upper boulder-clay of Yorkshire I consider to be the product of the same ice-sheet at its waning.

This final waning of the British ice-sheets, as I have elsewhere attempted to show,[4] must have been accompanied by conditions very different from the waxing stages. It appears from the evidence that the great ice-plateaus still lingered in their basins even after the amelioration of the climate had progressed so far that no permanent snow could remain on hills that rose considerably above their level. Deprived of reinforcement, and wasting ever more rapidly as their surfaces were brought lower, the lobes must in all their embayments have passed into that condition of "dead ice" with which the explorers of Polar regions have made us familiar. The "englacial" load of detritus which the ice was powerless farther to transport was gradually dropped to the ground, and often modified and spread by gravitational movement in the saturated mass.[5] The peculiar features of the upper part of the lowland drifts were thus explained many years ago by the late J. G. Goodchild, in his luminous description of the glacial

[1] "Drifts of Flamborough Head." *Quart. Journ. Geol. Soc.*, vol. xlvii. (1891), p. 421.

[2] *Glacialists' Mag.*, vol. i. No. 11 (1894), p. 231; and *Mem. Geol. Survey*, "Isle of Man" (1903), p. 395.

[1] "The Influence of Winds upon Climate during the Pleistocene Epoch." *Quart. Journ. Geol. Soc.*, vol. lvii. (1901), pp. 405–476.

[2] "Results of the National Antarctic Expedition." *Geograph. Journ.*, vol. xxv. (1905), p. 306.

[3] "A System of Glacier-Lakes in the Cleveland Hills." *Quart. Journ. Geol. Soc.*, vol. lviii. (1902), pp. 471–571.

[4] "The Geology of the Isle of Man." *Mem. Geol. Survey* (1903), pp. 395–7.

[5] The flow of loose material at the surface when saturated by water has been recently studied by J. G. Andersson (Upsala), who cites many remarkable illustrations of the phenomenon, and proposes to apply to it the term "solifluction." *Journ. Geol.*, vol. xiv. (1906), pp. 91–112.

deposits in the Vale of Eden,[1] and his conclusions have been supported by the researches of Dr. N. O. Holst in Southern Greenland, where there was found to be the same difference between the unoxidised ground-moraine and the overlying oxidised material of "englacial" origin as between the lower and upper boulder-clays in areas of ancient glaciation.[2] In adopting this explanation we must recognise that the uppermost boulder-clay of an extensive area was not formed at exactly the same time in every part, but was accumulated progressively as a marginal residue during the emergence of the land from its icy cloak.

Late Glacial and Post-Glacial Deposits.—Of the glacial and interglacial epochs of Prof. Geikie's scheme later than the "Polandian" it is admitted that no indication has been found in Yorkshire. There seems, on the contrary, to be evidence of steady amelioration in the climate, as the glacial deposits opposite the mouths of the Wold valleys are overlain, first by great deltas of chalky gravel, denoting torrential floods, probably from the seasonal melting of heavy snows; and then, in the hollows of these gravels, or of the boulder-clay itself, we find freshwater marl and peat that were deposited in the many lakelets and marshes that dotted the Holderness plain; and in the lower layers of certain of these freshwater deposits the leaves of the arctic birch (*Betula nana*) have been detected,[3] indicating a climate colder than at present.

In East Yorkshire, then, we appear to have a continuous record of the events from the beginning to the end of the Glacial Period; and yet, if I read the sections aright, we can find no place into which a single mild interglacial epoch can be intercalated.

Let us now more briefly consider certain glaciated areas within the influence of the "West British" ice-lobe which I have personally investigated.

DRIFTS OF THE ISLE OF MAN.—From its isolated position in the midst of the Irish Sea, the Isle of Man constitutes an excellent gauge or glaciometer, on which is recorded the course of events within the basin occupied by the West British ice-lobe. In carrying out the geological survey of this island I made a close examination of its glacial deposits in every part, and have stated the results rather fully in a recently published memoir.[4]

We find here, as in Yorkshire, that prior to the glaciation there was a sea-margin at approximately its present level and, where the coast is composed of "solid" rocks, in approximately its present position. In this sea, marine deposits indicative of cold conditions were accumulated, and were afterwards displaced and mingled with the boulder-clay of an ice-sheet that gradually filled the basin and swept southward, or south-south-eastward, over the very summit of the island. At its maximum the surface of this ice-sheet stood more than 2000 feet higher than present sea-level. The difference between the altitude attained by this ice and that of the East British lobe in the same latitude is especially noteworthy. In Yorkshire the eastern ice did not reach much above 800 feet on the flanks of the Cleveland Hills, declining to 500 feet or under off Flamborough Head. The higher land which surrounds the Irish Sea Basin may be in part responsible for this difference, but I think that it must have been mainly due to the heavier precipitation in the west.

Then followed a declining stage in the glaciation, during which the ice-sheet shrank away from the hills, which were never again covered. Owing to local circumstances that are readily recognisable, the recession of its margin was relatively accelerated in the northern part of the island, so that a broad hollow was formed there between the hills and the ice-border; and in this hollow a mass of stratified drift was deposited. From its terraced aspect and the occurrence of scattered shells, I thought at first that this deposit might be of marine origin; but examination in detail convinced me as it had previously convinced Prof. P. F. Kendall,[1] that the phenomena could only be explained by regarding the stratified material as marginal "overwash" from the ice-front. As in Yorkshire, the association of the boulder-clays with the stratified drift is in most places so intimate that again the evidence for the continuous presence of the ice-sheet in the surrounding basin seems irrefragable.

Following closely upon this local deposition of stratified drift, there appears to have been a limited readvance of the ice, which brought about the accumulation of an upper boulder-clay on parts of the low ground. But, unlike the Upper Clay of Yorkshire, this bed lies well within the limits of the lower clays, both in extent and elevation; and it seems to denote only a slight augmentation of the persisting ice-sheet, which was thus enabled to close in again upon the lower flanks of the hills.

The end of the glacial invasion was marked by similar conditions to those found in Holderness. Great fans of flood-gravel were spread out around the mouths of the upland glens; and the hollows in the drift-plain were occupied by lakelets, now mostly obliterated by an infilling of marly and peaty sediments. Among the plants found in a bed near the base of one of these hollows is a northern willow (*Salix herbacea*), along with the remains of a minute arctic freshwater crustacean (*Lepidurus glacialis*); and similar remains were also found in a peaty layer interbedded with the flood-gravels.

Here, then, is another area in which the drifts are fully developed and magnificently exposed in cliff sections, but still yield no proof of the supposed interglacial epochs or of the marine submergence.

IRISH DRIFTS.—During recent years, while attached to the staff of the Geological Survey in Ireland, I had occasion systematically to examine the drifts of four separate and typical areas. With my colleagues of the Irish staff, the mapping of the superficial deposits was carried out in the country around the cities of Dublin, Belfast, Cork, and Limerick. The results, which have been fully stated in recent publications of the Survey,[2] differ only in detail from those already dealt with, and need not detain us long.

Cork District.—In the south of Ireland, the infra-glacial beach, with its associated cliff and shore-line, discovered by Messrs. H. B. Muff and W. B. Wright,[3] is essentially similar to the buried cliff at Sewerby and at almost exactly the same level. The presence of the old beach-line within the submerged valleys or *rias* of this coast proves that the valleys were excavated during some earlier stage of elevation. In its eastward extension the beach, with its covering of sub-aërial land-waste or "head," is overlain by the shelly boulder-clay of the West British ice-lobe; but in the south-west of Ireland, where the glaciation was from landward, this boulder-clay is absent, and its place is taken by a till of more local origin. The Cork district appears to have lain not far within the southerly bounds of the ice-sheets, and its valleys were filled to the brim almost entirely with ice from the interior of Ireland. Where the products of this ice are seen in contact with the shelly drift, as in the vicinity of Youghal, the latter lies undermost; but the evidence implies that the two ice-sheets were coexistent, and there is no indication of any break in the glaciation.[4] Both here and in the Dublin district there appears to have been a shrinkage in the West British lobe while the Ivernian ice was still advancing, which again

[1] "Ice Work in Edenside." *Trans. Cumberland Assoc.*, No. 12 (1886-7), pp. 111-167.

[2] "Dr. N. O. Holst's Studies in Glacial Geology," by Dr. J. Lindahl, *American Naturalist*, Aug. 1888, pp. 705-712. It should be noted, however, that Prof. R. D. Salisbury did not find this difference apparent in the moraines of North Greenland glaciers. See *Journ. Geol.*, vol. iv. (1896), pp. 806-7.

[3] By Dr. A. G. Nathorst, at Bridlington; and by C. Reid, at Holmpton. "Geology of Holderness," pp. 78 and 85.

[4] "The Geology of the Isle of Man" (1903). *Mem. Geol. Survey.*

[1] "On the Glacial Geology of the Isle of Man." *Yn Lioar Manninagh*, vol. i. pt. 12. pp. 307-438.

[2] *Mems. Geol. Survey*: "The Geology of the Country around Dublin" (1903); "The Geology of the Country around Belfast" (1904); "The Geology of the Country around Cork and Cork Harbour" (1905); "The Geology of the Country around Limerick" (in press).

[3] Wright and Muff, "The Pre-glacial Raised Beach of the South Coast of Ireland." *Sc. Proc. Roy. Dublin Soc.*, N.S., vol. x. pt. 11 (1904), pp. 250-324.

[4] Wright and Muff, *op. cit.*, p. 272.

points to a shifting westward of the area of greatest precipitation.

Owing to its peripheral position, the Cork district seems to have been set free from its ice-mantle much earlier than the more northerly parts of Ireland; and if there had been marine submergence later than the period of maximum glaciation, it should have left clear traces in this area. But we found, instead, that all the deposits newer than the boulder-clay were unmistakably of fluviatile or sub-aërial origin, and occupied positions that they could not have maintained if any submergence had occurred.

Dublin District.—In the Dublin district the lower shelly boulder-clay was carried for some distance inland during an early stage in the glaciation, but afterwards there was a great outpouring of the Ivernian ice from west-north-west round the northern flank of the Dublin Mountains. As the Pennine ice was deflected southward on reaching the North Sea Basin, so was this Ivernian ice deflected southward parallel to the coast in the Irish Sea Basin, the persistence of ice-lobes within the basins being the only adequate explanation in both cases.

The shelly gravels associated with the Dublin drifts are of peculiar interest, since they occur at heights ranging up to 1200 feet above sea-level, and are typical of the other high-level shelly drifts of the "West British" basin, including the much-discussed deposits of Moel Tryfaen and Macclesfield. The position of these gravels on the flanks of the Dublin Mountains at the margin of the heavily drift-covered country, their moundy outlines, sporadic development, disregard for contours, character of the fauna, relationship to the boulder-clay, and, in fact, every feature they possess, tell against the possibility of these gravels being of marine origin or other than the marginal deposits of the ice-sheet. Gravels at much lower levels in the same district that are associated with the ice-flow from the interior of the country contain no shell fragments.

The fine coast sections between Killiney and Bray show the usual features of a lower shelly boulder-clay brought in obliquely from the seaward and an upper boulder-clay derived from the landward ice; and they show, too, that the so-called "middle glacial" gravels are merely local modifications of the glacial series, interwoven with the boulder-clays and of contemporaneous accumulation. In this district there is again strong evidence that the land remained above sea-level during the final waning of the ice, and that it has not since undergone any submergence, except to a depth of not more than 10 feet above present sea-level.

Belfast District.—In the country around Belfast the glacial phenomena presented the same general features. The principal constituents were again—a shelly boulder-clay, brought in from the northward, interlocked in a few places with moundy gravels, also containing a few shell fragments; and a contemporaneous drift in the hilly interior of more immediately local origin, associated with gravels of like composition and without any marine relics.

The only new feature was the presence of a mass of unfossiliferous sand and laminated clay in the recess at the head of Belfast Lough, which appears to have been deposited in a glacially dammed lake during the waning phase of the glaciation. This deposit is in places interbedded with and partly overlain by boulder-clay. Its relation to the surrounding drifts seems only explicable under the supposition that the oscillating margin of the ice-lobe was continuously present in the vicinity; and nowhere in the district did we find any evidence to suggest that there were epochs of glaciation separated by warm interglacial episodes.

The conditions in this district subsequent to the disappearance of the ice-sheets are recorded in the post-glacial deposits at the head of Belfast Lough, which have been carefully investigated by Mr. R. Lloyd Praeger.[1] A bed of peat, passing considerably below sea-level, proves that at first the land stood higher than at present, while the estuarine clays which overlie this peat demonstrate a more recent submergence to a depth of not more than 15 or 20 feet above present sea-level. This degree of submergence is marked also by the raised beach which almost everywhere fringes the north-eastern coast of Ireland, and there is no adequate evidence for any other epoch of submergence in Ireland between the beginning of the Glacial Period and the present time.

Limerick District.—In the country around Limerick we had to deal with the products of the Ivernian sheet-ice only, uncomplicated by exterior invasion; and here not even the staunchest supporter of Interglacial deglaciation and submergence could have found a basis for his hypothesis. Although the drifts occur thickly on low ground falling to sea-level, as well as on the hills, and although they include numerous eskers and broad fans of sand and gravel, not a single shell fragment has been discovered in them, nor any other indication of marine agency. On the other hand, there is abundant evidence that the boulder-clay and the stratified drift were formed contemporaneously, the one by the ice-sheet itself, and the other by the flood-waters in and around it. Another noteworthy point in this district is that, in spite of its proximity to the west coast, with the broad estuary of the Shannon offering at present an open passage thereto, the general movement of the land-ice was south-eastward across the low ground, trending inland, and not toward the coast. It appears, therefore, that the ice-sheet at the mouth of the Shannon was sufficiently thick to dominate that of the country to the east in this part of Ireland. Farther to the northward, however, and also to the southward, it is known that ice-lobes passed outward toward the Atlantic.

I think that this review of the testimony from the areas which I have closely investigated will serve to show how extraordinarily elusive is the evidence for even the principal Interglacial epoch of the proposed scheme. I shall venture to claim that in each of these areas all the available data concerning the superficial deposits were systematically examined in the field and conscientiously sifted, without prejudice towards one opinion or another. Yet the only support which has been found for the Interglacial hypothesis is from a single section in North Lincolnshire, and although in this case the facts give some encouragement to the idea, they can be as readily explained without recourse to it.

In view of some evidence which we have still to consider, it is especially remarkable that in the range of magnificent coast sections, not of these areas alone, but of the whole of our islands, there is not, so far as I am aware, a single known occurrence of fossiliferous land deposits, peaty or otherwise, interbedded with boulder-clays; and we have, therefore, to depend entirely upon much less satisfactory exposures in the interior of the country for evidence of this kind.[1]

After the experience above recorded, it is inevitable that I shall approach the remainder of the British evidence for the Interglacial hypothesis in sceptical mood, though, I hope, without dogmatism. In discussing this evidence from districts of which my personal knowledge is scanty, or altogether wanting, I shall perforce have to depend mainly upon the literature of the subject, although I am fully aware that of the opinionative churning of this literature there has already been more than enough.

East Anglia.—In East Anglia, the original opinion that the shelly "middle glacial" sands and gravels represent a mild interglacial epoch of submergence is no longer prevalent. Mr. F. W. Harmer[2] points out that both the mollusca and ostracoda they contain are generally of a boreal or arctic character; and my colleague, Mr. H. B. Woodward, after extensive field-experience of these deposits, concludes that they are inseparable from the associated

[1] "Report on the Estuarine Clays of the North-east of Ireland." *Proc. Roy. Irish Acad.* (3), vol. ii. (1892), pp. 217–289.

[1] I did, indeed, at one time think that I had discovered an ancient soil with land shells between two boulder-clays in the cliffs of Filey Bay, but after much examination I found that it was a recent soil, covered by a huge slip of boulder-clay from the upper part of the cliff and then exposed in section by the cutting back of the coast.

[2] "The Later Tertiary History of East Anglia," *Proc. Geol. Assoc.*, vol. xvii (1902), pp. 458–462; and "Pleistocene Deposits of East Anglia." *Proc. Yorks Geol. and Polytech. Soc.*, vol. xv. (1904), p. 322.

drifts acknowledged to be of glacial origin, and that their curiously mixed assemblage of shells does not represent a contemporaneous fauna.[1] These beds form part of the "Helvetian" interglacials of Prof. Geikie's scheme.

Midland Counties.—In the North Midlands, Mr. R. M. Deeley,[2] in classifying the complex drifts of the Trent Basin, has sought to explain these deposits as the product of several successive glacial and interglacial epochs, but the correlation of these supposed epochs with those of Prof. Geikie is found difficult.[3] All except the latest of the deposits classed as interglacial are unfossiliferous; and the evidence for glaciation later than this fossiliferous deposit—an ancient river-gravel of the Derwent containing mammalian remains (hippopotamus, rhinoceros, and elephant)[4]—is very questionable.[5] The recent work of the Geological Survey in the district, in which I am taking part, confirms Mr. Deeley's opinion that the basin was invaded by ice-lobes from different quarters, which attained their maxima at different times. It is also found that there are areas which apparently lay beyond the reach of these lobes, and remained unglaciated.[6] In these circumstances, the simplest explanation of the facts seems to be that the marginal area was sometimes exposed and sometimes ice-covered by the different flows in their oscillations during a single prolonged period of glacial conditions. There is no evidence of marine submergence in the district, though the whole of it lies much below the level attained by the shelly "middle glacial" stratified drifts of the country to the westward.

Farther south, Mr. W. Jerome Harrison, after a lengthy investigation of a wide area centring around Birmingham, finds that the drifts were the product of three great ice-lobes—the "Arenig Glacier," the "Irish Sea Glacier," and the "North Sea Glacier"; and he concludes that there has been no marine submergence and that "the district affords no proof of any 'interglacial' period."[7]

North-western Counties.—The glacial deposits of West Lancashire, Cheshire, and North Wales are essentially analogous to those of the Isle of Man. The supposed "middle glacial" submergence has figured largely in the voluminous literature of this part of the country; and Prof. Geikie, by supposing that certain Welsh and Yorkshire cave deposits of doubtful age are interglacial, and that an undefined part of the glacial sands and gravels indicates interglacial submergence, is able to picture a "Saxonian" glaciation, a "Helvetian" mild interglacial epoch with a wide land surface succeeded by marine conditions, and then a later "Polandian" glaciation from the same quarter as the first.[8] But the investigators who have studied this district most closely are agreed that the interstratification of the boulder-clay with the sands and gravels is so intimate and so many times repeated that the deposits must have been practically contemporaneous and of common origin; and the differences of opinion that have arisen are on the question whether these drifts as a whole have been deposited by the sea or by land-ice.[9] The case for the land-ice hypothesis and for the unity of the glaciation has been admirably summarised by Prof. P. F. Kendall.[10]

The systematic researches of the late J. G. Goodchild in Edenside,[11] and of Mr. R. H. Tiddeman in North Lancashire and Yorkshire,[1] failed to bring to light any evidence for this great "Helvetian" break in the glaciation; nor have the later investigations farther southward, among which we may mention those of Prof. T. J. Jehu in Pembrokeshire,[2] and of the Geological Survey in South Wales, shown any other result.

In support of the hypothetical Helvetian land surface in the north-western region, Prof. Geikie lays stress upon the discovery of a muddy deposit containing undetermined vegetable remains and diatoms in the boulder-clay near Ulverston, in North Lancashire. This material, penetrated in borings for iron ore, was first described by Mr. J. Bolton,[3] more than forty years ago, as occurring beneath the "pinel" (boulder-clay) and just above the Carboniferous Limestone; Miss E. Hodgson[4] shortly afterwards gave reasons for believing that the "muck" had been introduced into the cavernous top of the limestone by recent streams which drain underground; and eighteen years later Mr. J. D. Kendall[5] recorded further borings, which seem to show that the material sometimes occurs a few feet above the base of the boulder-clay; but his suggestion that the outcrop of the bed in question may be represented by the submerged forests occurring above the boulder-clay on the foreshore at Walney, Dring, and St. Bees indicates a misapprehension of the evidence. Prof. Geikie infers that the great mass of boulder-clay, in one place 70 feet thick, above the "muck" represents the Polandian boulder-clay, and the bottom clay, rarely more than 3 or 4 feet thick, the Saxonian glaciation; but this reading is quite contrary to the usual relations of the boulder-clays assigned to these epochs; and, indeed, the whole case is too indefinite to carry any weight.

Another peaty deposit to which an interglacial age has been assigned was observed many years ago near Macclesfield by Dr. J. D. Sainter,[6] but in this instance the bed occurred above all the boulder-clays, and was covered only by a few feet of coarse bouldery gravel, which, from its topographical position, is probably of fluviatile origin and of late-glacial or post-glacial age.

Northern Counties.—In Northumberland and Durham, so far as I am aware, no indication of the Helvetian interglacial epoch is forthcoming. The boulder-clays, with their interbedded sands and gravels, are like those of the North Yorkshire coast, and have received similar explanation. Dr. D. Woolacott,[7] in his recent description of glacial sections in Northumberland, remarks: "So far as the available evidence . . . goes there does not seem to be anything pointing to an interglacial period or periods. The deposits of sand and sandy clay intercalated in the true boulder-clay are, as a rule, most irregular in position, and vary laterally in thickness."

Southern England.—In the South of England, beyond the area of actual glaciation, evidence for an interglacial epoch has been brought forward from two or three localities, where deposits of very limited extent, partly of marine and partly of freshwater origin, have yielded a fauna and flora indicative of comparatively warm conditions.

Of these, the most important is a marine deposit containing a molluscan fauna of southerly facies, which occurs on the coast of Sussex near Selsey. The case for its interglacial age has been stated by my colleague, Mr. Clement Reid,[8] who observed numerous large erratic boulders resting on a floor of Eocene beds in a temporary exposure on the foreshore, and infers that these boulders represent a period of glacial conditions anterior to the deposition of the bed containing the temperate-climate shells, while a later period of glaciation is inferred from the presence of the "Coombe-rock," or chalky rubble, overlying the shell-bed. This interpretation of the section has, however,

1 "The Glacial Drifts of Norfolk." *Proc. Geol. Assoc.*, vol. ix. (1887), pp. 111–129.
2 "The Pleistocene Succession in the Trent Basin." *Quart. Journ. Geol. Soc.*, vol. xlii. (1886), pp. 437–480.
3 "The Glacial Succession." *Geol. Mag.*, dec. iii., vol. x. (1893), pp. 31–35.
4 H. H. Arnold-Bemrose and R. M. Deeley, "Mammalian Remains in Derwent River Gravels." *Quart. Journ. Geol. Soc.*, vol. lii. (1896), pp. 497–510.
5 C. Fox Strangways, *Mem. Geol. Survey*: "Country between Derby," &c. (1905), p. 41.
6 "Summary of Progress of Geol. Survey for 1905."
7 "The Ancient Glaciers of the Midland Counties." *Proc. Geol. Assoc.*, vol. xv. (1898), pp. 400–408.
8 "Great Ice Age," 3rd ed., pp. 367–374.
9 *e.g.*:—G. E. De Rance, *Rep. Brit. Assoc. for* 1893, p. 779; A. Strahan, *Quart. Journ. Geol. Soc.*, vol. xlii. (1886), p. 383; T. Mellard Reade, *Quart. Journ. Geol. Soc.*, vol. xxx. (1874), pp. 35–37; and *ibid.*, vol. xxxix. (1883), pp. 123–127.
10 In G. F. Wright's "Man and the Glacial Period" (London, 1892), pp. 145–153, and in H. Carvill Lewis's "Glacial Geology of Great Britain and Ireland" (London, 1894), pp. 394–434.
11 *Op. cit.*, and *Quart. Journ. Geol. Soc.*, vol. xxxi. (1875), pp. 55–99.

1 *Quart. Journ. Geol. Soc.*, vol. xxviii. (1872), pp. 471–491.
2 "The Glacial Deposits of Northern Pembrokeshire." *Trans. Roy. Soc. Edinburgh*, vol. xli. (1904), pp. 53–97.
3 *Quart. Journ. Geol. Soc.*, vol. xviii. (1862), pp. 274–7.
4 *Quart. Journ. Geol. Soc.*, vol. xix. (1863), pp. 19–31.
5 *Quart. Journ. Geol. Soc.*, vol. xxxvii. (1881), pp. 29–39.
6 "Geological Rambles round Macclesfield" (Macclesfield, 1878), pp. 65–7.
7 *Quart. Journ. Geol. Soc.*, vol. lxi. (1905), p. 68.
8 "On the Pleistocene Deposits of the Sussex Coast." *Quart. Journ. Geol. Soc.*, vol. xlviii. (1892), pp. 344–61. See also "The Origin of the British Flora" (London, 1899), chap. iv. *et seq.*

already been challenged by Prof. P. F. Kendall.[1] The erratics are not seen to pass under the clays with southern mollusca, as there is a gap of about half a mile between the two deposits, so that the succession cannot be proved by direct superposition. But Mr. Reid urges that "another method is available: to observe the occurrence of material derived from the one stratum and redeposited in the other." "No fragments of southern mollusca have yet been found in the erratic gravel,[2] but the clays with southern mollusca often contained redeposited erratics. The gravel with erratic blocks is, therefore, the older of the two." The bed overlying the shelly deposit also contains erratics, and these, too, Mr. Reid considers to be "redeposited"; but it appears to me that the grounds for this inference are insufficient. By Godwin-Austen,[3] who had previously described the section, it was considered that the horizon of the boulders was above the shell-bed; and, since the shelly deposit itself does not appear to exceed a few feet in thickness, it is probable that heavy stones dropped on the sea-floor by floating ice would embed themselves in the shelly mud.

Mr. Reid's suggestion that the shell-bed may represent a warm interglacial epoch newer than the glaciation indicated by the Chalky boulder-clay, and therefore newer than the so-called "middle glacial" of Northern England, or than the Helvetian Epoch of Prof. Geikie's scheme, adds further confusion to the issue; and the presence of estuarine and freshwater deposits on the same coast, at West Wittering and at Stone, in Hampshire, also regarded as belonging to the same interglacial episode, raises additional difficulties.

Without entering at length into the matter, I can only state that in my opinion, after full consideration of the records, these South Coast sections do not afford definite proof of a mild interglacial episode.

Some Deposits above the Boulder-clays.—The freshwater deposits at Hoxne,[4] in Suffolk, and at Hitchin, in Hertfordshire,[5] classed by Mr. Reid as interglacial, belong to a different category. They occur within the region of actual glaciation, but in both cases it has been proved by Mr. Reid that the beds overlie the Chalky boulder-clay; and there has been no subsequent glaciation of the district. At Hoxne, however, though not at Hitchin, the remains of arctic plants are found in one part of the series, overlying deposits containing temperate plants. It is to be noted, however, that several of the temperate plants occur also in the arctic plant-bed, but are supposed to have been derived from the older deposit.

Under the usual classification of the field-geologist, the whole series would be regarded as late-glacial or post-glacial. At any rate, being above the Chalky boulder-clay, they cannot belong to the supposed middle glacial, or Helvetian Epoch; and as the arctic plant-bed of Hoxne is classed by Mr. Reid[6] as "Late Glacial," along with other plant-beds with a similar flora which lie directly upon the glacial drift in many parts of Britain, it is difficult to know where, in the English glacial sequence, we are to place the supposed interglacial epoch represented by the temperate plant-beds of Hoxne and Hitchin.

From such deposits we regain at the most a mere fragment of the whole flora of the time; and I think there is a danger that we lay too much weight upon accidental instances of preservation. Is it not possible that the northern flora lingered for some time in suitable places alongside the re-advancing temperate plants? That some minor oscillations of climate have occurred during post-glacial times may be admitted; but, so far as my experience has reached, I have not yet seen any evidence for a general reversal of climatic conditions after the accumulation of the Upper boulder-clay of eastern and western England.

[1] "The Cause of the Ice Age." *Trans. Leeds Geol. Assoc.*, pt. viii. (1893), p. 64.

[2] Godwin-Austen, however, found southern shells in the Pholas-borings which Mr. Reid assigns to the supposed glacial deposit: *infra cit.*

[3] R. Godwin-Austen "On the Newer Tertiary Deposits of the Sussex Coast." *Quart. Journ. Geol. Soc.*, vol. xiii. (1857), pp. 40–72.

[4] "Report of Committee on Relation of Palæolithic Man to the Glacial Period." *Rep. Brit. Assoc. for* 1896, pp. 400–415.

[5] "The Palæolithic Deposits at Hitchin and their Relation to the Glacial Epoch." *Proc. Roy. Soc.*, vol. lxi. (1897), pp. 40–49.

[6] "Origin of the British Flora," *supra cit.*, p. 53.

SCOTLAND.—The Scottish evidence still remains to be considered, and I must confess to a certain timidity in venturing across the Border into this stronghold of the "Interglacialismus," especially as my personal acquaintance with the Scottish drifts is slight. But, armed with the experience gained south of the Border, I will attempt the raid.

On the eastern side of Scotland the drifts broadly resemble those of the east of England; while in western Scotland they appear to be more nearly akin to those of Wales and the west of Ireland; with this difference, that there is more plentiful evidence for local valley-glaciers during the waning stages of the Glacial Period.

The evidence for the Helvetian Epoch of deglaciation in Scotland is even more confused and indefinite than in England. Some sporadic patches of peaty and silty material associated with the boulder-clay are supposed to represent a continuous land surface during an epoch when previous ice-sheets had entirely melted away; and similar patches of marine origin are interpreted as the product of a Helvetian submergence with which this interglacial episode terminated. But the evidence is so widely scattered and so diverse in character that it leaves us sceptical, in spite of the admirable skill with which its arrangement into the scheme is effected.

The land deposits, almost without exception, were observed in temporary exposures of small extent that are not available for further study, and in several instances doubt has arisen as to their exact relations with the boulder-clay. The "elephant-bed" at Kilmaurs, Ayrshire, appears generally to have underlain the boulder-clay, and was originally supposed to be pre-glacial, though on other evidence it is regarded as intercalated between two boulder-clays where both happen to be present.[1] The plant-bed near Airdrie, Lanarkshire, as we learn from the careful description of the late James Bennie,[2] occurred in wisps in the boulder-clay, and was evidently displaced; and, moreover, as in other of these Scottish plant-beds, the flora is of arctic character. There are, in fact, according to Mr. C. Reid, only three localities at present known in Scotland where plants indicative of a temperate climate have been discovered in beds supposed to be intercalated with boulder-clay, viz., Cowden Glen (Renfrew), Redhall, and Hailes (both near Edinburgh), and in each case Mr. Reid has found such anomalous results in his critical examination of the plant remains said to have been obtained from the deposits that, in spite of his usual willingness to adopt the Interglacial hypothesis, he has been led to doubt the evidence for their "interglacial" position.[3] Prof. J. Geikie, it is true, has challenged Mr. Reid's results;[4] and as it is stated that the Cowden Glen section has been obliterated for many years, the Hailes interglacial deposit long since removed, and the Redhall quarry now obscure, there seems no likelihood of further evidence on either side; which is the more to be regretted in view of the curious circumstance, already commented on, that not a single interglacial peat-bed has ever been detected in all the length of our unrivalled coast sections. As the matter stands, we are, I think, justified in regarding these Scottish land deposits as an insecure foundation for the wide-reaching conclusions which have been drawn from them.

The hypothetical Helvetian submergence of Scotland rests on similar evidence to that which has been already discussed in the case of the English and Irish drifts. Its limits are not marked by any shore-line, and, indeed, are acknowledged to be uncertain by Prof. Geikie himself. Some patches of marine sediments, containing a molluscan fauna that is generally distinctly boreal, have been found, sometimes beneath, sometimes above, and sometimes intercalated with the boulder-clay; but it is especially noteworthy that these patches all occur along the outer margin of the country, contiguous to the sea-basins, and that a belt of shelly boulder-clay, denoting the dispersal of pre-

[1] "Great Ice Age," 3rd ed., pp. 133–5.

[2] "On the Occurrence of Peat with Arctic Plants in Boulder Clay at Faskine, near Airdrie." *Trans. Geol. Soc., Glasgow*, vol. x. (1894), pp. 148–152.

[3] "On Scottish Interglacial Deposits." *Geol. Mag.*, dec. iv., vol. ii. 1895), pp. 1–3.

[4] "Scottish Interglacial Beds" (letter). *Geol. Mag.*, dec. iv., vol. ii. (1895), pp. 283–4.

existing marine deposits, occupies a similar position in many places. From my knowledge of the conditions under which the patches of marine detritus occur in the Basement Clay of East Yorkshire, I think it most probable that the shell-beds at Clava, Inverness-shire, and in Kintyre,[1] which lie at or near the base of the boulder-clay, represent the disturbed sea bottom of early glacial times; while that at Chapelhall, near Airdrie, appears to have been a very small isolated patch in the boulder-clay, as no further trace of it was found in the search carried out by a Committee of the Association. These beds are certainly inadequate as proof of a mild interglacial submergence.

In Eastern Aberdeenshire and the neighbouring coastlands the drifts have been indefatigably studied by that honoured veteran among glacialists, Mr. T. F. Jamieson.[2] The general succession of the drifts is remarkably similar to that in East Yorkshire, and the evidence for the mild Helvetian Epoch is almost exactly that which we have already considered in England, Ireland, and the Isle of Man.

"Neudeckian" (Third Interglacial), "Mecklenburgian" (Fourth Glacial), "Lower Forestian" (Fourth Interglacial), "Lower Turbarian" (Fifth Glacial), "Upper Forestian" (Fifth Interglacial), and "Upper Turbarian" (Sixth Glacial) Epochs.

According to the terminology usually adopted by British geologists, the Glacial Period came to an end with the final disappearance of the confluent ice-sheets from our lowlands, and the events which followed are classed as Post-glacial. But the latter period has been sufficiently long to cover some extensive changes in the relative distribution of land and sea in Western Europe, accompanied by modifications of climate tending on the whole toward progressive amelioration. To classify these changes into a further series of three interglacial and three glacial epochs, as Prof. J. Geikie has done, is, so far as the British evidence is concerned, mainly a question of personal opinion as to the arrangement of the sequence and the application of terms. As we have already seen, the interpretation of the North European sequence, on which Prof. Geikie greatly depends for proof of these later epochs of glaciation, has been challenged abroad even by geologists favourable to the general principle of interglacial epochs; and we are, therefore, the more fully entitled to question its application in this country.

In Scotland, Prof. Geikie claims that the "Mecklenburgian" glaciation was marked by the reappearance of glaciers in the mountain valleys, and by their later extension over part of the neighbouring lowlands in the form of "district ice-sheets." After these had melted away during the "Lower Forestian" interglacial time, there is supposed to have been a regrowth of valley-glaciers that came down to sea-level during the "Lower Turbarian" stage. Then another melting away marked the "Upper Forestian," followed by a fresh appearance of glaciers in the glens of the higher mountain groups during the "Upper Turbarian" glacial epoch.

But all the phenomena on which this scheme is built seem explicable on the hypothesis of a gradually waning glaciation, during which there were occasional local advances of the mountain-glaciers in their glens, due to temporary increase of snowfall. We have already discussed the probability that the growth of the individual ice-sheets was largely influenced by the local impact of snowfall under changing meteorological conditions, and it seems equally probable that similar changes, in reverse order, accompanied the waning of the same sheets.

Indeed, from the study of recent glaciers, it has been shown that the presence of separate moraines need not indicate separate stages of advance in the ice. In discussing the influence of englacial débris on ice-flow, the late Prof. Israel C. Russell has the following pertinent remark: "The considerations . . . lead to the suggestion that a series of terminal moraines in a formerly glaciated valley, or a similar succession of ridges left by a continental glacier, are not necessarily evidences of repeated climatic oscillations, but may have been formed during a uniform and continuous meteorological change favourable to glacial recession. That is, a débris-charged sheet may retreat for a time, then halt, and again retreat, owing to its terminus becoming congested with foreign material, in response to a climatic change which would cause a glacier composed of clear ice to recede continuously and without halts."[1]

Prof. Geikie states his case for the "Mecklenburgian district ice-sheets" with intrepid but unconvincing persuasiveness.[2] He acknowledges that no interglacial deposits of the preceding Neudeckian epoch have been recognised in Britain, and bases his argument upon the relation of the hill-drift to that of the lowlands. Into the intricacies of this argument it is impossible for me to enter, but there is one point which requires particular notice. The shelly boulder-clay around Loch Lomond is held to represent the Mecklenburgian glaciation, and its marine detritus to have been derived from a sea-floor belonging to the "100-foot raised beach," which is supposed to mark an early stage of the same glacial epoch. But, as Mr. T. F. Jamieson[3] has shown, there is no valid reason for regarding this boulder-clay as newer than the bulk of the shelly boulder-clays of Scotland; it rests directly upon the solid rock, except at one place, where a wedge of blue clay with shells was found beneath it; and no older boulder-clay is known in the district. Even from the original description of the deposit given by Dr. R. L. Jack,[4] quoted with approval by Prof. Geikie, we can gather no other interpretation; for although Dr. Jack thought that the shells were more probably derived from an interglacial than from a preglacial bed, he still regarded the boulder-clay in which they occur as older than the "great submergence"—*i.e.*, than the Helvetian interglacial epoch of the new classification.

The evidence yielded by the freshwater deposits that overlie the drifts in Scotland, so far as I can judge, runs parallel with that of the similar deposits in Yorkshire and the Isle of Man. The researches of the late James Bennie brought to light several instances in which arctic plants and other remains occur in such deposits, but always at or near their base, and sometimes overlain by higher beds containing a temperate flora. By Mr. C. Reid, who has determined most of the material, these arctic plant beds are classed as "Late-Glacial," and the subsequent deposits as "Neolithic."[5]

Some evidence for changes of climate in the uplands during post-glacial times has been recently obtained from the study of peat mosses by Mr. F. J. Lewis; and these changes have been arranged according to the scheme,[6] with Prof. Geikie's approval,[7] by supposing that only certain parts of the sequence are represented in some places. Thus, in the Highland mosses (and presumably also on Cross Fell, in Cumberland),[8] where arctic plants are found at the base of the peat, it is assumed that earlier beds have been swept away by glaciation; while in the Southern Uplands an additional glacial and interglacial epoch are supposed to be represented. But as in all cases the peats lie above the glacial drifts, their suggested classification into five stages, ranging from the "Mecklenburgian" to the "Upper Turbarian," seems highly speculative; and it has yet to be decided whether the changes indicated by the plants are so great as to fulfil the requirements of the

[1] "Report on the Character of the High-level Shell-bearing Deposits at Clava, Chapelhall, and other Localities." *Rep. Brit. Assoc. for* 1893 (Clava), pp. 483–514; *ibid.* for 1894 (Chapelhall), pp. 307–315; *ibid.* for 1896 (Kintyre), pp. 378–399.

[2] Mr. Jamieson's latest papers: "The Glacial Period in Aberdeenshire and the Southern Border of the Moray Firth," *Quart. Journ. Geol. Soc.*, vol. lxii. (1906), pp. 13–39, and "On the Raised Beaches of the Geological Survey of Scotland," *Geol. Mag.*, dec. v., vol. iii. (1906), pp. 22–25, contain an excellent descriptive summary and discussion of the glacial sequence.

[1] "The Influence of Débris on the Flow of Glaciers." *Journ. Geol.*, vol. iii. (1895), p. 831.

[2] "Great Ice Age," 3rd ed., chap. xx.

[3] "Some Changes of Level in the Glacial Period." *Geol. Mag.*, dec. v., vol. ii. (1905), pp. 487–8.

[4] "Notes on a Till or Boulder-clay with Broken Shells . . . near Loch Lomond," &c." *Trans. Geol Soc. Glasgow*, vol. v. (1874), pp. 5–26.

[5] "Origin of the British Flora," p. 53.

[6] "The History of the Scottish Peat Mosses and their Relation to the Glacial Period." *Scottish Geogr. Mag.*, vol. xxii. (1906), pp. 241–252; see also *Trans. Royal Soc. Edinburgh*, vol. xli. (1905), part iii., No. 28.

[7] "Late Quaternary Formations of Scotland." *Zeitschrift für Gletscherkunde*, vol. i. (1906), pp. 21–30.

[8] F. J. Lewis, "Interglacial and Postglacial Beds of the Cross Fell District." *Rep. British Assoc. for* 1904, pp. 798–9.

hypothesis. In any case, it is not likely that many British geologists will be found willing to regard the hill peats as other than post-glacial.

Summary.

My subject has proved unwieldy; and in merely sketching its outlines I am uneasily aware that I have overstepped the usual bounds of an Address. My conclusions—if the term be applicable to results mainly negative—are as follows:—

(1) In the present state of opinion regarding the glacial sequence and its interpretation in North Europe, it is premature to attempt the arrangement of the British drifts on this basis.

(2) No proof of mild interglacial epochs, or even of one such epoch, was discovered during the examination of certain typically glaciated districts in England, Ireland, and the Isle of Man; and the drifts in these areas yielded evidence that from the onset of the land ice to its final disappearance there was a period of continuous glaciation, during which the former sea-basins were never emptied of their ice-sheets.

(3) The "middle glacial" sands and gravels of our islands afford no proof of mild interglacial conditions or of submergence. In most cases, if not in all, they represent the fluvio-glacial material derived from the ice-sheets.

(4) The British evidence for the Interglacial hypothesis, though requiring further consideration in some districts, is nowhere satisfactory. Most of the fossiliferous beds regarded as interglacial contain a fauna and flora compatible with cold conditions of climate; and in the exceptional cases where a warmer climate is indicated, the relation of the deposits to the boulder-clays is open to question.

(5) The British Pliocene and Pleistocene deposits appear to indicate a progressive change from temperate to subarctic conditions, which culminated in the production of great ice-sheets, and then slowly recovered.

(6) During the long period of glaciation the margins of the ice-lobes underwent extensive oscillations, but there is evidence that the different lobes reached their culmination at different times, and not simultaneously. The alternate waxing and waning of the individual ice-sheets may have been due to meteorological causes of local, and not of general influence.

Let me add, in closing, that it would have been a more gratifying task if, instead of probing into these outstanding uncertainties, I had chosen to deal only with the many and great advances that have been made during the last twenty-five years in the domain of British glacial geology. With these advances we have, indeed, reason to be well satisfied. But the necessity for further knowledge is insistent; and it is useless to set about the solution of our intricate problem until we have all the factors at command. Even then—"Grant we have mastered learning's crabbed text, Still there's the comment"—and, as I have tried to show, the comment may raise more difficulties than the text itself.

SECTION D.

ZOOLOGY.

OPENING ADDRESS BY J. J. LISTER, M.A., F.R.S., PRESIDENT OF THE SECTION.

The Life-History of the Foraminifera.

In the year 1881 the British Association, having completed the fiftieth year of its existence, met again in the city of York, where its first meeting had been held. By way of marking the completion of its first half-century, and also to do honour to the city which had welcomed its initiatory gathering, it was arranged that the president of each section of the Association should be selected from among the past presidents of the whole. At that time botanists and zoologists were not so far specialised into distinct groups as, for better or worse, they have since become, and were still, at any rate for the purposes of the British Association meetings, able to share their deliberations. Section D included, besides that of zoology and botany, the departments of anthropology and of anatomy and physiology, though the two latter had each its own vice-president.

The naturalist who was selected to preside in 1881 over the whole section was the veteran zoologist, Sir Richard Owen. By that time all or nearly all the 434 scientific memoirs which stand to his name in the Royal Society's Catalogue had been written. Those dealing with comparative anatomy and palæontology, and they are by far the greater part, constitute, to quote the words of Huxley, "a splendid record; enough and more than enough to justify the high place in the scientific world which Owen so long occupied. If I mistake not, the historian of comparative anatomy and of palæontology will always assign to Owen a place next to and hardly lower than that of Cuvier, who was practically the creator of those sciences in their modern shape." But Owen's presidential address dealt not with the anatomy or relationships of living or extinct animals, nor with any of those views on "transcendental anatomy" which have met with less acceptance. The subject selected was the great Natural History Museum at South Kensington, to the planning and establishment of which the energy of his later years was largely directed.

In considering the previous occupants of the chair which I have the honour to hold at this seventy-sixth meeting, I cannot refrain from expressing my sense of the loss which not only his friends, but zoology at large, have sustained in the death, last Easter, of Prof. Weldon, the Linacre Professor of Comparative Anatomy at Oxford.

Trained in the pathways of morphology under Balfour at Cambridge, Weldon's energies were, in the later years of his life, devoted to the endeavour to obtain determinations, by means of exact measurements, of the degree of variation from the normal type to which given populations are subject, and, so doing, to find an approximately exact measure of the action of natural selection.

This enterprise and the methods to be employed formed the subject of his address to this Section in 1898, at Bristol: and in 1901, assisted by the high mathematical ability of Prof. Karl Pearson, and in consultation with Mr. Francis Galton, he issued the first number of *Biometrika: a Journal for the Statistical Study of Biological Problems.*

It can hardly be doubted that these and similar methods, if properly applied, will render important service in the elucidation of the problems in which we are all, botanists and zoologists alike, interested; though I may confess, for my own part, that those who prophesy from the biometric side of the church use a tongue which is to me unfamiliar, and that, to my loss, I often go away unedified.

It may appear presumptuous in one who thus confesses his inability to grapple with the mathematical intricacies involved in the application of this method if he attempts to offer anything in the nature of advice to those who use it. Nevertheless I do venture—it may be in the "insolence of office"—to urge that the old adage should be borne in mind recommending that before beginning culinary operations it is advisable first to catch your hare—in other words, to make sure that the problem you seek to elucidate is sound from the standpoint of biology before bringing a formidable mathematical apparatus into action for its investigation.

Apart, however, from any misgivings on the propriety of the occasions on which this weapon has been used, there can be no question that, properly applied, the biometric method is a potent addition to the biological armoury, and in the victories that it achieves Weldon will be remembered as the leader of those who foresaw its usefulness and forged it.

Not the least memorable of the lessons he has left us is the eager and strenuous manner in which he did the work, in many fields of activity, which his hand found to do. And while we thus deplore his loss on our own account, as biologists and as friends, our respectful sympathy goes out, I am sure, towards the home where his endeavours found such skilled and devoted assistance.

Two reports of the Evolution Committee of the Royal Society have been published since Mr. Bateson's presidential address on Mendelism, or, as we are now to say, Genetics, two years ago. The coincidence of our meeting with that of the Hybridisation Conference in London, together, as I understand, with the fall of the pea-harvest, will prevent the attendance at Section D of some of the chief workers, though two papers on these lines have been promised us, and some aspects of the matter will, I believe, receive attention at the joint meeting which we hold with the botanists, in which several of the prominent foreign workers at Genetics are expected to take part.

The subject to which I wish to invite your attention is the life-history of a group of lowly organisms, the Foraminifera, which belong to a division of the animal kingdom standing apart from all others in the simplicity of the organisation of its members, the Protozoa.

For the last seventy or eighty years the attention of zoologists has been increasingly given to the Protozoa, not only from the interest arising from the particular study of its members, but because, forming as they do a group apart from other animals, and from most plants, they afford a point of view from which to judge of the results on fundamental questions of biology obtained in these more highly developed organisms.

The problems of the relations between protoplasm and nucleus, the significance of the karyokinetic figures and of chromosomes, the phenomena of fertilisation and the differentiation of sex, are all seen more clearly in the light of the results obtained from the Protozoa.

Apart from their interest from this wider standpoint the study of the Protozoa has, as I need hardly remind you, received a great impulse of late years from the discovery that, like the bacteria and their allies, the action of which in this respect has been longer recognised, many of them are, when they gain a footing in the body, the cause of disease in man and other animals. An essential step in counteracting their influence is a knowledge of their life-history and mode of attack. For the proper estimation and interpretation of the facts in the life-history of one organism it is, of course, necessary to be acquainted with its course in allied forms, and in other divisions of the class to which it belongs.

Whether we approach the matter from the philosophical or utilitarian side an essential step is to obtain as completely as possible the life-histories of species belonging to the main groups of Protozoa, worked out in detail. Certain aspects of the Protozoa, such as the shells of the Foraminifera, have received a great deal of attention, and we have much accumulated knowledge on particular phases of the life-histories of many forms, but of how few groups can it be said that we know the life-history of any one species completely! For the last thirty years students of biology have begun their studies with an examination of Amœba, yet the life-history of the common forms of amœba, occurring in streams and ditches, still remains, notwithstanding shrewd surmises as to its course—I think Prof. Calkins will permit me to say—unwritten.

When, therefore, the progress of knowledge of a group reaches a stage in which the main outlines, at least, of the life-history begin to stand forth clearly, it appears to be a matter of importance, not only to the students of that particular group, but, as a standard of comparison, to those of allied groups.

Such a stage has recently been attained in the study of the Foraminifera, and we are now able to sketch with some certainty the general course of the life-history. I have thought, therefore, that the occasion may not be inopportune for me to put the ascertained facts before you, and endeavour to set them in the light of our knowledge of other forms of Protozoa.

The zoologist who for the last twelve years has been pre-eminent in the investigation of the Protozoa was Fritz Schaudinn, whose early death occurred last June. Beginning his work in F. E. Schulze's laboratory at Berlin, his earlier investigations were directed to the Foraminifera, to the knowledge of which he made important contributions; and three years ago he published an account which, as we shall see, completed the main outline of their life-history. His short papers on Actinophrys and various forms of Amœba embody observations of the highest interest. Turning to the investigation of the Sporozoa, he was soon led to devote his attention more especially to the organisms which produce disease, and his latest achievement was to demonstrate the cause of one of the greatest scourges of humanity.

Much of his work rests on preliminary accounts of investigations which his splendid activity in research left him no time to publish in detail though we may hope that, in some cases at least, it may be found possible for the fuller accounts to appear. The papers which he did complete, such as those dealing with the Alternation of Generations in Coccidia[1] and in Trichosphærium,[2] are not only contributions of first-class merit, but models of research and exposition. In all his work he maintained the broad zoological point of view, and his results on the Amœba associated with dysentery are elucidated by those obtained in the study of the Foraminifera. In his insight into the essentials of the problem before him, and his fertility in technical resources, he was, I venture to think, without a rival.

Having chosen so special a subject, I will endeavour first to set forth briefly the elementary facts of the structure of the Foraminifera, in order that those of my audience who are unfamiliar with them may be able to follow.

In the hollows between the ridges on a ripple-marked stretch of sand it may often be noticed that the surface is whiter than elsewhere. On scooping up some of the sand and examining it with a lens it will be found that the whiteness is due in part, no doubt, to fragments of shells of molluscs of one kind or another, but in part to the presence of complete shells of minute size and the most exquisite shapes. Microscopically examined it will be found that in nearly all cases the shells are made up of a number of separate compartments or *chambers*, communicating with one another by one or more narrow passages, and disposed in some regularly symmetrical plan. In some the arrangement is a flat spiral, like that of a watch spring; in others helicoid, like a snail's shell. In some the series of chambers may form a straight or slightly curved line, or they may alternate on either side of a straight axis. There is great variety in the plans on which the shells may be built. They differ, too, in texture; some are transparent, and their walls are perforated by multitudes of minute pores, setting the interior of the chambers in direct communication with the outer world, while in others the walls are semi-opaque, white, and glazed like porcelain, and such perforations are absent. The shells are composed, for the most part, of carbonate of lime contained in an organic "chitinous" matrix, but in many cases grains of sand are included in the walls.

The planispiral chambered shells present such a close resemblance to the shell of a Nautilus that for a long time, notwithstanding their diminutive size, many of them were actually included in that genus, among the cephalopod mollusca. As knowledge advanced the Cephalopoda were divided by D'Orbigny into two groups: the Siphonifères, in which, as in Nautilus, the Ammonites and Spirula, the chambers are in connection by a siphon; and the Foraminifères, in which they communicate by pores.

If instead of examining the empty shells left stranded on the shore we take seaweed from shore pools or from shallow water and separate the adherent particles by means of a sieve, similar Foraminiferous shells will be found in the sand which comes through, and these will usually contain the live animal. If glass slides are set in the vessel on the sand, overnight, some of the animals will generally crawl on to them, and they may then be taken out and examined. About these active animals, springing from various points at the periphery of the shell, are multitudes of slender threads, forming fan-like or sheaf-like groups, by which the animal is attached to the substratum, and by which it moves. They are composed of a clear hyaline substance—protoplasm—containing scattered granules. If the animal is killed and the shell dissolved by a weak acid, no organs, such as muscles, stomach, brain, and so forth, are found in the interior, but the same granular protoplasm is found to fill the interior of all the chambers. As in the Protozoa in general, all the elementary functions subserved by the organs of other animals are performed by the undifferentiated protoplasm.

It was not until 1835 that the simple character of the

[1] *Unt. üb. Generationswechsel bei Coccidien.* Zool. Jahrbücher. Anat. Bd. 13. 1900

[2] *Unt. üb. Generationswechsel von Trichosphaerium*, Abh. Akad. Berlin. 1899. Anhang.

soft parts filling the shells of Foraminifera was recognised by Dujardin. He pointed out that, far from being allied to such highly organised beings as the cephalopod mollusca, they belonged to the simplest forms of animal life, such as Amœba, and proposed the name Rhizopoda, which is still in use, for the class containing them.

For many years, however, the correctness of Dujardin's views was matter of dispute. One of the first zoologists to recognise their truth and confirm them was the distinguished Yorkshire naturalist, Prof. Williamson, who in 1849 published his memoir "On the structure of the shell and soft animal of *Polystomella crispa*,"[1] in which, for the first time, the internal structure and the relation between the chambers were correctly described.

In the specimens described by Williamson the shell of Polystomella has the following structure. Externally it is a nearly biconvex shell, symmetrical about a median plane, and with a keel-like projection at the margin. In young specimens sharp points like those of a spur often project from the keel. The chambers of which it is composed are arranged in a spiral. They are convex towards the mouth, *i.e.* on their anterior faces, and concave in the opposite direction. Moreover, each is produced on either side into a process, or *alar prolongation*, projecting towards the axis about which the spiral turns, *i.e.* towards the convex prominence at the centre of each face. Thus each chamber of an outer whorl of the spiral is placed, as it were, astride of the next inner whorl, and the last whorl of the spire completely hides all the previously formed chambers from view. Careful examination of the anterior face of the terminal chamber reveals a row of foramina along the line where the chamber, including its alar prolongations, rests against the whorl which it bestrides. It results from what has been said that they present a V-shaped line. These foramina are the main openings by which the cavity of the last chamber opens to the exterior. Each chamber of which the shell is composed has been in its turn the terminal chamber, and the openings which then led to the exterior subsequently form communications leading from chamber to chamber. As we trace them back to the earlier chambers they become fewer in number until only a single foramen is found between the chambers. In specimens of the type we are considering a comparatively large globular chamber is the starting point from which growth proceeded. A short passage leads to the second chamber, which has a peculiar shape, being applied to the sphere, produced at one end into a point, and abutting at the other against the third chamber. From this onwards the typical shape is gradually assumed, though in these earlier chambers the alar prolongations are absent. A character of this genus is the presence of the line of pocket-like processes along the posterior margin of the chambers. It was not clear, until Williamson's paper was published, that these ended blindly and did not communicate with the chamber behind. The outer walls of the chambers are traversed by multitudes of pores of extreme minuteness, so that the chambers of the outer whorl have this additional means of communication with the exterior. There is, besides the structures described, a system of canals, lying in the thickness of the walls, and communicating with the chambers, but this need not detain us here.

It results from the structure of such a form as Polystomella that in the earliest stage of its existence the whole organism consisted of a single spherical chamber.

It is to be observed that in shells such as Polystomella the shape and mode of growth of the organism at all stages of its development are preserved in the central parts of the shell. These early formed chambers may be, in some types of growth, exposed to observation, or they may be, as in this genus, built in and hidden by the overlapping of the subsequent additions. They may then, however, be examined by making sections of the shell, or in the protoplasmic casts of the interior when the shell is dissolved.

The Foraminifera are found living attached to other objects on the sea bottom from shore pools down to great depths, and from arctic to tropical waters. A small group of them lead a pelagic life suspended in the upper layers of the great oceans, from the surface down, as Dr. Fowler's collections from the Bay of Biscay show, to at least 500 fathoms, and their empty shells falling to the bottom constitute the large proportion of the grey "Globigerina ooze" which in many regions forms the floor of the ocean.

[1] *Trans. Microscop. Soc.*, vol. ii. 1849, p. 159.

An attractive feature of their study is the abundance with which they are represented in geological deposits, right back to the Palæozoic period, so that in dealing with them we have that third dimension, the history of the group in the past, wide open to us in which to project our ideas of the course of their evolution.

It was from the study of fossil Foraminifera of the early Tertiary period that the recent advances in our knowledge of their life-history received its impulse.

The later Eocene rocks in many parts of the world abound in discoidal, slightly biconvex Foraminiferous shells, which, from their likeness to coins, have been called Nummulites. The Nummulitic limestones extend across the Old World from the Pyrenees to China, and often attain a thickness of thousands of feet. Visitors to Egypt are familiar with them in the blocks of which the pyramids of Gizeh are built, and the glittering coin-like discs polished by wind and sand and strewn in the desert have attracted notice from remote antiquity.

The structure of a Nummulite is very similar to that of Polystomella, but the most spacious part of each chamber lies in the median plane of the shell, while the alar prolongations are very thin and interrupted by supporting pillars of solid shell substance. Hence the median plane is a plane of weakness, and the shell readily splits into planoconvex halves, the broken surfaces exposing a section in the median plane of all the chambers of which it is built.

It has long been recognised that while the great majority of the specimens of Nummulites occurring in a deposit attain a certain moderate size, a few are found scattered through it the diameter of which far exceeds that of the others. On examining median sections of the smaller specimens it is usually[1] found that the spiral series of chambers starts from a large and nearly spherical chamber, readily visible to the naked eye, and occupying the centre of the shell, while in the large specimens the spiral series is continued to the centre, where in carefully prepared sections it may be seen to take its origin in a spherical chamber of microscopic size.

Although the two forms were thus found to be associated in the same beds, and to agree with one another closely except in the size to which they grow and in the characters of the central chambers, they were given separate specific names, and attention was called to the puzzling occurrence of these associated "pairs of species," a large and a small one, in various deposits.

It was especially by the labours of De Hantken and De la Harpe that this phenomenon was brought to light, the latter palæontologist formulating his "Law of the association of species in pairs" as follows: "Nummulites appear in couples; each couple is formed of two species of the same zoological group, and of unequal size. The large species is without a central chamber, the small always has one." More than sixteen pairs of species of Nummulites and the allied genus Assilina, associated in this manner, have been enumerated.

In the year 1880 Munier-Chalmas brought before the Zoological Society of France his conclusion that the kinds thus associated were not in fact distinct species but two forms of the same species—that, in fact, the species of Nummulites were dimorphic. He also expressed the opinion that the phenomenon of dimorphism would be found to be of general occurrence among the Foraminifera.

To this view, which further investigations have shown to be entirely correct, Munier-Chalmas added a corollary as to the nature of the relation between these two forms, which was wrong. This, however, need not detain us here.[2] Whether he was set against Munier-Chalmas's views by the error of part of them, or for whatever reason, De la Harpe failed to recognise, before his untimely death

[1] Usually, because the young of the other type occurs among the smaller specimens.

[2] Cp. the article by the author on "Foraminifera" in Lankester's "Treatise on Zoology," Part I., Fasc. 2, p. 47; and "On the Dimorphism of the English Species of Nummulites, &c.," *P.R.S.*, vol. lxxvi. B., p. 298.

which occurred shortly after, the truth which they contained.

Following up the clue which had been found, Munier-Chalmas and his colleague Schlumberger examined the shells of a large series of forms, especially of the Miliolidæ. It was shown, in a fine series of papers, that the phenomenon of dimorphism was present here too, and may find its expression, not only in differences in size of shell and of central chamber, but also in the plan in which the chambers of the two forms are arranged.

While they differ conspicuously—though, as we shall see, in very varying degrees—in the sizes of the initial chamber, it is by no means the case that in all species, as in those of the genus Nummulites we have considered, the size attained by the completed test presents so marked a difference. It is, in fact, more usual for the individuals of the two forms of a species to attain approximately the same size on the completion of growth, though standing so contrasted in the size of the initial chambers.

The names *megalosphere* and *microsphere* have been given to the large and the small initial chambers, and the two forms are generally known as the megalospheric and microspheric respectively.

The examination of other groups of Foraminifera has abundantly confirmed the view that the phenomenon of dimorphism is widely prevalent among them.

The Life-history of Polystomella crispa.

Turning now from the consideration of the shells of Foraminifera to the living animals, let us inquire what light has been gained from them on the problem of the significance of the phenomenon of dimorphism.

If a large batch of individuals of *Polystomella crispa* be killed with a reagent which dissolves the shell, though preserving its protoplasmic contents, it will be found, on examining the casts so obtained, that besides those of the type described and figured by Williamson with a comparatively large initial chamber (about 60 μ), and these are by far the most abundant, there are others in which the initial chamber is much smaller (about 10 μ). In other words, megalospheric and microspheric individuals occur in the batch, as among the fossil shells of Nummulites, preserved in the Eocene strata.

On staining them another point of difference appears. A single large nucleus is found in the majority of the megalospheric forms, while in the microspheric a number of small nuclei lie in the chambers most remote from the mouth of the shell.

The result of observations on the living and preserved animals may be briefly stated as follows:—

The Microspheric Form.

The *microspheric form* has many small nuclei, even at an early stage of growth. These nuclei consist of a homogeneous ground substance with many small nucleoli scattered through it. They lie in the chambers near the centre of the shell, and increase in number by simple division. They also exhibit a remarkable phenomenon to which I shall have to recall your attention later. Though several of the nuclei, and especially those that have recently divided, have a rounded contour, many of them are highly irregular in outline, giving off processes which extend in branching irregular strands, staining deeply with nuclear stains, into the protoplasm. Free shreds of such strands lie scattered in the chambers in the neighbourhood of the nuclei, and in large specimens of the microspheric form it is common to find the protoplasm crowded with such deeply staining strands, and with no trace to be found of the rounded nuclei present in the earlier stages. It is difficult to avoid the conclusion that the nuclei, after increasing in number by amitotic division, give off the strands and are ultimately wholly resolved into them.

In a culture of Polystomella it is common to find a mode of reproduction which on examination will be found to be that of the microspheric form. It is best followed when occurring in a specimen attached to a glass slide. In the early phases these specimens are distinguished by a great increase in the number of pseudopodia issuing from the shell, so that the latter appears when seen by transmitted light to be surrounded by a milky halo. The protoplasm gradually emerges from the shell until, after some hours, the whole of it has come out and lies massed between the shell and the supporting surface and within the area formerly covered by the halo. The internal protoplasm is darkly-coloured with brown granules, and the whole mass is during this time the seat of involved streaming movements. Clear spots make their appearance, and gradually the protoplasm collects about these and separates into as many spherical masses, which remain connected by a felt of hyaline pseudopodia. Some 200 is a common number to be found. Not long after they have become distinct it may be noticed that each attains a shining coat—the indication that a shell has been formed, a small aperture being left in each for the passage of the pseudopodia. After lying in close contact for some hours, the spheres rapidly and simultaneously draw apart from one another, and within half an hour from the beginning of the movement they are dispersed over a wide area, and each becomes the centre of a system of pseudopodia of its own.

The whole of the protoplasm of the parent is used up in the formation of the brood of young, the shell being left empty. The process from the first appearance of the halo to the dispersal of the young is complete in about twelve hours.

In a short time the protoplasm which lies outside the aperture of each of the spheres secretes the wall of a second chamber of characteristic shape, and the young individual is then clearly recognisable in size and shape as the two-chambered young of the megalospheric form. Each of the spheres was, in fact, a megalosphere. The microspheric parent has given rise to, indeed it has become, a brood of megalospheric young.

Even before the formation of the megalospheres small rounded, faintly staining nuclei can be seen in stained preparations of the emerged protoplasm, and the latter takes a deep flush owing to the presence of minute particles of chromatin. I am not aware that the origin of these nuclei has been directly observed, but it appears highly probable that they arise by the gathering together about new foci of the staining material distributed through the protoplasm of the microspheric parent.

The Megalospheric Form.

When the megalospheres have become formed their protoplasm contains abundance of irregular chromatin masses, which are at first diffused, and obscure the rounded nucleus near the centre, but I am inclined to think that it is the latter which grows into the large nucleus, the Principal-kern of Schaudinn, which is found throughout the greater part of the life of the megalospheric form.

As growth proceeds and the number of chambers increases the nucleus moves on from chamber to chamber, becoming greatly constricted as it passes through the narrow passages of communication. It grows *pari passu* with the growth of the protoplasm. Numbers of nucleoli are contained in it, lying in a reticulum, and the nucleoli appear to increase in number and to decrease in size as growth advances. Here, too, as in the microspheric form, the nucleus appears to give off portions of its substance into the protoplasm, the path along which it has travelled, through the earlier chambers, being strewn with deeply staining particles of irregular size. Towards the later stages the nucleus loses its compact shape and staining power, and ultimately disappears, and multitudes of minute stained bodies may then be detected scattered through the protoplasm. These become aggregated as distinct nuclei, the protoplasm gathers about them, and they divide by karyokinesis. Then follows a second karyokinetic division, and, the protoplasm having divided correspondingly, the whole contents of the megalospheric shell emerges as a multitude of minute biflagellate zoospores, some 4 μ in diameter.

It so happened that I had been working at the life-history of the Foraminifera at the same time as Schaudinn, though in ignorance of his work.[1] The results that I have

[1] F. Schaudinn, "Die Fortpflanzung der Foraminiferen, und eine neue Art der Kernvermehrung," *Biol Centralblatt,* Bd. xiv. N. 4. February, 1894.
—— "Ueb. d. Dimorphismus der Foraminiferen," *Sitz. Ber. d. Ges. naturf. Fr. zu Berlin,* 1895, N. 5.
J. J. Lister, "Contributions to the Life-history of the Foraminifera," *Phil. Trans.*, vol. cxxxvi. B. (1895), p. 401.

set before you on Polystomella were obtained by both of us independently of one another, though I had not obtained evidence of more than one division of the spore-nuclei or of the number of the flagella of the zoospores.

The evidence pointed strongly in the direction of the view that the foraminiferal life-history consists of an alternation of generations. While the megalospheric form would, on this hypothesis, arise by a simple vegetative asexual reproduction of the microspheric parent, many considerations seemed to indicate the probability that the microsphere, the initial chamber of the microspheric form, arose by the conjugation of zoospores. In addition to the general probability of the occurrence of a sexual stage somewhere in the life-history, the sizes of zoospore and microsphere fitted in with the view that the latter might be formed by the coalescence of two of the former. Again, the fact of the rarity of the microspheric form in comparison with the megalospheric was comprehensible, on the supposition that, to be able to conjugate, the zoospores must be of different parentage. The point remained, however, a matter of inference until three years ago, when Schaudinn published an account of the processes that he had observed,[1] turning inference into certainty. Premising that *chromidia* is the name applied to the fragments of staining material distributed in the protoplasm, I will quote the passage :—

"With the onset of the cold part of the year I observed that many large Polystomellas in a vessel were nearly approaching the formation of flagellated spores—that is, that most of the examples which I fixed and stained presented already the complete filling with chromidia, and others had even formed the spore-nuclei. I now took out at random a large number, and, breaking the shells, squeezed out the plasma under a coverslip. In the specimens which had already formed spore nuclei the masses of plasma did not die, but the spores developed quite normally and "swarmed" apart. I was thus not only able to follow clearly with an immersion lens the twice-repeated division of the vesicular nuclei, which occurs very rapidly, but was able repeatedly to observe directly the conjugation[2] of the swarm-cells. The reason that I had not succeeded earlier in this latter, though I had often observed the formation of swarm-cells, is that conjugation only occurs between those arising from separate individuals. I proceeded now as in fertilisation experiments with the eggs of sea-urchins; that is, I crushed a great number of large Polystomellas in sea-water, sucked up the expressed plasma in a capillary tube, stirred it about on the cover-glass of a moist chamber, and then had the joy of witnessing many conjugations. The swarm-cells have, as previously stated, two flagella, and a similar wobbling motion to those of Hyalopus which I have minutely described; they conjugate in pairs, and cast off their flagella as in Trichosphærium. The karyokinesis occurs very slowly (5–6 hours). When it is finished the nucleus of the zygote soon divides by direct division, and the typical growth begins, with formation of a shell. I have cultivated the young microspheric individuals in a moist chamber as far as the five-chambered stage, when they died, probably from want of nourishment. In most cases the nucleus had repeatedly divided. From these small, many-nucleated microspheric individuals the youngest many-chambered stage described in my earlier publications directly proceeds, so that the life-cycle of Polystomella is now complete."

We are then, at last, able to give with confidence an answer to the question—What is the significance of the phenomenon of dimorphism in the Foraminifera? The answer is, It results from the occurrence of two modes of reproduction in the life-history, sexual and asexual. The megalospheric form is the product of asexual reproduction, the microspheric form arises from the conjugation of two similar zoospores, produced by individuals of the megalospheric form.

In the life-histories of Foraminifera belonging to other families—though not, so far as I am aware, in the Nummulitidæ, to which Polystomella belongs—there is clear evidence that the members of the megalospheric generation do not always end their existence by the production of zoospores. The protoplasm may emerge from the shells and break up into a brood of megalospheres, as in the reproduction of the microspheric form. In such Foraminifera, therefore, we have to conclude that the megalospheric phase may be repeated in the life-history, and that there may be a succession of megalospheric forms before the sexual stage recurs in the life-cycle. Such a repetition of the asexual mode of reproduction is a common phenomenon in the life-histories of other groups of Protozoa.

In the great majority of cases the size of the megalosphere is much larger than that of the microsphere, and the two forms are thus easily distinguished. There are, however, species (*e.g.* Peneroplis, *Discorbina globularis*) in which the range of variation of the small megalospheres overlaps that of the microspheres, and we have to rely on other characters for discrimination of the two forms.

We must not, however, too hastily apply these results to all the organisms included among the Foraminifera. Wherever there is dimorphism, as expressed in the sizes of the initial chambers, it is clear evidence of the occurrence in the life-history of the sexual and asexual modes of reproduction; and this applies to a wide range of existing species and to fossil forms as far back as the Palæozoic period. The pelagic Foraminifera present a curious and interesting problem in the fact that their initial chambers are, at least in the great majority of cases, of uniformly small size, a condition which I suspect to depend on their peculiar mode of life. Again, in the simpler groups (Gromiidæ and Astrorhizidæ) the covering appears, in many cases at least, to expand with the growing protoplasm, so that the evidence of their initial condition is not preserved in the shells. In these cases also we have to seek for evidence of the course of the life-history in nuclear and other characters.

Review of Nuclear Characters.

Turning now to the nuclear changes which are found in Polystomella, there are many features which are worthy of attention. In their feeding, locomotion, and the mode of forming the shell, in fact in all that concerns their vegetative existence, the megalospheric and microspheric forms are, so far as I am aware, exactly alike; yet in one the economy is dominated by a single nucleus, and in the other by many. Richard Hertwig has compared a uninucleate organism, whether a whole protozoon or a metazoan cell, to an absolute monarchy, and the multinucleate organism to an oligarchy, in which the rulers, though many, perform identical functions. In the life-history of Polystomella the apparently revolutionary change in government occurs at each reproductive phase, yet the internal and external relations of the State, as far at least as its vegetative life goes, appear to remain unaltered. Why the nucleus of the microspheric form should divide up into a number of daughter nuclei, while that of the megalospheric form remains single, is, to me at least, entirely obscure.

The separation of portions of the chromatic substance of the nuclei, in both forms of the species, and the ultimate resolution of the whole of it into such shreds, dispersed through the protoplasm, appeared at first a puzzling and obscure phenomenon. In metazoan cells, which are advancing to the formation of the reproductive elements, the nuclear divisions occur in regular succession, and the nucleus of a germ-cell may be regarded as the daughter nucleus, granddaughter, great-granddaughter, and so forth, of some other nucleus which went before it. The aphorism *omnis nucleus e nucleo* appears to hold good for the metazoa, but how does it find its application in the case we are considering? Is there any recognition of the hereditary principle when the change of government of our State occurs? Light has recently come on this obscure phenomenon, and, as usual, by the results obtained in other groups of Protozoa. In the introductory essay, "Die Protozoen und die Zelltheorie," which he contributed to the first number of Schaudinn's "Archiv" Richard Hertwig drew attention to morphological elements of the protozoan body, distinct from the protoplasm on the one

[1] "Untersuchungen üb. d. Fortpflanzung einiger Rhizopoden," *Arb. a. d. Kais. Gesundheitsamte*, Bd. xix. Heft 3, 1903.

[2] I have translated the word "Kopulation" as "conjugation," which in its biological usage describes the nature of the process more accurately than the English equivalent.

hand and from the formed nucleus on the other, and applied to them the name *chromidia*. They consist of groups of granules or branched strands of a substance staining with the same reagents as the chromatin of the nucleus. In Actinosphaerium, in which Hertwig first recognised them, they are normally present in the protoplasm, but their number is increased in particular states of the body in relation to metabolism, as by over-feeding, but also, it was found, by starvation. The chromidia are derived from the nuclei, and indeed in certain circumstances the nuclei may completely resolve themselves into chromidia. A structure present in the body of many shelled Rhizopods, and regarded by Hertwig as of the same nature as the chromidia, is the *chromidial net*. In Arcella this lies in the peripheral parts of the disc-like body, and sends reticulate processes into the rest of the protoplasm. Like the chromidia it stains with chromatin stains. Hertwig concludes that in Arcella the two or three nuclei originally present may, in a certain phase of the life-history, completely disappear, and that in that case nuclei are formed afresh by the aggregation of chromatin material about new foci in the chromidial net.[1] A similar chromidial net was described by Hertwig in Echinopyxis. In the following year Schaudinn[2] pointed out that the chromidia and chromidial net of Hertwig were comparable with the strands of staining substance which had been described in the Foraminifera. In tracing out the very interesting life-history of Centropyxis he showed that, as in the Foraminifera, the nuclei of the gametes are derived from the chromidial net, while here also the vegetative nucleus disappears. Comparable structures were also shown to exist in Chlamydophrys, a species of Amœba, and in Entamœba.[3] Schaudinn found that in all the cases investigated by him the nuclei of the gametes are derived from the chromidia, whether diffused or united into a reticulum, and concluded that the chromidia are in fact the substance of the nuclei of the sexual cells. He also instituted a very enlightening comparison with the Infusoria, the macronucleus of which, formed at the division of the zygote nucleus and disintegrating prior to conjugation, he compared with the vegetative nucleus of the Rhizopoda, while the micronucleus finds its homologue in the more or less dispersed chromidia.

By this comparison a number of previously isolated phenomena fall into line. The nuclear apparatus of the Infusoria, differentiated into vegetative and reproductive portions, finds, though not an explanation, at least a parallel in other groups of Protozoa. The scattered chromidia of the Foraminifera are thus connected with the chromidial nets of monothalamous Rhizopods, which present various degrees of compactness, and through them with the definitely rounded Infusorian micronuclei. In the involved streaming movements which precede the separation of the protoplasm of the microspheric parent into the megalospheric brood we may recognise a process of equal distribution of the minutely divided chromidia through all parts of the mass which is about to divide, leading to their transmission in equal portions among the offspring.

The fact that in the Foraminifera, at any rate, the chromidia are directly derived from the vegetative nuclei, though they increase in size independently, is at least some acknowledgment of the hereditary principle in the transmission of nuclear material, though we have at present no evidence whatever to show that the foci about which they gather to form the nuclei of the megalospheres or the mother nuclei of the zoospores are in any way derived from preexisting nuclei.

Though light appears ahead, it seems to me that we are not yet at liberty to consider ourselves out of the wood. The comparison of chromidia with infusorian micronuclei has brought us a long way from Hertwig's original observations in Actinosphaerium of the dependence of the formation of the chromidia on states of metabolism; moreover, no evidence has as yet been found that in Actinosphaerium the gametic nuclei are formed from chromidia.

In comparing the abundant deeply-staining chromidia of the Foraminifera with the Infusorian micronucleus, so poor in chromatin, Schaudinn ascribes the difference to the fact that in the former, as in Rhizopods in general, the formation of the brood (of zoospores) occurs by simultaneous multiple fission, and is connected with the act of fertilisation, so that sufficient chromatin to provide for the nuclear equipment of each of the thousands of zoospores must be ready in the parent as it approaches the reproductive stage. In the Infusoria, on the other hand, where the gametes are the ultimate product of a succession of binary fissions there is never the occasion, at any one time, for so large a store of chromatin in the body.[1] While admitting that there is much force in this explanation, we may notice that in Polystomella the formation of the chromidia begins early in the growth of the microspheric individuals, and they are in my experience very prominently present in full-grown specimens of this generation, although the sexual nuclei are not formed until the next or megalospheric generation has reached maturity. It would appear, therefore, that in Polystomella the chromidia are associated with the formation of the nuclei of the reproductive elements, whether these do or do not engage in conjugation.

Goldschmidt,[2] in a very capable review of our knowledge of chromidia, is inclined, on the ground of the apparent difference in relation to the life of the organism between the structures so called by Hertwig, in Actinosphaerium, and the chromidial nets and strands of Rhizopods, to the view that two physiologically distinct elements have assumed a morphological similarity and mode of origin. While retaining the name chromidia for the former, he distinguishes the latter under the name Sporetia. It is, however, perhaps somewhat early at present to insist on this distinction. Hertwig's essay has already been most fruitful in results, and we cannot doubt that the nature of the chromidia will be further elucidated now that attention has been directed to them.

The relation in size between the microspheric parent and the members of the megalospheric brood.

There is one other point to which, before concluding, I wish to invite your attention.

In the course of the discussions on the significance of the occurrence of nummulites in pairs, objection was taken to the view that the members of the pair belonged to the same species on the ground that solitary forms—megalospheric or microspheric, unaccompanied by the usually associated sister form—occurred in certain localities. De la Harpe himself, having at first urged this objection, withdrew it; but it is still entertained by some palæontologists, and made the ground for maintaining the view that the members of a pair are specifically distinct.

On looking into the matter I found that two out of the three species of Nummulites which occur in the Bracklesham and Barton beds in the Hampshire basin were only known, so far as published descriptions went, in the megalospheric form, although the corresponding microspheric forms had been found associated with these megalospheric forms on the Continent. It therefore seemed worth while to examine the English beds to see whether they might lend any support to the view I have mentioned. The three English species are the following:

Nummulites laevigatus (Brug.), megalospheric form "*N. Lamarcki*, d'Arch."

N. variolarius (Lamk.), microscopic form "*N. Heberti*, d'Arch."

N. Orbignyi (Galeotti), megalospheric form "*N. wemmelensis*, d. l. H. and v. d. Br., var. *elegans*, Sow."

In *N. laevigatus* the microspheric form far exceeds the megalospheric, in the size attained by the full-grown tests,

[1] R. Hertwig, "Ueb. Encystierung u. Kernvermehrung bei Arcella vulgaris," Kupffer's *Festschrift*. 1899.

[2] "Untersuchungen üb. d. Fortpflanzung einiger Rhizopoden," *Arb. au d. Kais. Gesundheitsamte*, Bd. xix., 3, 1903.

[3] Calkins in his very interesting observations on *Amoeba proteus* also found that the chromidium-like bodies are derived from the vegetative nuclei. See his paper, "Evidences of a Sexual-cycle in the Life-history of *Amoeba proteus*." *Arch. f. Protistenkunde*, Bd. v. H. (1904).

[1] I have here considerably expanded what I take to be Schaudinn's meaning. His words are (*l.c.* p. 553): "Die Chromidien (of Polystomella) entsprechen den in der Ein- oder Mehrzahl vorhandenen Geschlechtskernen oder Mikronuclei der Infusorien. Der Unterschied besteht nur darin, dass wegen der Verknüpfung der Brutbildung mit den Kopulationsvorgängen die Geschlechtskernsubstanz bei Polystomella in viel grösseren Quantitäten vorhanden ist, als bei den Infusorien.

[2] "Die Chromidien der Protozoen." *Arch. f. Protistenkunde*. Bd. v., 1 (1904), p. 126.

as we have seen to be usually the case with nummulites; but in the other two species the size attained by the two forms is approximately the same. Hence there is in them no external indication of dimorphism, and it is necessary to grind down the little shells to expose the initial chambers in section before they can be referred to one form or the other. The results of the investigation are fully set forth elsewhere,[1] and I need only say here that on proceeding in this manner with these two species, after grinding down a number of examples which proved to belong to the commoner megalospheric form, I came in each, as I fully expected I should, on examples of the microspheric forms. The English beds, therefore, offer no support to the view that one or other of the forms of a species may occur solitary.[2]

On examining sections of the two forms, megalospheric and microspheric, in the three species, a further point of interest presented itself, namely, that the megalosphere, the initial chamber of the megalospheric form of *N. laevigatus*, was much larger in proportion to the size of the megalospheric shell than the megalospheres of *N. variolarius* or *N. Orbignyi*. I was, therefore, led to examine the proportion in a larger number of forms, and the fine series of nummulites contained in the collection presented by Dr. H. B. Brady to the University of Cambridge gave me the opportunity of doing so on ten species or varieties.[3]

In *N. complanatus* the microspheric form attains a diameter of about 2 inches (51 mm.), the megalospheric form a diameter of 5·9 mm. In *N. variolarius* the microspheric form has a diameter of about 1·92 mm. and the megalospheric form of about 1·8 mm.

The result of careful measurement was to show that the volume of the megalosphere is, within narrow limits, proportional to the volume of protoplasm contained, not in the whole megalospheric, but in the whole microspheric test. In other words, and in the light of our knowledge of the life-history of the dimorphic Foraminifera, the volume of each of the individual members of a brood of megalospheric young is in Nummulites proportional to the bulk of the protoplasm of the microspheric parent out of which they are formed. In Hertwig's essay, above quoted, it is pointed out (p. 30) that in functional cells (not eggs) there is a definite proportion between the mass of a protoplasmic body and the mass of nuclear substance contained in it. If we apply this to the result attained for Nummulites it would appear that *the mass both of the protoplasm and its contained nuclear material are in this asexual mode of reproduction proportional to the whole bulk of the protoplasm out of which they are formed.* It would appear to follow that among Nummulites the number of the members of the brood in the asexual mode of reproduction ought to be approximately the same in all species.

In the sexual mode of reproduction no such relation holds, for the microsphere in *N. gizehensis*,[4] the microspheric form of which attains a diameter of 23·7 mm., is hardly larger than that of *N. variolarius*, in which the diameter of this form is, as we have seen, 1·92 mm.

[1] Paper by the author "On the Dimorphism of the English Species of Nummulites and the Size of the Megalosphere in relation to that of the Microspheric and Megalospheric Tests in this Genus." *Proc. Roy. Soc.*, vol. B. lxxvi., 1905, p. 298.

[2] When the two forms are of different sizes, and the materials of a bed have been rearranged by currents, they may, of course, be differently distributed.

[3] The species (or, on the old view, pairs of species) thus examined are:—

N. complanatus, Lamk.,	megalospheric	form	"*N. Tchihatcheffi*, d'Arch."
N. perforatus (de Montft.)	,,	,,	"*N. Lucasanus*, Defr."
N. Gizehensis (Forsk.)	,,	,,	"*N. curvispirus* (Menegh.)"
N. perforatus, var. *obesus*	,,	,,	"*N. Lucasanus*, var. *obsoletus*, d. l. H."
N. laevigatus (Brug.)	,,	,,	"*Lamarcki*, d'Arch."
Assilina exponens (Sow.)	,,	,,	"*A. mamillata* (d'Arch.)"
N. biarritzensis, d'Arch.	,,	,,	"*N. Guettardi*, d'Arch."
N. discorbinus (Schlot.)	,,	,,	"*N. sub-discorbinus*, d. l. H."
N. Orbignyi (Gal.), var. *elegans* (Sow.), and	,,	,,	"*N. wemmelensis*, d. l. H. and v. d. Br., var. *elegans*, Sow."
N. variolarius (Lamk.)	microspheric	,,	"*N. Heberti*, d'Arch. and Haime."

[4] I have been unable to measure the microsphere in the larger species owing to the cavities of the chambers in my specimens being filled with calcite, and their outlines obliterated.

In addition to the structural and other characters, binding the members of "a pair" of Nummulites together, which led De la Harpe to conclude that they belong to the same zoological group, we may now therefore add another—the ratio in volume between the megalosphere of one and the protoplasmic contents of the whole shell of the other.

It would be interesting to find how far this proportion holds good in other genera of Foraminifera. I do not know of any phenomenon precisely comparable with it elsewhere, but the result is so definite that it would appear to be the expression of a general principle.

In conclusion, I may call attention to the difference presented by the species of the genus Nummulites in the relative length of life (as indicated by size) of their sexually and asexually produced forms. In *N. variolarius* the life-cycle is apparently equally divided between the two, while in *N. complanatus* the small megalospheric form ("*N. Tchihatcheffi*") is almost as much dwarfed by the gigantic microspheric form as, in the life-history of a fern, the prothallus is by a member of the sporophytic generation.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. O. W. RICHARDSON, of Trinity College, Cambridge, has been appointed to the chair of physics in the University of Princeton, New Jersey.

Science announces the gift of 10,000*l.* to Yale University by Mr. E. Milner, of Plainfield, Conn. The interest is to be used for the education of some resident of Plainfield.

MR. E. B. HART has been elected professor of agricultural chemistry, and chemist, in connection with the agricultural experiment station of the University of Wisconsin.

THE King has approved of the appointment of Admiral Sir Arthur Dalrymple Fanshawe, K.C.B., as president of the Royal Naval College, Greenwich, in succession to Sir Robert Harris, K.C.B., K.C.M.G.

SIR WILLIAM THOMSON has been appointed by the Chief Secretary for Ireland inspector of schools of anatomy for the provinces of Connaught, Ulster, and Leinster, in the place of Dr. W. J. Martin, deceased.

AT Lehigh University Messrs. P. A. Lambert and A. E. Meake have been appointed professors of mathematics, and at the same university Mr. J. D. Irving has been elected to a professorship in geology.

DR. D. NOËL PATON, superintendent of the laboratory of the Royal College of Physicians, Edinburgh, has been appointed regius professor of physiology in the University of Glasgow in succession to Prof. J. G. M'Kendrick, F.R.S., resigned.

PROF. WM. H. HOBBS, of the University of Wisconsin, has been appointed successor to the late Prof. Israel C. Russell in the professorship of geology in the University of Michigan. Prof. Hobbs, who is at present in Europe, will leave for America to take up his new duties on August 25.

THE eleventh annual examination in the science and practice of dairying for the national diploma of the National Agricultural Examination Board will take place at the Midland Agricultural and Dairy College, Kingston, Derby, from September 24–27 for English students, and at the Dairy School, Kilmarnock, from October 1–5 for Scottish students. All applications must be sent in by, at latest, August 31. The subjects of examination are the general management of a dairy farm, the management of a dairy, chemistry and bacteriology, practical skill in dairy work, and capacity for imparting instructions to others. Forms of entry and copies of the regulations may be obtained from the secretary of the Royal Agricultural Society, or from the secretary of the Highland and Agricultural Society.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 31.—"The Affinity Constants of Amphoteric Electrolytes." I. "Methyl Derivatives of Para-amino-benzoic Acid and of Glycine," by John **Johnston.** II. "Methyl Derivatives of Ortho- and Meta-amino-benzoic Acids," by A. C. **Cumming.** III. "Methylated Amino-acids," by James **Walker.**

The object of the present series of papers was to determine the influence of the substitution of the methyl group in NH_2 on the acidic and basic dissociation constants of amino-acids. The methods employed for the determination of the dissociation constants were for the most part hydrolytic, *i.e.* the degree of hydrolysis in aqueous solution of both types of salts of the amino-acids was estimated at given dilutions. For the basic constant methyl acetate catalysis, Löwenherz's solubility method and Farmer and Warth's distribution method were employed. In addition to these methods, the delicate diazo-acetic ester catalysis of Bredig and Fraenkel was used in a few instances. For the acidic constant, the electrical conductivity and Shields's saponification method were utilised.

Each substance investigated was subjected to careful purification, and many new methods were devised for the preparation of the methyl derivatives required. It may be noted that the monomethyl-meta-amino-benzoic acid described by Griess is a mixture of the monomethyl and dimethyl derivatives which it is practically impossible to separate by recrystallisation.

A comparison of the acidic and basic constants of the various substances examined showed that they were in general accordance with the following scheme. The primary influence of the substitution of methyl for hydrogen in the amino group is to raise the basic and diminish the acidic constant, the effect in both cases being, however, only slight. This primary influence is usually obscured by greater secondary influences due to stereochemical changes. These changes may exert their influence (1) by mere approximation of the active groups; (2) by change in degree of hydration of the basic group; (3) by ring-formation. In the case of ring-formation the acidic constant is diminished, speaking in general terms, proportionally to the extent to which the ring-formation has taken place. The basic constant, on the other hand, need not be so diminished, because the basic constant in the bodies investigated is principally a function of the hydration constant of the basic group, and the degree of hydration may not be diminished by increased ring-formation. A comparison of the basic constants of the amino-acids with those of their methyl esters affords information regarding the reciprocal stereochemical influence of the active groups. When there is little stereochemical influence the basic constant of the acid is nearly equal to that of the ester. When the stereochemical influence is marked the basic constant of the acid is much less than that of the ester. The following table of the constants of ortho-amino-benzoic acid and of para-amino-benzoic acid and their methyl derivatives may serve as illustrations. In the ortho series stereochemical influences are apparent, in the para series they are nearly absent.

Ortho Series.

	$k_a \times 10^5$	$k_b \times 10^{12}$	Ester $k_b \times 10^{12}$
Acid	1.4	1.3	1.7
Monomethyl	0.46	0.9	33
Dimethyl	0.00023	0.28	60
Betaine	0.00000	0.28	very great

Para Series.

	$k_a \times 10^5$	$k_b \times 10^{12}$	Ester $k_b \times 10^{12}$
Acid	1.2	2.5	2.4
Monomethyl	0.92	1.7	2.1
Dimethyl	0.94	3.2	3.3
Betaine	0.00000	32.3	very great

The great drop in the acidic constant of dimethyl-ortho-benzoic acid is due to ring-formation. In the case of the betaines the ring-formation must be nearly complete, as the acid constant has practically vanished. The basic constant of the betaines still assumes a comparatively high value, notwithstanding the extensive ring-formation, owing to the very high constant of the quaternary basic group, which cannot suffer dehydration except through ring-formation. The quaternary basic group of the betaine esters was proved to have basic properties comparable in strength with those of the caustic alkalies.

June 21.—"On the Distribution of Radium in the Earth's Crust." By the Hon. R. J. **Strutt,** F.R.S.

In a paper read before the society on April 5, the author gave determinations of the quantity of radium in igneous rocks. Similar data for sedimentary deposits will now be given to complete the survey of the radium content of the earth's crust.

The results for sedimentary rocks are given in Table I.

TABLE I.

Rock	Locality	Radium per gram, in grams
Oolite	Bath	5.84×10^{-12}
Oolite	St. Alban's Head	4.05×10^{-12}
Marble	East Lothian	3.87×10^{-12}
Kimmeridge clay	Ely	3.77×10^{-12}
Oil-bearing sandstone	Galicia	3.04×10^{-12}
Roofing slate	Wales (?)	2.57×10^{-12}
Silicified gritty slate	St. Ives, Cornwall	2.50×10^{-12}
Gault clay	Cambridge	2.13×10^{-12}
Clay	Terling, Essex	1.73×10^{-12}
Red sandstone	East Lothian	1.68×10^{-12}
Gravel (fine siftings)	Terling, Essex	1.42×10^{-12}
Red chalk	Hunstanton	1.07×10^{-12}
Flint (large nodules)	Terling, Essex	1.06×10^{-12}
White marble	Deccan, India	0.54×10^{-12}
Marble	East Lothian	0.52×10^{-12}
Chalk	Bottom of pit, Cherry Hinton, Cambridgeshire	0.78×10^{-12}
Chalk [1]	Top of same pit	0.25×10^{-12}

On comparing these figures with those given in the former paper for igneous rocks (Roy. Soc. Proc., vol. lxxvii., A, p. 479, last column but one of the table), it will be observed that the average radium content of sedimentary deposits does not differ appreciably from that of igneous rocks. This is what might be expected on the received view that sedimentary rocks derive their material from the disintegration of igneous ones.

The author has examined a number of specimens of rock-forming minerals for radium. The results are given in Table II. In some cases the quantity of material taken

TABLE II.

Mineral	Locality where found	Quantity taken. grams	Radium per gram, in grams
Zircon	Ural Mountains	1	865×10^{-12}
Zircon	North Carolina	1	658×10^{-12}
Zircon	Brevig	0.690	139×10^{-12}
Zircon	Kimberley	1.17	74.8×10^{-12}
Perofskite	Magnet Cove, Arkansas	1	197×10^{-12}
Sphene	?	1	102×10^{-12}
Apatite	Sweden	8	29.7×10^{-12}
Apatite	California	47	11.0×10^{-12}
Hornblende	?	7.5	4.27×10^{-12}
Tourmaline	Devonshire	11.3	3.32×10^{-12}
Labradorite	Labrador	17	1.1×10^{-12}?
White felspar	Nellore, India	20	0.6×10^{-12}?
White mica	Nellore, India	10	1.0×10^{-12}?
Brown mica	Deccan	10	1.0×10^{-12}?
Brown mica	?	10	Nil
White quartz	Nellore, India	30	Nil
Rutile	?	1	Nil
Ilmenite	?	1	Nil

[1] This determination was made on 500 grams of material, in order to get a sufficient leak for measurement.

for the experiment proved insufficient to give a satisfactory quantitative measure of the amount of radium in the mineral. This is indicated by a note of interrogation. In other cases no radium at all was detected. In all probability some traces would have been found if more of the mineral had been taken, but the object was to determine whether the mineral made any important contribution to the total radium in the rock. Thus it was not thought worth while to push the examination of accessory minerals, such as ilmenite or rutile, which only occur in small proportions, very far. The quantities of material taken for these experiments are given, so that the quantitative significance of a negative result may be judged.

It will be observed that certain of the accessory minerals, *i.e.* zircon, sphene, perofskite, and apatite, which occur in granite, are rich in radium. The hornblende, micas, tourmaline, and felspars examined contain much less, while in quartz none could be detected.

Paris.

Academy of Sciences, July 30.—M. H. Poincaré in the chair.—The observatory on Mt. Blanc: M. **Janssen.** An account of the improvements carried out at the observatory during the past year. At present MM. Millochau and Stefánik are carrying out spectroscopical researches, and the observatory will shortly be visited by MM. Guillemard and Moog for the continuation of biological work commenced last year, and by Alexis Hansky for the continuation of his work in astronomical physics.—The underlying principles of direct colour photography. The direct photography of colours based on prismatic dispersion: G. **Lippmann.** The single slit of a spectroscope is replaced by a series of slits very close together, formed of fine transparent lines, five to the millimetre. Full experimental details are given.—General remarks on interference photography in colours: G. **Lippmann.** The mercury mirror, theoretically, can be replaced by any other method of producing interference bands. Practically, the unavoidable defects of construction of the biprism or Fresnel double mirror would render the use of either of them inapplicable. The interference systems produced by half-silvered mirrors offer more chances of success.—The results obtained for the determination of two instrumental constants which occur in certain meridional observations: H. **Renan.** The application of the method described in a previous communication to the measurement of the angle between the cross-wires of a meridian circle micrometer has shown that the mutual inclination of the wires is not absolutely constant, but is a function of the direction of the optic axis of the telescope. It is shown that this error, although small, can be eliminated by the author's method.—Observations of the Finlay comet (1906*d*) made with the bent equatorial of the Observatory of Lyons: J. **Guillaume.**—The area of Asiatic Russia and the method employed in its determination: J. **de Schokalsky.**—The combinations of ammonia with aurous chloride, bromide, and iodide: Fernand **Meyer.** The preparation and properties of the compounds $AuI.6NH_3$, $AuI.NH_3$, $AuBr.2NH_3$, $AuCl.12NH_3$ and $AuCl.3NH_3$ are described.—Some reactions of liquid chlorine: V. **Thomas** and P. **Dupuis.** A description of the reaction of liquid chlorine with iodine, bromine, sulphur, selenium, arsenic, antimony, bismuth, and gold.—The alloys of manganese and molybdenum: M. **Arrivant.** These alloys have been prepared in two ways, by heating a mixture of the two metals in the form of powder to 1500° C., and by the action of aluminium powder upon a mixture of the oxides Mn_3O_4 and MoO_2. A series of alloys containing from 12 per cent. to 30 per cent. of molybdenum was obtained, all of which were shown to consist of free manganese associated with either Mn_6Mo or Mn_4Mo. Both the latter compounds were isolated.—The variations of electrical resistance of steels outside the regions of transformation: P. **Fournel.**—The estimation of ammonia in water by Nessler's reagent: Albert **Buisson.** The reaction between ammonia, potash, and mercuric iodide is a reversible one, and hence any estimation of ammonia based on the determination of mercury in the brown precipitate is inexact.—Synthetically prepared *l*-idite: Gabriel **Bertrand** and A. **Lanzenberg.**—Silver sulphide, selenide, and telluride: H. **Pélabon.** Deductions from a study of the melting points of mixtures in varying proportions of silver and sulphur, silver and selenium, and silver and tellurium. The complete curve for the last named can be traced experimentally, and shows a eutectic melting at 345°, and Ag_2Te, melting at 955°.—The washing of colloidal precipitates: J. **Duclaux.** The author holds that the complete washing of a gelatinous precipitate is theoretically possible, and that in both gelatinous and colloidal precipitates there is no proportionality between the impurity removed at each washing and that remaining in the precipitate.—The true nature of the α-glucoproteins of M. Lepierre: J. **Galimard,** L. **Lacomme,** and A. **Morel.** The constitution attributed by M. Lepierre to the nitrogenous products employed by him for microbial cultures is inexact.—The amylase and maltase of the pancreatic juice: MM. **Bierry** and **Giaja.**—The mechanism of the valves of certain Acephaleæ during opening and closing, and its morphogenic consequences: F. **Marceau.**—A curative product derived from tuberculinine, a crystallised tuberculous poison: G. **Baudran.** Tuberculinine is a poisonous alkaloid extracted in the proportion of 0·06 per cent. to 0·10 per cent. from tubercle bacilli. This alkaloid, when oxidised under conditions specified with calcium permanganate, yields a substance possessing antitoxic power against the poison of the tubercle bacillus.—A tectonic sketch of France: E. **Jourdy.**

Göttingen.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part ii. for 1906, contains the following memoirs communicated to the society:—

February 17.—Seismic records at Upsala (October, 1904–May, 1905): F. **Åkerblom.**

March 3.—Outlines of a general theory of linear integral equations (iv.): D. **Hilbert.**

May 12.—Characters of inorganic colloids (ultramicroscopic observations): W. **Blitz.**

The Business Notices (part i., 1906) include a report on the Samoa Observatory, and an obituary discourse on the late Baron Ferdinand von Richthofen.

CONTENTS.

THURSDAY, AUGUST 23, 1906.

TUNNELS AND TUNNELLING.

Modern Tunnel Practice. By D. McNeely Stauffer. Pp. viii + 314. (London: Archibald Constable and Co., Ltd., 1906.) Price *21s.* net.

THE author of this book is to be congratulated both upon having produced what will prove to be a useful book of reference for engineers engaged in the arduous work of tunnelling, and also upon the fair and impartial manner in which he writes. He has given credit to those men whose names are associated with certain great improvements, and has not attempted, as is sometimes unfortunately the case, to claim inventions for his countrymen which rightfully belong to English, Italian or other nationalities.

Mr. Stauffer is an American engineer in New York, but he is also enrolled as a member of our Institution of Civil Engineers of London, and it is evident that he has had considerable and practical experience of the difficulties of tunnelling.

Naturally tunnels are things to be avoided as being both costly and difficult, but for penetrating mountains, crossing under rivers and arms of the sea, or for traversing our great towns and cities, they are indispensable. There is, however, one well-known case of a tunnel in South America in which the engineers deliberately ran their railway into a mountain in order that their country should not retain the notoriety, undesired by them, of not possessing a single work of the kind, and over the portal of that tunnel is marked in large letters, "This is the first tunnel in the country."

The illustrations are good and brought down to a recent date, but they unfortunately suffer from the one defect that the dimensions and notes of reference are almost too small to be read except with the aid of a magnifying-glass; it is a recognised principle that drawings which are to be reduced for publication in the leaves of a book should have all the writing and figures several times the usual size, so as to be easily legible when reduced.

The chapter on surveying for tunnels contains the latest practice, and will be useful to all students and young engineers. The author describes how a ray of light is now used in many cases in place of wires, but where the latter are still employed the inconvenience resulting from their acting as long pendulums is overcome by suspending the plummets in buckets of water; tar, with its greater viscosity, is, however, more certain in its action, but has the drawback of being easily floated out by water falling down the shaft.

The use of explosives is gone into very fully, many of the various kinds being described, with rules for their handling and thawing in cold weather; the general principles of blasting and the position and depth of bore-holes are carefully explained.

It is found by experience that when driving a heading or gallery through hard material, more rapid progress is made if a wedge-shaped mass of rock be blown out first, in the centre of the work, as by so doing the excavation round the margin of the tunnel section is more easily removed to a true line. This is effected by making the centre holes converge to a point, and charging them in such a manner, by shortening the fuse, that their charges will be fired a few seconds earlier than those in the remaining holes. Useful hints are given as to the precautionary measures to be taken in case of a misfire, when a charged hole has to be bored out.

The effects upon the engineers and workmen from the products of combustion of the explosives are referred to, and instructions are given as to remedies, but the principle of ample ventilation right up to the very face of the work cannot be too strongly insisted upon. If large volumes of fresh air are provided for the men in the most advanced working, no danger of asphyxia is to be feared.

The introduction of high explosives, powerful drills, and ample machinery has reduced the necessity for a large number of shafts, and work is now often conducted only from the two portals. The author discusses from a practical point of view the size and shape of shafts when required, and is of opinion that those of rectangular form are preferable to either square or circular ones. Doubtless there is much to be said in favour of his views, but if water be encountered in a shaft and has to be "tubbed out," the circular is the only permissible form. As regards the actual sinking through water-bearing strata, compressed air cannot be made available under a greater "head" than 100 feet. Pumping can be resorted to, as is usually the case, or the "Kind-Chandron" method of sinking, as was done at Whitburn, whilst the more modern system of freezing has been tried with success recently in one or more of the collieries in Durham.

It is, however, costly, and has its own inherent dangers which must be provided against; for instance, a case recently occurred in which the frozen material gave way under the hydrostatic head of the water behind it, and blew in the side of the shaft.

The various methods of tunnelling known as the English, the Belgian, the German, and the Austrian systems are described, and it is satisfactory to note that the Americans adopted the first of these in several of their important tunnels. The use of steel needles in a London tunnel under houses is referred to, but notwithstanding every possible care and precaution, some injury was done to the property; now, however, by the adoption of the shield, this is reduced to a minimum.

It is satisfactory to observe that the author gives the credit to the late Mr. Greathead of his shield, for although he was not the actual inventor, yet it was he who so modified and introduced it into practical work that it has been universally adopted by the engineering profession as the solution of much of the difficulty encountered in tunnelling. In like manner the name of Signor Saccardo is given as having invented the admirable system of ventilation with which his name is connected, although in more than one case in America his proposals have been adopted without his name even being mentioned.

The important tunnels in Paris, Budapest, Boston, and New York are fully discussed, and one of the most instructive chapters is devoted to the Simplon Tunnel with its approaches on the Italian side between Domo d'Ossola and Iselle. The arrangements for the men, the power installation, ventilation, air refrigeration, illumination, drainage, workshops, buildings, as also the transportation service, are dealt with in such a manner as cannot fail to be useful to readers, and when it is remembered that notwithstanding the innumerable difficulties which were encountered from hard rock, hot springs, and crushing timbers, an annual progress was attained of one mile at each face, a record has been established which it will be very hard to beat. Subsequent to the date at which the book was written, it was found that in the bad ground at 4·4 km. from Iselle steel girders and timbers could not contend with the load they were called upon to carry, and that steel girders with cement concrete alone enabled the work to be proceeded with.

Much information is given as to the ventilation of tunnels, and if only from a public point of view this is satisfactory as indicating the greater amount of attention which is now being devoted to this branch of scientific engineering.

The use of compressed air in caissons, which was first applied at Rochester Bridge by Sir Charles Fox, is gone into at length, and in connection with the illness known as caisson disease it can be mentioned that the admirable system of re-compression in cases of men being affected was first proposed and carried out by Mr. Moir.

A very important part of the book describes the extended use which is being made throughout the world of concrete in cement. Within the last ten years this has come into favour and is being applied to works of all kinds. Even subaqueous tunnels, such as that at Boston, are being wholly constructed of concrete, and whereas a few years ago the material was regarded with suspicion, to-day it is being loaded to the extent of 15 tons per square foot. How to render concrete air-tight and waterproof is a problem with which the author deals.

In the appendix is given a useful glossary of terms used in tunnelling, and the book is rendered complete by a fairly extended index of contents.

ANCIENT ASTRONOMY.

Astronomy in the Old Testament. By Prof. G. Schiaparelli. Authorised English translation, with many corrections and additions by the author. Pp. viii + 178. (Oxford: Clarendon Press, 1905.) Price 3*s.* 6*d.* net.

Researches into the Origin of the Primitive Constellations of the Greeks, Phoenicians, and Babylonians. Vol. ii. By Robert Brown, jun. Pp. xx + 261. (London: Williams and Norgate, 1900.) Price 10*s.* 6*d.*

WE have in these two books works of very different scientific value. Prof. Schiaparelli's little book is that of an expert astronomer who has also a remarkable knowledge of the archæological evidence as to the early history of astronomy in the East. This knowledge he uses with telling effect, bringing out his points in an orderly, marshalled, logical, and therefore convincing way. He is moderate and sensible in his deductions also, and never allows himself to be carried away by that deplorable impulse to wild philological comparison and identification which has been the curse of work of this kind hitherto. He has in his English edition also had the benefit of the collaboration of the sanest and most trustworthy critics of the Old Testament, Dr. Driver and Mr. Cowley to wit, so that the reader may rest assured that in reading the book he is not groping darkly among Cheyneian cryptograms, nor need he fear that he will be haunted by the unquiet spirit of Jerahmeel. Neither the ubiquitous "Jerahmeel" nor the elusive "Musri" (see NATURE, June 26, 1902) have a place in this eminently sane and work-a-day volume, which both archæologists and astronomers will find useful. The archæologists, indeed, would only be too grateful if the astronomers would help them more than they do. The mysteries of Mahler, for instance; no unastronomical archæologist quite knows whether they are scientific gospel or not. An instance of archæological ignorance of astronomy is given on p. 68—Arcturus confounded with Arctos, and said to be a star in the Bear.

Prof. Schiaparelli gives us a very lucid introduction, followed by a series of chapters on the general cosmology of the Old Testament, the stars and constellations, the doubtful *Mazzoroth* (perhaps the two phases of Venus), the arrangement of months, days, &c., among the early Hebrews. All is most interestingly expressed, and the archæological and historical references are most valuable. The connection of the Jewish star-lore with that of the Babylonians is carefully but moderately brought out. A serious defect in the book is the lack of an index. The translator or publishers undoubtedly deserve blame for not having had one compiled. No doubt French or Italian writers do not habitually make indices to their books. That is their defect; in England the reader wants indices, and the fact ought not to have been forgotten in this case.

We wish we could praise so highly Mr. Brown's "Primitive Constellations," as, to judge from his introduction, he is very sensitive to former criticisms. But honestly we cannot. The author of the "Great Dionysiak Myth" used to be hag-ridden by philological speculations of the kind which were fashionable in the days of Max Müller, Gladstone, and Sir George Cox, but have been recognised to be bad archæology these twenty years past. Of this we are bound to say we do not see so much in the present volume, and are glad of it, but at the same time we regret that Mr. Brown cannot bring himself to abandon his foolish explanation of the name Amalthea as the Assyrian *Ammâ*, "mother" + *l* (which we suppose is the Arabic *el*) + the Greek θεῖα; here you have it, Amalthea, "the divine mother" (!) Mr. Brown is still unable to perceive the absurdity of this. The learned author also used to be a victim of the Greek transliteration fad of Gladstone and

Cox, which led him not only to transliterate after their manner, but even to extend the fad into English, and to write such dreadful words as "Hellenik" and "Dionysiak." As a critic said, "Why not Dionusiak Muth?" which was a palpable hit. However, to be just, much of this sort of thing also has disappeared from Mr. Brown's present book, which we readily allow to be a heap of antiquarian learning, Assyriological and other, on the subject of which it treats.

Whether the Assyriology and the Sumerology are all right the lay critic is unable to tell, but there is probably a good deal in Mr. Brown's Assyrian learning that is not entirely orthodox, to judge from the undoubtedly unorthodox nature of much of his Greek philology, to which *Ammâ-el-θεία* testifies. That dreadful soloikism (as we suppose Mr. Brown would say) makes us perhaps unduly suspicious. If so, we hasten to beg Mr. Brown's pardon, as we do not wish to share the fate of the Assyriological reviewer (not ourselves) of vol. i. of "Primitive Constellations" in NATURE (April 13, 1899, vol. lix., p. 553), who said that Mr. Brown made mistakes in his Assyrian and was smitten by a Browniak thunderbolt for his temerity. The learned author refers to this circumstance in a note in the volume under review. Perhaps Mr. Brown may think he scored, but it is perfectly plain that when he wrote "Barsipki" as the name of the town of Barsip (Borsippa) he was under the erroneous impression that the written suffix *-ki* was pronounced, otherwise he would not have spelt it out. "Barsip^{ki}" was written, "Barsip" was said; "Barsipki" was never either written or said. If Mr. Brown does not understand what is meant he does not understand the cuneiform writing, and if his Assyriology is bad the whole of his book must be bad too.

OUR BOOK SHELF.

Biologische und morphologische Untersuchungen über Wasser- und Sumpfgewächse. Erster Teil. Die Lebensgeschichte der europäischen Alismaceen. By Prof. Hugo Glück, Heidelberg. Pp. xxiv+312+xiv figures and plates. (Jena: G. Fischer, 1905.) Price 20 marks.

THIS elaborate and apparently exhaustive monograph is one of the fruits of the morphological school founded in Munich by Goebel, but the author, struck, as so many writers have been, with the enormous variability of these plants, has here attempted to bring together the facts, not only of the influence of the environment as expressed in the direct action of such agencies as light, situation, water, and other factors, but has also tried to weave these into a sort of system such as can be used by the systematist.

He says:—"Meiner Ansicht nach ist das der einzige Weg, der uns über das Zustandekommen der einzelnen Formen und ihre Abhängigkeit vom Standort sicheren Aufschluss erteilt, da ja in der freien Natur die Standortsverhältnisse dieser Pflanzen einem steten Wechsel unterworfen sind und sich der direkten Beobachtung mehr oder minder entziehen."

But, in addition, extensive collections of herbarium material were made and examined, and plants over wide areas examined *in situ*.

The book falls into two parts, of which the first or special part deals with the biology in the German sense of the word, of the various species of Alysma, Echinodorus, Elisma, Caldesia, Damasonium, and Sagittaria. Each of these species is then examined in detail as regards the general action of the environment, its aquatic forms or varieties, its land forms, its seedlings, and its so-called monstrosities whether found wild in nature or produced in culture, and lastly, the condition in which it passes the winter. Here and there are notes on other matters of detail, such as floating apparatus, the influence of light, turios, submersed forms, &c.

The second or general part of the work describes an investigation of the adaptation of the various parts to different functions in general. One of the most interesting sections here will be the examination of the formative factors (gestaltbildener factoren), and another is the results considered in respect to systematic botany. There is a rather too meagre index, but a very special word of praise should be given to the plates, and we congratulate author and publisher alike on the drawing and reproduction of the figures. Few morphologists will be able to dispense with the book, and certainly no systematist concerned with the biology of this interesting group of water-plants.

School Gardening for Little Children. By Lucy R. Latter. Introduction by Prof. P. Geddes. Pp. xxiv+166. (London: Swan Sonnenschein and Co., Ltd., 1906.) Price 2*s.* 6*d.* net.

THE value of any particular scheme of education for little children depends more on the interest the teacher feels in the subject, and on the sympathy he or she is able to manifest towards the pupils, than on the scheme itself. We think this will be obvious to anyone who peruses the pages of the volume before us. Most children bred in the country have a "garden all to themselves," but we doubt whether any permanent benefit is derived by them unless their work in it is directed with sympathetic intelligence such as is revealed in Miss Latter's pages. "I have tried," says the author, "to prove that it is possible to make nature-teaching the central point of the life of a school without detriment to the children; that such teaching gives a real meaning and incentive to all the handwork and leads to a richer and truer appreciation of poetry, pictures and music.

"The experiment has been going on for nearly six years, during which time it has successfully stood the test of Government inspection. Each year has shown an increasing gain to the children intellectually as well as physically and morally. Instead of the children being less prepared for the work of the senior schools, it is found that they read, write, and do arithmetic as well, if not much better, for having had daily contact with plants and animals and opportunities for observing the various natural phenomena which affect their lives in one way or another. It is further found that such children pass on to the senior schools with a quickened power of observation, a far greater amount of intelligence, a keener desire to learn, and a greater refinement of heart than if their earlier years had been spent in acquiring mechanical perfection in the arts of reading, writing, and arithmetic before any real experience had been accumulated as a basis for those more formal branches of instruction."

Miss Latter speaks with authority, and a perusal of her book leads us to accord willing assent to it. In subsequent pages she tells us what have been the procedures which have contributed to her success, how part of the hard asphalt playground has been converted into the school-garden, how the garden is "laid out," how it is maintained and cultivated, and what are the moral and religious lessons which arise gradually and spontaneously in a child's mind from the lessons afforded by the observation of plant-life and the habits of animals. We have no doubt of the truth of all this, but only on the condition before mentioned as to the tactful sympathy of the teacher.

LETTER TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither con 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 ononymous communications.*]

The Earth's Interior.

It has long been suspected that the earth is an iron planet, and now, through the work of Strutt and others, the evidence both for and against is intensifying.

It is just worth noting, as a matter of simple arithmetic, that a core of metallic iron of density 7, covered with a crust of rock 500 miles thick of density 2·5, together make up the known average terrestrial density, 5·6; but recent evidence, interestingly summarised by Principal Griffiths in his presidential address to Section A of the British Association, points to a crust much thinner than the above. It is to be hoped that the "boring" proposals of the Hon. Chas. Parsons will before long attract the attention they deserve.

Oliver Lodge.

THE EARTHQUAKE IN SOUTH AMERICA.

Between seven and eight o'clock on Thursday evening last, Valparaiso, Santiago, and many other parts of Chile were visited by a very severe earthquake, causing, it is feared, heavy loss of life and widespread damage. As was the case in San Francisco, the earthquake was followed by many outbursts of fire and the failure of the gas and electric light. According to a telegram to the *New York Herald* from Valparaiso, that city experienced, without any warning, the day having been unusually calm and pleasant, two distinct shocks of earthquake, and, standing as it does upon a formation of granite and gneiss, it suffered severely. The same correspondent reported the occurrence of many landslides round the city. According to Reuter, the shock at Santiago de Chile was the most severe within living memory; it lasted three and a half minutes, and was followed by heavy showers. The seismograph at the observatory was thrown out of order by the violence of the shocks, which, though slight, continued for some days.

The disturbance extended over a zone of nearly two degrees, and it is impossible at present to estimate the number of lives lost and the damage done, the accounts received being of a very conflicting nature.

The Chilian Legation in London received the following telegram from Santiago on Monday last, and the wording is in marked contrast to that found in the communications sent by Press correspondents:—

"On the evening of the 16th a severe earthquake was felt between Valparaiso and Talca. The loss of life is not very great. The damage to property is considerable at Valparaiso but less at Santiago. Public order has been entirely maintained. The authorities and private persons are succouring the distressed people, and the foreign Legations are lending their aid. The north has been wholly unaffected by the earthquake."

The earthquake was duly recorded by seismographs in different parts of the world.

The instrument at Kew Observatory plainly showed the magnitude of the disaster. The record indicated that the first tremor took place at thirty-three minutes after midnight, Greenwich time, on Friday morning. The first maximum was reached at 1.2 a.m., which was followed by continuous convulsions until a second maximum was reached at 1.50 a.m.

Prof. Milne is reported to have obtained good records by means of his instruments at Shide, Isle of Wight. The first records were observed at twenty-four minutes past twelve in the morning, and from these it was known that a disaster had occurred somewhere along the western side of South America. According to Valparaiso time, it would then have been 7.15. The duration was more than five hours.

According to Reuter's correspondent at Washington, a very heavy and distinct earthquake shock was recorded on Thursday evening by the seismographs of the Weather Bureau, beginning at five minutes twenty-two seconds after seven o'clock, time of the seventy-fifth meridian. Complete and perfect records were obtained of both north to south and east to west movements of the earth's crust. The tremors were comparatively slow, and their motion was deliberate, each complete movement covering from eighteen to forty seconds.

The disturbances lasted without intermission for several hours, and finally ceased about midnight. The most violent shock seems to have occurred at forty-two minutes twenty-six seconds after eight o'clock.

The instruments at the Hamburg Seismographic Institute are said to have shown greater and more prolonged signs of disturbance than at the time of the San Francisco disaster.

A telegram from Victoria, B.C., stated that the local seismograph recorded that the earthquake lasted four hours.

The tide gauges at Honolulu showed a disturbance, apparently of distinct origin, beginning at 5.23 a.m. on August 17. Three waves were indicated hourly, showing an oscillation of between three and four inches from the normal tides. Wireless reports from Maui and Hilo state that a wave 5 feet high occurred there. It manifested itself by an unprecedentedly heavy surf. In the enclosed Bay of Maalaea, on the island of Maui, the wave reached a height of 12 feet.

News has been received in New York that the earthquake has destroyed the island of Juan Fernandez (made famous by its supposed connection with Defoe's "Robinson Crusoe"), which was used as a Chilian penal settlement.

A despatch from Fort de France, Martinique, reports that earthquake shocks of varying severity were experienced on the island at 1.15 p.m. on August 19 and at 3.47 a.m., 4 a.m., and 8.37 a.m. on August 20, but that no damage was done; and a Reuter telegram from Lima states that Valparaiso was visited by another heavy earthquake on the night of Monday last: also that slight shocks were felt at Lima and Huacho on that day.

PROF. BROUARDEL.

We regret to record the death of Prof. Paul Brouardel, of Paris, who died on July 23 at the age of sixty-nine years. Prof. Brouardel had held a large number of most important positions in the University of Paris and in the official life of France, and he had many friends in England in connection with the important work in legal medicine and in hygiene which he had done.

He was born in St. Quentin in 1837, and received his early education at the Lycée St. Louis, in Paris. In 1859 he was an *interne* at the hospitals; he took his M.D. in 1865; in 1869 he became médecin des hôpitaux and professeur agrégré, in 1879 he became a professor in the Faculty of Medicine, in 1881 a member of the Académie de Médecine, and in 1892 of the Académie des Sciences. For many years he was dean of the Faculty of Medicine at Paris, his work in connection with the medical faculty being chiefly concerned with pathology and legal medicine. As a medical jurist he occupied a most distinguished position, and there is scarcely a portion of this subject which has not received illumination from the numerous lectures and cases which he published in the "Annales d'Hygiène publique et de Médicine légale." His work as a medical jurist brought his name frequently before the public through the evidence which he had to give on many technical points. He published many volumes upon legal medicine, dealing with such problems as infanticide, medical responsibility, le secret médical, sudden death, asphyxia by gases and vapours, &c., and his work as professor of legal medicine at the University of Paris, in which chair he succeeded Tardieu in 1879, made him perhaps the best-known teacher in Europe on this subject. For many years he gave practical instruction in pathology at the Paris Morgue, and he ascribed his illness and death to the insanitary conditions under which this work was carried on.

At many international congresses Prof. Brouardel was the representative of the French Government. He will be best remembered in this country by the speeches which he gave at the International Congress of Hygiene and Demography in 1891, and by the address which he gave at the British Congress on Tuberculosis in 1901. In the former he bore eloquent testimony to the priority of England in practical sanitary reform, and to the willingness of the English to sacrifice, not only much money, but also a large share of personal liberty, and thus by solidarity of effort to secure the communal welfare. In this remark he brought out the strong point of popular representative government; for in this country, although there is possibly more blundering, there is greater practical action than in France, although in the latter the non-enforced theoretical recommendations are excellent of their kind. In the same address he drew a favourable augury for the twentieth century, from the fact that the nineteenth had seen Jenner at its commencement and Pasteur near its end.

But the public address which was most influential for good was that given in 1901 by Prof. Brouardel to the British Congress on Tuberculosis. In this address he particularly emphasised the close association between tuberculosis and alcoholism. Quoting with approbation Sir J. Simon's remark that "the wretched lodging is the purveyor of the public house," he said, "the public house is the purveyor of tuberculosis." To this he added, "in fact, alcoholism is the potent factor in propagating tuberculosis. The strongest man who has once taken to drink is powerless against it. . . . A universal cry of despair rises from the whole universe at the sight of the disasters caused by alcoholism. . . . Any measures, State or individual, tending to limit the ravages of alcoholism will be our most precious auxiliaries in the crusade against tuberculosis."

The preceding sketch gives a very imperfect idea of the important work which Prof. Brouardel did. His influence pervaded every department of medical life in Paris and in France. Not only was he a distinguished physician, but also a great diplomat, and he thus succeeded in securing reforms which would otherwise have been impossible. His last public appearance was as president of the recent congress in Paris for the suppression of the illegal practice of medicine. He was buried on July 26 in the Montparnasse Cemetery after a funeral service in the Church of Ste. Clotilde, and by his own request no funeral orations were pronounced.

A. N.

NOTES.

The annual meeting of the British Medical Association began at Toronto on Tuesday last. In addition to a large representation from the British Isles, the meeting is being attended by very many medical men from all parts of Canada and the United States.

The pressure upon our space prevents us from doing more than direct attention to the important letters on radium contributed to the *Times* of August 9, 15, 20, and 21 by Lord Kelvin, Sir Oliver Lodge, and the Hon. R. J. Strutt.

According to a Reuter telegram of August 16 from Bombay, Dr. Bullock Workman, who has been mountaineering in Kashmir, ascended a peak in the Nunkum range more than 23,000 feet high. Dr. Workman, with his wife and Italian guides and porters, camped two nights at an altitude of more than 21,000 feet. This is stated to be the highest camp ever made by mountaineers.

Further particulars respecting the forthcoming French exploring expedition under Major Lenfant are given by the Paris correspondent of the *Times*, quoting from the *Dépêche Coloniale*. Major Lenfant will go first to Brazzaville, where the real organisation of the expedition will take place; the mission will then proceed to Nola, the point of junction of the Mambere and the Kadei which form the Sangha. At Nola it is probable that some time will be spent in the study of the immense forest there. From Nola the mission will ascend the Mambere to Bania. Thus far it will have followed the route recently taken by Major Moll for the delimitation with a German mission of the Cameroon frontier. From Carnot Major Lenfant will plunge into the wilderness. His goal is Lake Laka, which is situated between the Upper Logone and the depression of the Tuburi which he has already traversed. His object is to trace the various navigable stretches permitting the linking, so far as possible by means of the river routes, of the basin of the Logone to that of the Sangha, and to establish between the Upper Logone and the Upper Sangha a direct trade route permitting France to dispense with the services rendered by the German colony.

A portrait of Robert Bunsen by Prof. Trübner, of Karlsruhe, is to be presented to the German Museum of Munich by the Grand Duke of Baden.

The Graefe medal of the German Ophthalmological Society has been awarded to Prof. Hering, of Leipzig.

Dr. Thoinot has been appointed professor of medical jurisprudence in the Paris Faculty of Medicine in succession to the late Prof. Brouardel.

The appointment of Prof. A. Gruvel, formerly of Bordeaux, to examine and report upon the sea and river fisheries of the French possessions in West Africa is announced.

Mr. William Lutley Sclater has resigned the directorship of the South African Museum, Cape Town, which he has held for the last ten years, and has returned to England. He has accepted the post of director of the

Colorado Museum, Colorado Springs, U.S.A., which is in connection with a large college recently established there. Before leaving Cape Town, Mr. Sclater completed the "Birds" of his series of the "Fauna of South Africa" by the issue of the fourth volume. It is to be hoped that his successor will be induced to carry on this important work to a conclusion.

MR. MICHAEL JOHN NICOLL, who recently returned from accompanying the Earl of Crawford as naturalist during his winter voyage in the *Valhalla*, R.Y.S., round Africa, has accepted the post of assistant-director of the Zoological Gardens at Giza, near Cairo, and has left England to take up the duties of his appointment.

THE Royal Economic Society is about to inaugurate an annual economic congress to be held in London in the January of each year. The first congress will take place on January 9 and 10, 1907, when it is hoped that many prominent economists, including visitors from foreign countries, will be present. It may be mentioned that Viscount Goschen, who has been president of the society from its inception in 1890, now resigns that position. The new president is the Right Hon. R. B. Haldane, M.P.

A COMMITTEE for the furtherance of cancer research has been formed by the Swedish Medical Society under the chairmanship of Prof. Berg.

WE record with much regret the death of Mr. James Dredge, C.M.G. (joint editor with Mr. W. H. Maw of *Engineering*), which occurred on Wednesday, August 15, at the age of sixty-six years. Mr. Dredge took great interest in the various international exhibitions held both in this country and abroad. He was created a Companion of the Order of St. Michael and St. George for his services as Commissioner-General for Great Britain at the Brussels Exhibition of 1897.

THE death is announced of Prof. S. Tomaselli, of the University of Catania; of Dr. Alexander Bogdanov, professor of pathology at Odessa; also of Prof. Léon Adrien Prunier, director of the Pharmacie centrale des Hôpitaux, and a member of the Paris Académie de Médecine.

AT the seventy-eighth annual meeting of the Association of German Men of Science and Physicians, which is to take place at Stuttgart from September 16–22 next, the following addresses will be delivered:—transplantation in surgery, by Prof. Garré, of Breslau; embryonal transplantation, by Dr. Speman; regeneration and transplantation in the animal kingdom, by Prof. Korschelt, of Marburg. In the medical section a report by Profs. Starling, of London, and Krehl, of Strassburg, will be presented on chemical correlations in the animal organism.

IN addition to the courses of lectures on "Hygiene in its bearing on School Life" and "Food and Meat Inspection," to which attention was directed in our issue of August 9, the Royal Sanitary Institute has arranged for the following courses:—the forty-second course of lectures for sanitary officers, commencing on September 10; the tenth course of practical training for meat inspectors, beginning on September 21; and "Sanitary Science as applied to Buildings and Public Works," from September 28.

THE following lectures are announced for delivery at the meeting of the Verband selbständiger öffentlicher Chemiker to be held in Dessau from September 23–25 next:—the founding of a chemical Reichsanstalt, Dr. Treumann; the need of reform in the wine laws, Dr. Kayser; on the radio-activity of the waters of health resorts, Dr. Aschoff; on the analysis of certain coals, Prof. Dr. Heyer; on the conditions imposed on industrial chemists when appointed, Dr. Treumann; modern milk hygiene, Dr. Lenze; demonstration of an apparatus for photomicrography, Dr. Wilhelm Lenz; modern methods of lighting, Dr. Thiele; on the preservation of secrecy of analytical methods, Dr. Vaubel; investigations of the phosphorus and sulphur compounds used in the manufacture of matches, Dr. Becker; the occurrence of manganese in well water and the determination of the same, Dr. Woy.

A TUBERCULOSIS museum, to which the public is to be admitted free, will, it is stated in the *British Medical Journal*, be opened at Darmstadt on August 29. The museum, which is the first of the kind in Germany, is intended for the instruction of the people in the nature of the disease and the means of its prevention. After two months the museum will be transferred to some other town, and so on through the whole of the Grand Duchy of Hesse.

ACCORDING to *Engineering*, some interesting experiments have recently been carried out on the military Berlin-Zossen railway line the object of which was to ascertain the value of a new invention to prevent trains from leaving the metals on account of faulty rails, breakages of wheels or axles, or other causes. In order to make the experiments as realistic as possible, 2 kilometres of line were given up to the purpose, and on this distance intentional derailments were effected, the experiments naturally being of interest to both the civil and military authorities. The German State Railways suffer, it is said, an annual expenditure of 250,000*l.* through damage done by derailments.

ALTHOUGH the hydrographic appropriation by Congress has been reduced, the investigation of underground waters in the eastern United States is still being conducted by the U.S. Geological Survey, and the work is to be extended later in the season.

AN economic investigation of iron-ore deposits in Utah, Colorado, and the Lake Superior region will, it is stated in *Science*, be conducted next year by Mr. C. R. Van Hise, of the U.S. Geological Survey. The mapping of the iron ores of the Iron Springs Special quadrangle of southern Utah was completed on July 1. A special topographic map on a scale of 1 : 45,000, with 50-feet contour intervals, has been made of an area of 225 square miles. The ore deposits themselves were mapped on a still larger scale of 250 feet to the inch. The maps and the report on the district will be published during the coming winter.

THE department of vertebrate palæontology of the American Museum of Natural History has, according to *Science*, no fewer than three expeditions at work this season. Mr. B. Brown is continuing the search for dinosaurs in the Cretaceous beds of Montana, Mr. W. Granger is searching for fossil mammals in the Eocene formations of Wyoming, and Mr. A. Thomson is exploring the later Tertiary formations of South Dakota.

ACCORDING to the *British Medical Journal*, an ingenious apparatus, invented by M. Chaulin, for the destruction of mosquitoes was recently presented to the Paris Academy. It is a simple kind of metallic cage formed of fine chains almost touching, and held rigid by two metallic rings above and below. This is suspended from the ceiling, an alternating electric current passes through the apparatus, and the insects, which are attracted by an electric light showing within, are literally electrocuted.

A SUBSTANCE that is spoken of as "a kind of celluloid" has recently been patented in Italy by an English inventor. Celluloid, as is well known, is largely used as a substitute for tortoiseshell in the manufacture of combs and other small articles, but the use has always been attended with a certain amount of risk from its inflammable nature. It is claimed for the new invention that in the most aggravated circumstances it will only carbonise, and not flow like a stream of melting sealing wax, setting fire to any inflammable substance that may happen to come in its way. The immunity from taking fire is secured by mixing glue, gum arabic, and colza oil with the original substance when in a liquid state, and purifying it from sediment by various processes, until it becomes perfectly clear, when it can be worked up to resemble any kind of tortoiseshell at a very much lower price.

OF the 728 persons who in 1905 underwent preventive treatment for hydrophobia at the Pasteur Institute in Paris, four only died of the disease, and in one of these cases the disease manifested itself before the completion of the treatment. Excluding this case, the total mortality shows a percentage of 0·54. In the preceding year the number of persons treated was slightly higher, being 755. The persons treated at the Paris Institute are divided into three categories, as follows:—(*a*) Where the presence of rabies in the animal which inflicted the bite has been proved experimentally by the development of the disease in animals which were bitten by it or were inoculated with its medulla; (*b*) where the presence of rabies in the animal which inflicted the bite has been confirmed by veterinary examination; (*c*) where the animals in question were supposed to be suffering from rabies. One hundred and sixty-six of the persons treated are comprised in class (*a*), 306 in class (*b*), and 255 in class (*c*).

A STRIKING proof of the value of the finger-print method of identifying criminals is to be found in the recently issued report of the Commissioner of the City Police. During the past year 1028 persons were arrested for offences under the Prevention of Crimes Act, such as being found in enclosed premises or in other circumstances suggestive of felonious intent. Of these individuals 562 were not recognised at the time of their apprehension as having previously been under arrest, but on their finger-prints being taken and compared with the Scotland Yard registers it was ascertained that 265 of them were old offenders.

RECOGNISING the danger to art which was entailed by the use of cheap aniline dyes, the Amir of Afghanistan some time ago forbade the entry into his territory of carpets coloured with such dyes. The Kashmir Durbar has now, according to the *Pioneer Mail*, taken a step which should assist materially in saving the various beautiful arts for which the vale of Kashmir is famous from deterioration or destruction. The Durbar has decided to charge a heavy duty of 45 per cent. on all aniline dyes at the frontier, and at a certain district within the frontier to confiscate and at once destroy them.

WHILE acknowledging the good results obtained in the past by the Forest Department, the Government of India has decided to make better provision for scientific research in connection with Indian forests by the appointment of six special officers for the branches of sylviculture, working plans, botany, zoology, chemistry, and economics to form an Imperial Forest Research Institute at Dehra Dun. The *Indian Forester* (June) contains a copy of the resolution and a short editorial note voicing the appreciation of the Service, and pointing out the necessity for working out sylvicultural problems for and in India. The editor also contributes a second article, with illustrations, on the types of forest rest-houses in India—the first article appeared in the February issue—contrasting the poor accommodation provided in Burma with the more substantial quarters found in the United Provinces.

PROF. A. H. R. BULLER has taken up a useful subject for research in making a study of the basidiomycetous fungus, *Polyporus squamosus*, that grows as a wound parasite on maples, elms, and other trees. An account dealing with the life-history of the fungus and its action on the wood of Acer is published as vol. i., No. 3, of the *Journal of Economic Biology*. As observers have noted for the spores of other basidiomycetes, germination is not easily effected; spores were germinated in artificial media, such as malt-wort extract and solutions containing peptone and asparagin, but the factors necessary to natural germination were not discovered. Prof. Buller has devoted a separate paper, published in the *Annals of Botany* (January), to his examination for ferments, in which his tests point to the presence of seven ferments, including amylase and emulsin, but the tests for maltase and invertase yielded negative results.

COLOURED drawings made by Prof. L. Errera in connection with his studies on glycogen and paraglycogen in the fungi, to which reference was made in NATURE, June 7, p. 134, have been discovered, and have been issued as part of vol. i. of the *Recueil de l'Institut botanique*, Brussels. The test consists in producing a distinct red or brown colour with a solution of iodide in potassium iodide, that disappears on heating strongly and reappears on cooling. A very marked reaction was obtained with the zoospore of *Polyphagus Euglenae*, with the young oidium of *Sphaerotheca Castagnei*, and with the young ascus of *Geoglossum hirsutum*.

ACCORDING to the report for the past year, the Boston (U.S.A.) Natural History Society is making satisfactory progress in the matter of exhibiting a complete collection of the fauna of New England. During the year specimens of moose and caribou have been installed, while the series of birds has been increased by specimens representing thirty-three species new to the collection.

IN an exceedingly interesting article published in the August number of the *American Naturalist* Prof. R. S. Lull discusses the various structural modifications for flight occurring in vertebrates. Inclusive of extinct forms, volant evolution, in the author's opinion, has occurred in seventeen distinct instances, ten of which are, however, merely adaptations for soaring leaps. Among these latter Mr. Lull includes the so-called flying-frogs (Rhacophorus), the volant powers of which have been denied, and the Sifaka lemurs (Propithecus) of Madagascar, the long leaps of which are said to be aided by a rudimentary patagium. In connection with flying-fishes, it may be noted that the author considers Colonel Durnford to have definitely proved the necessity for wing-vibrations. As regards pterodactyles, Mr. Lull is of opinion that while the long-tailed Rhamphorhynchus flapped its wings during flight, the gigantic Pteranodon of the Cretaceous had a sailing flight, with little or no wing-flapping, and may, indeed, have been unable to fly at all except on a windy day, when, by facing the wind, it would be able to rise to a considerable altitude before its inertia was overcome.

In connection with the foregoing paragraph we may take the opportunity of referring to the marked discrepancy in the matter of nomenclature which distinguishes the papers of systematic specialists from those of biologists with a wider range of studies. In Prof. Lull's paper, for instance, the flying-lemur is referred to by the time-honoured title of Galæopithecus, whereas in a recent paper by Mr. G. S. Miller (Proc. U.S. Nat. Mus., No. 1481) we find it figuring as Cynocephalus, a name until recently used for the baboons. As the president of the Bavarian Ornithological Society remarked in his address for 1904, in connection with the proposed transposition of the names *Turdus musicus* and *T. iliacus*, "all these changes of long-established names, even when the alteration was justifiable, should be most rigorously guarded against, as the greatest confusion would be the only result."

In addition to Prof. Lull's communication, the August number of the *American Naturalist* contains an article by Messrs. Dexler and Freund on the external morphology of the dugong, which is illustrated with reproductions from photographs throwing new light on the form of the muzzle. In the third article Mr. M. L. Hammatt describes the manner in which the anemone *Metridium marginatum* multiplies by fission. After either natural or artificial fission, "the fragment cut off curls together until its extremities meet, making parts of mesenteries before nearly parallel now radial in position, thus attaining to the sea-anemone structure with the least possible expenditure of energy."

In vol. xxii., art. 2, of the Bulletin of the American Museum of Natural History, Prof. H. F. Osborn publishes a complete description and restoration of the skeleton of the gigantic carnivorous dinosaur Tyrannosaurus from the Upper Cretaceous of North America. The creature stood about 16 feet, to the crown of the head, and there is a possibility that it may have carried an armour. The most remarkable feature in its osteology is the presence of a series of abdominal ribs comparable to those of the tuatera (Sphenodon), such structures having hitherto been unknown either among dinosaurs or crocodiles. The author states, however, that they have been found to exist in the allied genus Allosaurus, and suggests that they may also be represented in the herbivorous sauropodous dinosaurs, in which group they have been regarded as referable to the shoulder-girdle.

As a contribution to the Hann jubilee volume of the *Meteorologische Zeitschrift*, 1906, Dr. J. M. Pernter has selected the interesting subject of the determination of the size of cloud components from the phenomena of optical meteorology, *e.g.* halos and coronæ round sun and moon, and glories such as formed by the shadow of the observer, like the Spectre of the Brocken, &c. Among the first to undertake the measurements of the ice-crystals or minute rain-drops were Fraunhofer and Kämtz. Many of these measurements have been re-calculated, together with much additional information obtained chiefly from observations made on Ben Nevis, by using the revised formulæ of Airy and Verdet. These measurements are given in detail in several tables; the general conclusions arrived at are that both in clouds and fogs, up to the altitude of the highest clouds, the diameters of the ice-crystals are from about 5 μ to 20 μ, and that consequently 5 μ is the lower limit of the thickness of the ice-prisms. For rain-drops in clouds and fogs the diameters are found to be between 20 μ and about 100 μ. Dr. Pernter points out that these dimensions only hold good when no precipitation is falling, and further that it does not follow that still smaller ice-crystals, &c., may not be floating about in the clear atmosphere, their number being too few to cause any visible appearance of condensation.

In a memorandum (dated August 5) on the meteorological conditions in Egypt and the Sudan during July, Captain Lyons, director-general of the Survey Department, estimates that the Nile flood will be near the average this year, so far as information is at present available; the critical period is said to be the first ten days of August, as the volume of the flood depends on the level attained by the Blue Nile being maintained for a sufficient time during this month. The rainfall recorded at the principal stations around the Nile basin in July shows that the excess, which had been persistent since the beginning of the year, is now, however, replaced by a deficiency, while the fall over the Sudan plains has been somewhat above the average at most stations from which observations have been received.

The *Psychological Bulletin* (vol. iii., No. 4) contains an article by Prof. G. M. Stratton on the character of consciousness. The conclusion to which the writer comes is that consciousness is either the generical mark of all psychic processes or else a special one of these processes, viz. that of knowing. If, therefore, we apply the term consciousness to the act of cognition, "it should not be understood that knowing is the supreme function in the world of objects, or that it really breaks loose from those connections with feeling and will which modern psychology has recognised." Consequently, it seems to him that it would be best to say "knowledge" when we mean "knowledge," and to let the term "consciousness" designate the common and generic features of our psychic acts.

The *Bulletin de l'Institut Général Psychologique* (5e Année, No. 6) contains two interesting articles, one a full account of the marine laboratory at Wimereux, founded in 1874 by Prof. Giard, the other on the fifth international psychological congress held at Rome last year. A short account is given in this last of the dispute between Flechsig and Sciamanna regarding the localisation of functions in the frontal and pre-frontal regions. The former maintained that all the frontal region corresponded to the most elevated associations, the feelings of personality, of self-consciousness, and of self-control, and that to the pre-frontal region in particular belonged voluntary action. Sciamanna, after experiments on monkeys, came to the conclusion that in them, at any rate, the pre-frontal lobes could not be considered as the seat of intelligence, morality and the like, but that these higher functions ought to be considered, as a rule, the result of the regular and harmonious working of the cerebral mass as a whole, and that any disturbances consequent on lesion were to be attributed to the rupture of this complete harmony. A committee appointed to examine the monkeys before and after death confirmed Sciamanna's account of their undisturbed mental condition, but, on the other hand, found that the removal of the frontal lobes had not been so complete as Sciamanna believed.

The Manchester Microscopical Society has just issued a revised list of the lectures arranged for delivery by members of the extension section of the society during the coming winter. The object in view by the section is to bring scientific knowledge, in a popular form, before societies unable to pay large fees for professional lectures, and all fees paid for lectures are devoted to the working expenses of the section. Applications for the list by the secretaries of natural history and kindred societies should be made to the honorary secretary of the extension section of the Manchester Microscopical Society at 22 Filey Road, Fallowfield, Manchester.

Messrs. Wratten and Wainwright have sent us a batch of their panchromatic plates, which have been recently prepared in response to the demand for a plate having more uniform sensitiveness to the various spectral colours. Very searching tests on photographs of various spectral radiations show conclusively the unique qualities of the new emulsion. For instance, on a photograph of the spectrum of the iron arc the green region, usually difficult to obtain with such exposures as give the blue of normal density, is shown of actually greater density than the blue; at the same time, the red end of the spectrum is very uniformly rendered up to λ 7000, and with slightly longer exposure somewhat beyond this. This particular batch of plates was of medium rapidity, the sensitiveness measured to daylight being 94 H and D, 138 Watkins and F 94 Wynne. Development took about 3 minutes for most of the exposures tried, and the plates were clear and clean in working. An important factor in spectroscopic work is the fineness of the grain of the silver deposit, and in this respect the Wratten panchromatic is excellent. There is no doubt that for spectrum investigation extending over the whole region from ultra-violet to extreme red these plates are the most satisfactory at present obtainable. If one might be permitted to ask for further convenience, it would be to maintain the present colour sensitiveness ratios, and endeavour to increase the general rapidity. Should it be found possible to do this and, at the same time, keep the grain within reasonable bounds, this type of emulsion would be of immense service for stellar spectrum photography, as for this purpose a rapid plate is essential on account of the feebleness of the light. A notable feature of the instructions sent out with the plates is the provision (for the first time, so far as we are aware) of a table showing the normal time of development for varying temperatures. It is well known that the temperature of the developing solution has a considerable effect on the speed of appearance and subsequent growth of the latent image, and as the new plates are practically equally sensitive to all colours, requiring development in darkness, it is very advantageous to be able to control by time the correct duration of the process. The figures given for this purpose are not arbitrary, but have been obtained from exhaustive experimental trials, and can therefore be relied on without hesitation to give comparatively uniform results. The developer recommended is a very weak combination of metol hydroquinone, but excellent results have been obtained with other ordinary developers, some much more concentrated, so that no difficulty is likely to be found from this cause when the time best suited to the developer chosen is once determined.

Two more parts of Prof. O. D. Chwolson's "Traité de Physique," which M. A. Davaux is translating into French from the Russian and German editions, have been published in Paris by M. A. Hermann. The first parts of vols. i. and ii. were reviewed at length in our issue for February 15 last (vol. lxxiii., p. 362), and the present fascicles are the second parts of these volumes. The former deals with the gaseous state of bodies, and the latter with indices of refraction and the dispersion and transformations of radiant energy. As in the volumes reviewed on a previous occasion, the two new parts are provided with notes on theoretical physics by MM. E. and F. Cosserat.

Prof. H. Erdmann's "Lehrbuch der anorganischen Chemie," the fourth edition of which has just been published by Messrs. F. Vieweg and Son, Brunswick, is a comprehensive text-book containing nearly eight hundred pages and three hundred figures. The work presents a concise statement of the present position of inorganic chemistry; it should be of service, not only to students of chemistry, but also to those concerned with the study or progress of other branches of pure and applied science.

OUR ASTRONOMICAL COLUMN.

Comet 1906*d*.—From an observation made at Lyons on July 21, M. J. Guillaume recorded that Finlay's comet, on that date, had a nebulous appearance with diffuse edges, and that the central condensation was of the twelfth magnitude, the magnitude of the whole object being 11·5.

The observation also showed that the position given by M. Schulhof's ephemeris for that date needed but small corrections; a further abstract from the ephemeris is given below:—

Ephemeris (12h. M.T. Paris).

1906	α (app.) h. m. s.		δ (app.) ° ′		log Δ		$1:r^2\Delta^2$
Aug. 26 ...	5 6 19	...	+14 31	...	9·50197	...	10·25
28 ...	5 18 7	...	+15 18	...	9·51725	...	9·66
30 ...	5 29 17	...	+15 59	...	9·53258	...	9·08
Sept. 1 ...	5 39 51	...	+16 37	...	9·54783	...	8·53

The comet will pass about 1° south of 15 Orionis on August 26 (*Astronomische Nachrichten*).

A Memorial to the late Prof. Tacchini.—From No. 7, vol. xxxv., of the *Memorie della Società degli Spettroscopisti Italiani*, we are pleased to learn that an international subscription list has been opened for the purpose of founding some lasting souvenir in honour of that great Italian astronomer the late Prof. Tacchini.

A circular letter to this end has, evidently, already been addressed to the members of the society which he founded, and a goodly sum thus realised, but not sufficient to fulfil the object aimed at in a manner worthy of the occasion.

No doubt the fellow-workers and admirers of Pietro Tacchini, who did so much for the cause of astronomy, will be glad to have this matter brought to their notice, and to help forward the scheme. Subscriptions should be addressed to Prof. L. Palazzo, Directeur du Bureau Central de Météorologie et Géodynamique, Rome.

Report of the Paris Observatory for 1905.—Although M. Lœwy, in opening his report of the work done at the Paris Observatory during the year 1905, mentions that observations were curtailed owing to the preparations for the total eclipse of the sun, the lamented death of M. Paul Henry, the necessary alterations to the principal meridian circle, and other causes, it appears from the report itself that a great deal of work was prosecuted during the year.

The publications included twenty-seven sheets of the "Cart du Ciel" showing images of 39,697 stars, the ninth part of the photographic atlas of the moon, the second volume of the "Catalogue photographique du Ciel," giving the rectangular coordinates of some seventy thousand stars between declination +22° and +24°, and the *Annales* for 1902.

Two important pieces of work, the determination of the difference of lóngitude Greenwich-Paris, and the reduction of the magnitudes and positions of the stars in the cluster Messier 3, were completed.

The programme for the current year includes, among other things, the determination of the constant of aberration by M. Bigourdan, the measurement of stellar radial velocities by M. Hamy, and the photographical record of the ionisation of the atmosphere by M. Nordmann.

Italian Observations of the Total Solar Eclipse (1905).—An interesting illustrated report of the organisation, equipment, and results of the Italian observations of the total eclipse of August last is given by Prof. Ricco in No. 7, vol. xxxv., of the *Memorie della Società degli Spettroscopisti Italiani.*

When first organised, the eclipse party included Prof. Tacchini, and, on his lamented death, the programme proposed had, therefore, to be somewhat modified.

Finally, it was decided that the expedition should make its observations at Alcalà de Chivert, the programme including spectroscopic and direct observations of the prominences, photography of the corona, photographic observations of the spectrum of the eclipsed sun with a slit spectroscope and a prismatic camera, and observations of the solar radiation, the ionisation of the atmosphere, and the polarisation of the coronal radiations.

Although the work was interfered with by clouds, some interesting and valuable observations were made, and are recorded in the article referred to above.

The Spectra of Sun-spots and Red Stars.—In a previous paper Profs. Hale and Adams considered the question of the similarity of the spectra of sun-spots and of fourth-type stars, and arrived at the conclusion that the coincidences met with in comparing the spectra suggested the existence of spots, similar to those on the sun, on such stars. Their evidence was confirmed by Sir Norman Lockyer, who further suggested that the temperature conditions of fourth-type stars, taking the absorbing atmospheres as a whole, are about the same as those obtaining in the restricted region of a spot nucleus in the sun's photosphere, both the stellar and the sun-spot atmospheres having a lower temperature than that indicated by the ordinary Fraunhoferic solar spectrum. In a paragraph added to the present paper, reprinted as a Contribution from the Solar Observatory, Mount Wilson (No. 8), Prof. Hale acknowledges the possibility of this suggestion affording the true explanation. Prof. Hale's conclusion was examined by Dr. W. M. Mitchell, who compared his Princeton observations of spot spectra with the star spectra, and was unable to confirm the coincidences of the lines.

In a paper now communicated to No. 5, vol. xxiii., of the *Astrophysical Journal*, Profs. Hale and Adams point out that in the spectra of fourth-type stars the spot lines may be obliterated by bright lines, and that their apparent absence may not, therefore, be accepted as final evidence until better photographs of the fourth-type spectra can be obtained. Such spectra will probably be obtained when the 5-feet reflecting telescope is erected at Mount Wilson and a suitable spectrograph adapted to it. Comparing the spot spectra with the spectrum of α Orionis, the same observers show that the lines of the elements vanadium, titanium, and manganese, which are strongly affected in spot spectra, are also especially strong in this third-type star.

THE BRITISH ASSOCIATION.

SECTION G.

ENGINEERING.

Opening Address by J. A. Ewing, LL.D., F.R.S., M.Inst.C.E., President of the Section.

I intend to devote this Address to considering in certain aspects the inner structure of metals and the manner in which they yield under strain. It will not be disputed that this is a primary concern of the engineer, who in all his problems of design is confronted by the limitations imposed on him by the strength and elasticity of the materials he employs. It is a leading aim with him to secure lightness and cheapness by giving to the parts such dimensions as are no larger than will secure safety, and hence it is of the first importance to know in each particular case how high a stress may be applied without risk of rupture or of permanent alteration in form. Again, the engineer recognises the merit, for structural purposes, of plasticity as well as strength, and in many of his operations he makes direct use of that property, as in the drawing of wires and tubes or the flanging of plates. He is concerned, too, with the hardening effect that occurs in such processes when work is expended on permanently deforming a metal in the cold state, and also with the restoration to the normal condition of comparative softness which can be brought about by annealing. Nor can he afford to be indifferent to the phenomena of "fatigue" in metals, which manifest themselves when a piece is subjected to repeated alternations or variations of stress—fatigue of strength and fatigue of elasticity, which, like physiological fatigue, admits under some conditions of rest-cure, inasmuch as it tends to disappear with the lapse of time. No apology need be made in selecting for a Presidential Address to Section G a subject that touches so many points of direct practical interest to engineers. It is a subject which has for me the additional attraction of lying in the borderland between engineering and physics—a borderland in which I have often strayed, and still love to stray, and I enter it to-day even at the risk of wandering into regions which, to engineers, may seem a little remote from home, regions where the landscape has, perhaps, a suspicious likeness to that of the country over which the learned men of Section A hold rule.

To engineers, quite as much as to physicists and chemists, we owe in recent years an immense extension of knowledge regarding the structure of metals. This has come about mainly by the intelligent use of the microscope. Take any piece of metal, in the state in which an engineer makes use of it, polish and lightly etch its surface, and examine it under the microscope, and you find that it is a congeries of a multitude of grains, every one of which may be proved to be a crystal. It is true that the boundaries of each grain have none of the characteristics of geometrical regularity which one is apt to look for in a crystal, but the grain is a true crystal for all that. Its boundaries have been determined by the accident of its growth in relation to the simultaneous growth of neighbouring grains—the grains have grown, crystal fashion, until they have met, and the surface of meeting, whatever shape it may happen to take, constitutes the boundary. But within each grain there is the true crystalline characteristic—a regular tactical formation of the little elements of which the crystal is built up. It is as if little fairy children had built the metal by piling brickbats in a nursery. Each child starts wherever it happens to be, placing its first brickbat at random, and then piling the others side by side with the first in geometrical regularity of orientation until the pile, or the branches it shoots out, meets the advancing pile of a neighbour; and so the structure goes on, until the whole space is entirely filled by a solid mass containing as many grains as there have been nuclei from which the growth began.

We now know that this process of crystal growth occurs not only in the solidification of a metal from the liquid state, but in many cases during cooling through a "critical" temperature when the metal is already solid. We know also that the process may in certain conditions go on slowly at very moderate temperatures. We know also that the process of annealing is essentially the raising of the metal to a temperature at which recrystallisation may take place, though the metal remains solid while this internal rearrangement of its particles goes on. Whether crystallisation occurs in solidifying from the liquid or during the cooling of an already solid piece it results in the formation of an aggregate of grains, each one of which is a true crystal. Their size may be large or small—in general, quick cooling means that crystallisation starts from many nuclei, and the resulting grains are consequently small; with very slow cooling you get a gross structure made up of grains of a much larger size.

For simplicity of statement I shall ask you in what follows to confine your attention to simple metals, omitting any reference to alloys. Alloys present many complexities, into which we need not at present enter. With simple metals every crystalline grain is made of the same substance: the elementary brickbats are all exactly alike, though there may be the widest variation from grain to grain as regards the form of the grain, and also as regards the direction in which the elementary brickbats are piled.

In any one grain they are piled with perfect regularity, all facing one way, like a regiment of perfectly similar soldiers formed up in rows, where each man is equidistant from his neighbours, before and behind, as well as to right and to left. Or perhaps I might compare them to the well-drilled flowers of an early Victorian wall-paper.

It was shown by Mr. Rosenhain and myself[1] that when a piece of metal is strained beyond its limit of elasticity, so that permanent set is produced, the yielding takes place by means of slips between one and another portion of each crystal grain. A part of each crystal slides over another part of the same crystal, as you might slide the cards in a pack. It is as if all the soldiers to one side of a given line were to take a step forward, those on the other side remaining as they were, or as if all the men in the front rows took a step to the left, while those in the rows behind kept their places. In other words, the plasticity which a metal possesses is due to the possibility of shear on certain planes in the crystal that are called "cleavage" or "gliding" planes. Plastic yielding is due to the occurrence of this shear; it may take place in three or more directions in a single grain, corresponding to the various possible planes of cleavage, and in each direction it may happen on few or many parallel planes, according to the extent of the strain to which the piece is subjected. Examine under the microscope the polished surface of a piece of metal which has been somewhat severely strained after polishing, and you find that the occurrence of this shear or slip is manifested on the polished surface by the appearance of little steps, which show themselves as lines or narrow bands when looked at from above. To these we gave the name of slip-bands. Just as the piece of metal is an aggregate of crystal grains, the change of shape which is imposed upon it in straining is an aggregate effect of the multitude of little slips which occur in the grains of which it is made up. Each grain, of course, alters its form in the process.

Speaking broadly, this distortion of the form of any one grain by means of slips leaves it still a crystal. If part of the group of brickbats moves forward, keeping parallel to themselves and to the others, the formation remains regular, except that a step is formed on the outermost rows; the orientation of the elements continues the same throughout. Considerations which I shall mention presently lead to some qualification of this statement. I now see reason to believe that in the process of slip there is a disturbance of the elementary portions or brickbats adjoining the plane of slip, which may alter their setting, and thereby introduce to a small extent some local departure from the perfectly homogeneous orientation which is the characteristic of the true crystal. In very severe straining there may even be a wide departure from true crystalline character. We shall recur to this later; but meanwhile it will suffice to say that substantially the slip which is involved in a plastic strain of moderate amount is a bodily translation, parallel to themselves, of part of the group of elementary brickbats or molecules which build up the grain. If a crystal the form of which has been altered, even largely, by such straining is cut and polished and etched it appears, under the microscope, to be to all intents and purposes as regular in the tactical grouping of its elements as any other crystal.

Further, in the process of straining we have, first, an elastic stage, extending through very small movements, in which there is no dissipation of energy and no permanent set. When this is exceeded, the slip occurs suddenly; the work done in straining is dissipated; if the straining force is removed a strain persists, forming a permanent "set"; if it continues to act it goes on (within certain limits) producing augmented strain. In general a large amount of strain may take place without the cohesion between the gliding surfaces being destroyed. Immediately after the strain has occurred there is marked fatigue, showing itself in a loss of perfect elasticity; but this will disappear with the lapse of time, and the piece will then be harder than at first. If, on the other hand, a process of alternate straining back and forth be many times repeated, the piece breaks.

[1] Ewing and Rosenhain, "The Crystalline Structure of Metals," Bakerian Lecture, *Phil. Trans. Roy. Soc.*, vol. cxciii. A, 1899.

These are now familiar facts. Can we attempt to explain them on the basis of a molecular theory which will at the same time offer a clue to the process of crystal-building as we find it in metals? I venture to make this Address the occasion of inviting attention to some more or less speculative considerations which may be held to go some little way towards furnishing the material for such an explanation.

At the Leeds Meeting of this Association, in 1890, it was my privilege to bring forward certain contributions to the molecular theory of magnetism, and to show a model which demonstrated that the rather complex phenomena of magnetisation were explainable on the very simple assumption that the magnetic molecules are constrained by no other forces than those which they mutually exert on one another in consequence of their polarities.[1] From this were found to result all the chief phenomena of permeability and magnetic hysteresis. Let us attempt to-day to apply considerations of a similar character to another group of physical facts, namely, those that are associated with the crystalline structure of metals and with the manner of their yielding under strain. Just as in dealing with magnetic phenomena, I take as starting-point the idea that the stability of the structure is due to mutual forces exerted on one another by its elementary parts or molecules, and that the clue to the phenomena is to be sought in the play of these mutual forces when displacement of the molecules occurs.

Iron and most of the useful metals crystallise in the cubic system; for simplicity we may limit what has to be said to them. Imagine a molecule possessing polarity equally in three directions, defined by rectangular axes. We need not for the present purpose inquire to what the polarity along the axes is due; it will suffice to assume that the molecule has six poles, three positive and three negative, and that these repel the like and attract the unlike poles of other molecules. We may make a model by using three magnetised rods fixed at right angles to one another at their middle points. I imagine, further, that the molecule has an envelope in the shape of a sphere, which touches the spherical envelopes of its neighbours, and assume that these spheres may turn on one another without friction.[2]

Think now of the process of crystal-building with a supply of such spherical molecules for brickbats. Starting with one molecule, let a second be brought up to it and allowed to take up its place under the action of the polar forces. It will have a position of stability when a positive pole in molecule A touches (or lies in juxtaposition to) a negative pole in molecule B, with the corresponding axes in line, and when the further condition is satisfied that the axes in molecule B the poles of which are not touched by A are stably situated with respect to the field of force exerted by the poles of A.

In other words, we have this formation:—

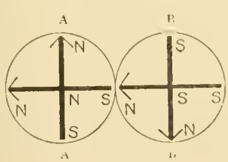


FIG. 1.

For convenience of representation in the diagram the poles are distinguished by the letters N. and S., but it must not be assumed that the polarities with which we are here concerned have anything to do with magnetism.

Suppose, now, that the crystal is built up by the arrival of other molecules, each of which in its turn assumes the position of maximum stability consistent with formation in

[1] "Contributions to the Molecular Theory of Induced Magnetism," *Proc. Roy. Soc.*, vol. xlviii., June 19, 1890, or *Phil. Mag.*, September, 1890.
[2] Or, let the envelope be a shell of any form, inside of which the axes of polarity are free to turn as a rigid system.

cubic or normal piling. The group in that case takes an arrangement which is essentially a repetition of this quartette :—

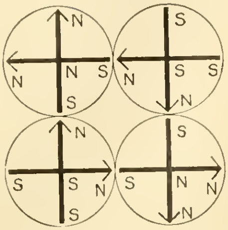


FIG. 2.

Along each row the polarity preserves the same direction, but the polarity of each row is opposite to that of each contiguous parallel row. This description applies equally to all three axes. The whole group (Fig. 3) consists of the quartettes of Fig. 2 piled alongside of and also on top of one another. In this way we arrive at what I take to be the simplest possible type of cubic crystal.

In this grouping each molecule has the alignment giving maximum stability, and it seems fair to assume that it will take that alignment when the crystal grain is formed under conditions of complete freedom, as in solidifying from the liquid state. As a rule, the actual process of crystal-building goes on dendritically; branches shoot out, and from them other branches proceed at right angles, leaving interstices to be filled in later. We have, therefore, to conceive of the molecules as piling themselves preferably in rows rather than in blocks, though ultimately the block form is arrived at. In this position of maximum stability each molecule has its six poles touching poles of contrary name.

Now comes a point of particular importance. Imagine two neighbouring molecules in the same block to be turned round, each through one right angle, in opposite senses. They will now each have five poles touching five poles of contrary name, but the sixth pole will touch a pole of the same name as itself. They are still stably situated, but much less stably than in the original configuration, and they will revert to that configuration if set swinging through an angle sufficient to exceed the limited range within which they are stable in the new position.

Similarly we may imagine a group of three, four, or more molecules, each to be turned through a right angle, thereby constituting a small group with more or less stability, but always with less than would be found if the normal configuration had been preserved. The little group in question may be made up of molecules in a row, or it

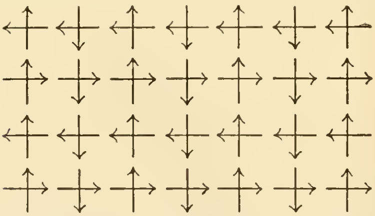


FIG. 3.

may be a quartette or block, or take such a form as a T or L. A sufficient disturbance tends to resolve it into agreement with the normal tactics of the molecules which build up the rest of the grain.

It is conjecturally possible that small groups of this kind, possessing little stability, may be formed during the process of crystallisation, so that here and there in the grain we may have a tiny patch of dissenters keeping one another in countenance, but out of complete harmony with their environment.

If this happens at all during crystallisation, it would seem less likely to happen in free crystallisation from a liquid state than in the more constrained process that occurs when a metal already in the solid state recrystallises at a temperature far below its melting-point. Though rare or absent in the first case, it might occur frequently in the second. There are differences in the appearance of crystal grains under the microscope in metal as cast and in metal as recrystallised in the solid state, of which this may be the explanation. It may also explain a difference pointed out by Rosenhain,[1] that the slip lines in cast metal are straight and regular, whereas in wrought iron and other metals which have recrystallised in the solid they rarely take a straight course across the crystal, but proceed in jagged, irregular steps. These may be due to the presence here and there of small planes of weakness, resulting from the existence of what I have called dissenting groups. Again, these groups, possessing, as they do, less stability than their normal neighbours, may be conjectured to differ from the normal parts of the grain in respect of electrolytic quality, and to be more readily attached by an etching reagent. Hence, perhaps, the conspicuous isolated geometrical pits that appear on etching a polished surface of wrought iron.

It will help in making clear these points, and others that are to follow, if we study the action of a model formed by grouping a number of polarised "molecules" in one plane, supporting them on fixed centres, about which they are free to turn. In the model before you the centres are uniformly spaced in rectangular rows, and the "molecules" are + shaped pieces of hardened steel, strongly magnetised along each of the crossed axes, each having, therefore, two north poles and two south poles. The third axis is omitted in the model, the movement to be studied with the help of the model being movement in one plane. On placing these "molecules" on their centres they readily take up the position already indicated in Fig. 3. Each one within the group has its four poles in close proximity to four poles of contrary name, and is, therefore, highly stable. If disturbed by being turned through a small angle, and let go, it swings back, transmitting a wave of vibration through the group, which is reflected from the edges, and is finally damped out in the model by pivot friction and air friction. We may assume some damping action (say by the induction of eddy-currents) in the actual solid, of which the model may be taken as a very crude representation.

By turning two molecules carefully round together, each through one right angle in opposite senses, we set up a dissenting pair, the equilibrium of which has feeble stability. A slight displacement, such as might be produced by the transmission of a vibrational wave, breaks them up, and they swing back to the normal configuration, giving out energy, which is taken up by the rest and is ultimately dissipated. By making the dissenting coterie consist of three or more we can give it additional strength.

An example is shown in Fig. 4, where the three molecules marked *a*, *b*, and *c* are turned round in this way.

Notice that the normal molecule *d*, adjoining a line of such dissenters, is in a peculiar position. His neighbours present to him three N. poles and one S. pole. He has the choice of conforming to the majority, or of throwing in his lot with the dissenters; and he has a third possible position of equilibrium (very feeble equilibrium) which is reached when his two S. poles are turned until the one neighbouring south pole faces just between them. I have laboured these points a little because they seem important when we come to speak of the effects of strain.

Consider now the straining action, which we may imitate in the model by sliding one part of the group past the other part. For this purpose the centres are cemented to two glass plates which can slide parallel to one of the axes.

[1] Rosenhain, "The Plastic Yielding of Iron and Steel," *Jour. Iron and Steel Institute*, No. 1 for 1904, p. 335.

At first, when the displacement by sliding is exceedingly small, the strain is a purely elastic one. The molecules adjacent to the plane of sliding pull one another round a little, but without breaking bonds, and if in this stage the strain is removed, by letting the plate slide back to its original position, there is no dissipation of energy. The work done in displacing the molecules is recovered in the return movement. We have here a representation of what happens between each pair of adjoining rows in the elastic straining of a metal. So far the action is within the limit of elasticity; it leaves no permanent effect: it is completely reversible.

But now let the process of straining be carried further. The opposing molecules try to preserve their rows intact, but a stage is reached when their resistance is overcome; the bonds are broken, and they swing back, unable to exert further opposition to the slip. The limit of elasticity has now been passed. Energy is dissipated; set has been produced; the action is now no longer reversible. The model shows well the general disturbance that is set up in molecules adjoining the plane of slip, which we may take to account for the work that is expended in a metal in producing plastic strain.

Moreover, when the slip on any plane stops and the molecules settle down again, the chances are much against their all taking up the normal orientation which they had before the disturbance. What I have called dissenting groups or unstable coteries are formed as a result of the disturbance. Here and there like poles are found in juxtaposition. Viewed as a whole, the molecular constitution of the metal in the region adjacent to the plane of slip

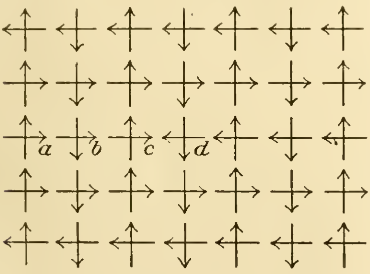


Fig. 4.

is now uncertain and patchy. It includes parts the stability of which is much less than normal. Individual molecules or small groups in it are very feebly stable; a touch would make them tumble into positions of greater stability.

Observe how all this agrees with what we know about the nature of plastic strain through experiments on iron or other metals. Its beginning is characteristically jerky. Once the critical force is reached, which is enough to start it, there is a big yield, which will not be stopped even by reducing the amount of the straining force.

Again, we know that there is a slow creeping action that continues after the straining force has done its main work. I ascribe this to the gradual breaking up of the more unstable groups which have been formed during the subsidence of disturbance in the earlier stage of the slip.

Further, we know that overstrained iron is very imperfectly elastic until it has had a long rest, or until it has been raised for a short time to a temperature such as that of boiling water.[1] This is to be expected when we recognise the presence of unstable individuals or groups resulting from the overstrain. When the elasticity of the overstrained piece is tested by removing and reapplying the load, some of these tumble into new positions, making inversible movements, which dissipate energy and produce hysteresis in the relation of the strain to the stress although the strain is quasi-elastic. At the ordinary temperature these unstable groups are gradually becoming resolved, no doubt through the action of the molecular movements that are associated with heat, and hence the slow progressive recovery of perfect, or nearly perfect, elasticity shown by the experiments of Muir. Let the temperature be raised and they disappear much more quickly; in warm surroundings the rest-cure for elastic fatigue does not need to be nearly so long.

Rosenhain[1] has recently shown that after the slip-bands on the surface of an overstrained specimen have been obliterated by polishing, traces of them will reappear on etching if only a short interval of time is allowed to lapse since the overstraining; but if time is given for complete recovery no traces are found. This is in remarkable agreement with the view now put forward, that the layers contiguous to the surface of slip contain for a time comparatively unstable groups. They are consequently different from the normal metal until the unstable groups are resolved, and the temporary difference manifests itself on etching, provided that is done while the difference still exists.

From the engineer's point of view a much more important matter than this fatigue of elasticity is the fatigue of strength that causes fracture when a straining action is very frequently repeated. Experiments which I made with Mr. Humfrey[2] showed that this action begins with nothing more or less than slight slip on surfaces where the strain is locally sufficient to exceed the limit of elasticity. An alternating stress, which makes the surfaces slip backwards and forwards many thousands, or it may be millions of times alternately, produces an effect which is seen on the polished surface as a development of the slip lines into actual cracks, and this soon leads to rupture.

We have, therefore, to look for an effect equivalent to an interruption of continuity across part or the whole of a surface of slip, an effect progressive in its character, becoming important after a few rubbings to and fro if the movement is violent, but only after very many rubbings if the movement is slight.

That there is a progressive action which spreads more or less into the substance of the grain on each side of the original surface of slip was clearly seen in the experiments referred to. It was found that a slip-band visible on the polished surface of the piece broadened out from a sharply defined line into a comparatively wide band with hazy edges, and this was traced to an actual heaping up of material on each side of the step which constituted the original line.

I think this suggests that under alternating stresses which cause repeated backward and forward slips, these do not occur strictly on the same surface in the successive repetitions, and hence the disturbance spreads to some extent laterally. It may be conjectured that slip on any surface leaves a more or less defective alignment of the molecular centres; that is to say, the rows on one side of the plane of slip cease to lie strictly in line with those on the other side. If this occurs over neighbouring surfaces, as a result of slips or a number of parallel planes very close together, the metal throughout the affected region loses its strictly crystalline character, and with it loses the cohesion which is due to strict alignment.

Mr. G. T. Beilby, in a very suggestive paper,[3] has advanced grounds for believing that portions of a metal may pass from a crystalline to an amorphous formation under the mechanical influence of severe strain, as in the hammering of gold leaf or the drawing of wire, and that this occurs in the polishing of a metallic surface, and also in the internal rubbing which takes place at a surface of slip within the grain. In both cases he suggests the formation of an altered layer. When a polished metal surface is etched, the altered layer is dissolved away, and the normal structure below it is revealed.

Without accepting all Mr. Beilby's conclusions, I think the idea of an altered and more or less amorphous layer is supported by the considerations I am now putting forward. We have assumed that in normal crystallisation the intermolecular forces lead to a normal piling, in which

[1] J. Muir, "On the Recovery of Iron from Overstrain," *Phil. Trans.*, vol. cxciii. A, 1900.

[1] *Journ. Iron and Steel Institute*, 1900.

[2] Ewing and Humfrey, "The Fracture of Metals under Repeated Alternations of Stress," *Phil. Trans.*, vol. cc. A, 1902.

[3] Beilby, "The Hard and Soft States in Metals," *Phil. Mag.*, August, 1904.

each molecule touches six neighbours. But it may be conjectured that some of them may take up pyramidal piling (touching twelve others) under the compulsion of strong forces—such forces, for example, as act on the superficial molecules of a surface that is being polished.

If this also occurs at a surface of slip, it gives us a clue to several known facts. It at least assists in explaining the familiar result that metal is hardened by straining in the sense of being made less plastic. Again, it accounts for the general increase of density which is found to take place in such an operation as wire drawing. Further, if a local increase of density occurs in the interior of a grain through piling of some molecules in the closer manner where repeated slips are going on, the concentration of material at one place requires it to be taken from another; in other words, the closer piling tends to produce a gap or crack in the neighbourhood where it occurs. This is consistent with what we know of the development of cracks through repeated alternations of strain.

Recourse to the model shows that with pyramidal piling the polar axes point in so random a manner that the aggregate may fairly be called amorphous. To illustrate this a group is shown with centres fixed at the corners of equilateral triangles.

It is obvious that any pyramidal piling at a surface of slip tends to bar further slip at that particular surface. Hence not only the augmented hardness due to strain, but the tendency in repeated alternations to lateral spreading of the region on which slip occurs. The hardness due to straining is, of course, removed when we raise the metal to such a temperature that complete recrystallisation occurs, normal piling being then restored in the new grains.

Taking a previously unstrained piece, it is clear that the facility with which slip will occur at any particular surface of slip in any particular grain depends not only on the nature of the metal and on the orientation of the surface in question to the direction of the stress, but also on the amount of support the grain receives from its neighbours in resisting slip there. In other words, for a given orientation of surface the resistance to slip may be said to consist of two parts; one is inherent in the surface itself, and the other is derived from the position of the grain with reference to other grains.

To make this point clear, think of a grain (under stress) in which there is a gliding surface oriented in the most favourable direction for slipping. Slip on this surface can take place only when its yielding compels the neighbours (which are also under stress) to yield with it, and the surfaces in these on which slip is compelled to occur are, on the whole, less favourably situated. Hence the original grain cannot yield until the stress is considerably in excess of that which would suffice to make it yield if it stood alone, or had neighbours equally favourably inclined.

Apply this consideration to the case of steel, where there are two classes of grains: the ferrite, which is simply iron, and the pearlite, which is a harder structure. Slip on any ferrite grain is resisted partly by the strength of the surface itself, and partly by the impossibility of its yielding without forcing slip to take place on neighbouring (harder) grains. Now suppose the structure is a very gross one, such as Mr. Stead has shown may be found in steel that is seriously overheated. On the large grains of ferrite in overheated steel the resistance to slip will be but little greater than it would be in iron, and, consequently, under an alternating stress fatigue of strength, leading to rupture, may be produced by a very moderate amount of load. Mr. Stead[1] has shown how the effects of overheating can be removed by the simple expedient of raising the steel to a temperature sufficient to cause recrystallisation—a homœopathic remedy that transforms the gross structure of the overheated metal into an ordinarily fine structure, where no ferrite grain can yield without compelling the yielding of many pearlite grains. Hence we find, as Rogers[2] has demonstrated by experiment, that steel cured by reheating from the grossness of structure previously produced by overheating, has an immensely increased power to resist the deteriorating effects of often repeated stress.

[1] See especially a paper by J. E. Stead and A. W. Richards on "The Restoration of Dangerously Crystalline Steel by Heat Treatment," *Journ. of the Iron and Steel Inst.*, No. 2, 1903.

[2] F. Rogers, "Heat Treatment and Fatigue of Steel," *Journ. Iron. and Steel Inst.*, No. 1, 1905.

I trust you will not feel I have abused the license of the Chair in presenting contributions to molecular theory that are for the most part in the nature of speculative suggestions, thrown out in the hope that they may some time lead to fuller and more definite knowledge. Remote as they may seem to be from the concerns of the workaday engineer, they relate to the matter which it is his business to handle, and to the *rationale* of properties, without which that matter would be useless to serve him. We have attempted to penetrate into its very heart and substance in order the better to comprehend the qualities and functions on which the practical work of engineering relies. The man whose daily business leads him through familiar tracks in a forest does well to stray from time to time into the shady depths that lie on either hand. The eyes of his imagination will be opened. He will at least learn his own limitations, and, if he is fortunate, he may gain some clearing on a hilltop which commands a wider view than he has ever had before.

SECTION I.

PHYSIOLOGY.

OPENING ADDRESS BY PROF. FRANCIS GOTCH, M.A., D.Sc., F.R.S., WAYNFLETE PROFESSOR OF PHYSIOLOGY IN THE UNIVERSITY OF OXFORD, PRESIDENT OF THE SECTION.

"THE investigators who are now working with such earnestness in all parts of the world for the advance of physiology have before them a definite and well-understood purpose, that purpose being to acquire an exact knowledge of the chemical and physical processes of animal life and of the self-acting machinery by which they are regulated for the general good of the organism."[1]

In this admirable and concise manner the late Sir John Burdon-Sanderson described the aims and methods of physiology. The words were spoken in 1881, when the British Association last met in this historic city. At that time the subjects of Anatomy and Physiology formed a subsection of the Section of Biology, and it was presided over by this distinguished man, whose recent death has deprived not only physiology but natural science of one of its most honoured leaders. His continuous work, extending over a period of fifty years, was remarkable from many points of view, but in none more than the extent of its scope. Sanitary science, hygiene, practical medicine, botany, pathology, and physiology have all been illuminated and extended by his researches. His claim for being included among the great names in English science does not rest merely upon his acknowledged eminence as an original and exact investigator, but also upon the influence which, for four decades, he exerted upon other workers in medical science, endowing their investigations with purpose and materially helping to give English physiology and pathology their proper scientific status. Many circumstances contributed to make this influence widely felt; among these were the peculiar charm of his manner, his striking and commanding personality, the genuine enthusiasm with which he followed the work of others, the devotion with which he advocated the use of experimental methods, his scientific achievements, and his extensive knowledge. All these qualities of mind and character marked him as one of those great masters who inspire the work and mould the thought of a generation. It is in tribute to his memory that, as one of his pupils and his successor in the Oxford Chair of Physiology, I utilise this occasion for recalling such fruitful features of his scientific conceptions as are expressed in the felicitous phrase which I have quoted.

Probably the most important of the many services which Burdon-Sanderson rendered to English medical science was that of helping to direct physiological and pathological inquiry towards its proper goal. It will be admitted by all who knew him intimately that among his most characteristic scientific qualifications were the insight with which he realised the essence of a physiological problem,

[1] Address to the Subsection of Anatomy and Physiology, by J. Burdon-Sanderson, *British Association Report*, York, 1881.

and the tenacity with which he kept this essential aspect in view. The faculty which enables the mind to review the varied aspects of complex phenomena and to determine which of these are mere incidents, or external trappings, and which constitute the core of the subject, is one which every scientific worker must possess in a higher or lower degree; it may, indeed, be confidently asserted that scientific training is successful only in so far as it develops a nice and just discrimination of this character. Many attain this capacity after several years of labour and effort; but in the case of rare and gifted individuals its possession comes so early as to seem almost an intuitive endowment. In 1849, during his student days at Edinburgh, Burdon-Sanderson showed by the character of his earliest scientific work that he viewed the proper aim of physiological inquiry as essentially the study of processes. At the present time it may appear superfluous to dwell upon the importance of this standpoint, but fifty-seven years ago this aspect of the subject was rarely, in this country, a stimulating influence in physiological work, whilst, as regards pathology, the point of view taken by Burdon-Sanderson was, even in 1860, probably unique.

The obvious fact that living processes occur in connection with certain definite structural forms transferred attention from the end to one of the means, and thus education and research in physiology and pathology were almost entirely confined to the elucidation of that structural framework in which the essential processes were now displayed and now concealed. Improved methods of microscopic technique revealed the complexity of this structure, and minute anatomy absorbed the interest of the few physiologists and pathologists who prosecuted researches in this country. Even when attention was directed to the living processes, it was with an unconscious anatomical bias, and detailed descriptions of structural framework were advanced as affording a sufficient scientific explanation of the character of the subtle processes which played within the structure. Yet upon the Continent the great physiologists of that time had long realised that physiological study must ascertain the characters of these processes, and that research conducted along experimental lines could alone advance scientific physiology as distinct from scientific anatomy. In 1852 Burdon-Sanderson went from Edinburgh to Paris to study the methods used in physics and chemistry. Whilst there he came under the inspiring influence of one of these great Continental physiologists, Claude Bernard, and his views as to the proper end of physiological inquiry received from this master ample confirmation. The sentence which I have quoted from the York address sets forth with scientific precision his enlarged conception of living phenomena, for whilst it asserts that the characteristics of processes form the true aim of all physiological investigation, it defines the particular processes which should be investigated as chemical and physical, and it particularises two further aspects of these, the machinery for their coordination described as self-acting, that is automatic, and the *raison d'être* of their occurrence, which is said to be the welfare of the whole organism. All these various aspects are strikingly exemplified in the progress of physiology in this country and in the researches now being carried on both at home and abroad; their consideration may thus be not inappropriate in a general address such as it is my privilege to deliver to-day.

At the outset it is desirable to refer to certain wide issues which are involved in the statement that the business of the physiologist is "to acquire an exact knowledge of the chemical and physical processes of animal life." The limitation of physiology to ascertainable characters of a chemical and physical type does not commend itself to certain physiologists, physicists and chemists, who have revived under the term "neo-vitalism" the vitalistic conceptions of older writers. They deny that physiological phenomena can ever be adequately described in terms of physics and chemistry, even if these terms are in the future greatly enlarged in consequence of scientific progress. It is undoubted that there are many aspects of living phenomena which in the existing state of our knowledge defy exact expression in accordance with chemical and physical conceptions; but the issues raised have a deeper significance than the mere assertion of present ignorance, for those who adopt "neo-vitalism" are prepared to state not only that certain physiological phenomena are, from the chemical and physical point of view, inexplicable to-day, but that from the nature of things they must for ever remain so. This attitude implies that it is a hopeless business for the physiologist to try by the use of more appropriate methods to remove existing discrepancies between living and non-living phenomena, and this is accentuated by the use of a peculiar nomenclature which, in attributing certain phenomena to vital directive forces, leaves them cloaked with a barren and, from the investigator's point of view, a forbidding qualification.

It is of course possible in describing phenomena to employ a new and special terminology, but since many aspects of the phenomena of living processes can be described in accordance with physical and chemical conceptions, the creation of a vitalistic nomenclature duplicates our terminology. A double terminology is always embarrassing, but it becomes obstructive when it is of such diversity that description in the one can never in any circumstances bear any scientific relation to that in the other. In this connection it is somewhat significant that the one kind, namely vitalistic, is abandoned as soon as the observed phenomena to which it referred have been found to be capable of expression in terms of the other. The reason for this abandonment raises questions of principle, which appear to me to render it impossible for a scientific physiologist seriously to employ vitalistic nomenclature in describing physiological phenomena. Science is not the mere catalogue of a number of observed phenomena; such a miscellaneous encyclopædia may constitute what many people would describe as knowledge; but science is more than this. It is the intellectual arrangement of recognised phenomena in a certain orderly array, and the recognition of any phenomenon is only the first step towards the achievement of this end. The potent element in science is an intellectual one essentially connected with mental grouping along one particular line, that which tends to satisfy our craving for causative explanation. Hence it involves the intellectual recognition of widespread characteristics, so general in their distribution that they are termed fundamental. The most fundamental of such characteristics are those which possess the widest intellectual sphere, and in natural science these are the broad conceptions of matter and motion which form the essential basis of both chemistry and physics. If this grouping is, in regard to any phenomenon, at present impracticable, then this subject-matter cannot be justly regarded as forming a part of natural science, though it might be considered as natural knowledge, and in so far as this is the case in physiology it appears to me to be a confession of present scientific ignorance. If, however, it is boldly asserted that the nature of any phenomenon is such that it can never by any possibility be brought into accord with the broad conceptions which I have indicated, then I fail to understand how it can claim to bear any relation to natural science, since, *ex hypothesi*, it can never take its proper place in the causative chain which man forges as a limited but intelligible explanation of the world in which he lives. Only in so far as physiological phenomena are capable of this particular intellectual treatment and take part in this intellectual construction can we hope to obtain, however dimly, a knowledge of permanent backgrounds among the shifting scenes of the living stage, and thus, by gradually introducing order amidst seeming confusion, claim that gift of prevision which has long been enjoyed by other branches of natural science.

Neo-vitalism, like its parent vitalism, is fostered by the imperfect and prejudiced view which man is prone to take in regard to his own material existence. This existence is, for him, the most momentous of all problems, and it is therefore not surprising that he should assume that in physiology, pathology, and, to a lesser degree, in biology, events are dealt with of a peculiarly mystic character, since many of these events form the basis of his sensory experience and occur in a material which he regards with a special proprietary interest. He is reluctant to believe that those phenomena which constitute the material part of his existence can be intellectually regarded as processes of a physicochemical type, differing only in complexity from those exhibited in the non-living world, and impelled by this reluctance he fabricates for them, out of his own conceit, a special and exclusive realm. The logical pressure of physical and chemical conceptions forbids the postulation, by either the public or the neo-vitalist, of such an incongruous entity as a vital chemical element capable of blending with the familiar chemical elements recognised in the material world; yet the physiological processes of life are in popular estimation still held to be due to peculiar forces blending with those of the material world, but so essentially different that they can only be described as "vital." The neo-vitalistic school of men of science, without adopting this popular view in its entirety, retains the same term for such physiological characteristics of cell processes as, with our present limited knowledge and with our present inadequate methods of investigation, seem to be in disagreement with present chemical and physical conceptions. This disagreement is accentuated by the assumption of directive vital forces, and since these cannot be ranged alongside those of chemistry and physics, transcendental phenomena may be always expected to occur the orderly array of which as part of natural science is not merely a futile but on *a priori* grounds an absolutely impossible task. In order to justify this description as representing the views of some neo-vitalists, I will quote a few sentences from the presidential address delivered in 1898 by Prof. Japp in the Chemical Section of this Association. This address dealt with the formation of the optically active substances found in vegetable and animal tissues or their extracts. It asserts that "the absolute origin of compounds of one-sided symmetry to be found in the living world is a mystery as profound as the origin of life itself." In regard to this it may be remarked that the absolute origin of anything, living or non-living, is a mystery which science does not attempt to solve, relative not absolute causation being the object of scientific grouping, hence this assertion does not necessarily imply any fundamental distinction between the two classes of phenomena. But there is more than appears upon the surface, for the whole argument leads up to the sweeping statement that "no fortuitous concourse of atoms, even with all eternity for them to clash and combine in, could compass this feat of the formation of the first optically active organic compound." It is thus inferred that because the manner of such formation cannot be accounted for in the present condition of scientific knowledge, its scientific causation is from the nature of things unknowable. However, although unknowable in the strictly scientific sense, the intellectual craving for causative explanation of some sort urges Prof. Japp to say, "I see no escape from the conclusion that at the moment when life arose a directive force came into play." There is here introduced a grandiose term for life which is viewed as involving directive forces; the term, however, adds nothing to our physiological knowledge, is not in itself explanatory, and not only offers no new method of physiological investigation, but brands as useless all the methods derived from physics and chemistry, past, present, and future. In a recent work Prof. Moore has attempted to set forth a conception which shall be vitalistic in essence, and yet not so completely out of touch with the principles of natural science.[1] He regards living cells as transformers of energy and thus leaves them absolutely dependent upon its receipt; the transformed mode which is achieved by the cells is, however, one which cannot be interpreted in terms of the familiar modes presented in the non-living world. He terms the transformed mode "biotic energy," and the distinction between this and "vital directive force" appears to be its absolute dependence upon the other modes for its appearance. It thus does not run counter to the law of the conservation of energy, and warrants, in the opinion of some, the confident expectation that it will be found capable of precise scientific expression. I confess that I am unable to share this confidence. The introduction of the conception entails the same double terminology to which I have referred, and I feel convinced that the assumption, in the case of any given physiological phenomena, of biotic energy as a causative explanation, would be immediately abandoned if the phenomena were subsequently found to be explicable on physical and chemical conceptions. Biotic energy appears to me as only an intellectual compromise, an abortive attempt to clothe the naked form of vitalism in a decent scientific dress; but, although partially clothed, it offers, like neo-vitalism, no new method for physiological investigation, and must, in consequence, remain barren, never contributing towards physiological achievement. To what extent its adoption may be an intellectual solace is a question which does not fall within the scope of physiology. Certain physiological phenomena are especially brought forward as necessitating the assumption of vitalistic or biotic conceptions; among these are the phenomena of nervous activities, the formation and activities of enzymes, and the passage of substances through living membranes. The question of the nervous activities will be dealt with later; but as regards the diffusion of gases or substances in solution through cellular membranes a few general considerations may be advanced now.[1] The passage of substances into and through non-living membranes is modified in regard to both the velocity and the selective character of the passage by a large number of factors, among which are nature of substance, pressure, osmotic index, temperature, and the structural, electrolytic, and chemical characters of the membrane. Tissue membranes, whether animal or vegetable, possess a complicated particulate structure, and it is obvious that experiments must be carried out extensively on dead tissue membranes in order to determine how far the general particulate arrangement may modify the rate and character of the passage. In this respect our present information is not sufficiently extensive to warrant any definite general statement, and such experimental evidence as exists opens up difficult problems in molecular physics which still await solution; moreover, the presence of electrolytes, by assisting adsorption, appears to modify the apparent rate and character of the total passage, and further experiments are necessary on this point. But in the living membrane, especially when it is composed of cellular units, the whole question is additionally complicated by the great probability that the cells are the seat of chemical processes the nature of which is imperfectly known; such processes constitute the metabolism of the cells. It would, therefore, be somewhat surprising if the phenomena of the passage of substances through such cellular membranes were in strict accord with the passage of similar substances through non-living membranes which have not the same particulate framework and are not the possible seat of similar chemical processes. The statement, therefore, that any discrepancy between the two classes of phenomena necessitates the assumption of a peculiar vital directive force disregards the circumstance that between the conditions in the one case and those in the other lies a large and little explored field; moreover, such a statement implies, without any warrant, that any physico-chemical explanation must necessarily be insufficient in the case of the living membrane, although it is realised that there may be active chemical processes of the operations of which we have at present little exact knowledge.

What possible justification is there, therefore, for branding as hopeless all further physical and chemical investigation of certain aspects of the phenomena by attributing these to vital directive forces? The gaps and imperfections of the palæontological record were triumphantly vaunted by the opponents of evolution; and now that the work of successive years has convincingly contributed towards the filling up of these gaps not only has this objection collapsed, but the hypothesis of special creations which it supported has been involved in its fall. There are indications that the discrepancies in diffusion phenomena through widely different structures may be knit by the results of experiment on intermediate modifications. It may be many

[1] See article by B. Moore in "Recent Advances in Physiology and Biochemistry." Edited by L. Hill, F.R.S. (London: Arnold, 1906.)

[1] The conception of Ostwald as to the action of catalytic substances is extremely suggestive in connection with the activities of enzymes, both intracellular and extracellular. It is possible that the changes brought about by enzymes may, with the growth of our knowledge in physical chemistry, be shown to be of the same order as those which slowly occur in the absence of enzymes, and that the enzyme itself by facilitating adsorption phenomena may merely act by accelerating the velocity of the special change. See Leathes, "Problems in Animal Metabolism" (London: Murray, 1906).

years before these are completed, but the introduction of vitalism or biotic energy as a fictitious causative explanation is so opposed to the spirit and the progress of science that we may safely predict the complete abandonment of this position at a comparatively early date.

I venture now to define my own position in regard to this matter. I assert that, although the complexity of living tissues makes our present knowledge extremely limited, it is essentially unscientific to say that any physiological phenomenon is caused by vital force or is an argument in favour of "vitalism," and that, if this phraseology is offered as a sufficient description of the phenomenon, its further scientific study is prejudiced because the only terminology which admits of scientific exactitude is excluded. I assert, further, that if the term "vitalism" connotes no more in physiology than the term "living," its employment does not in any way enlarge our intellectual view of the subject-matter of physiology, and can only be considered either as meaningless tautology or as an expression of faith; but if the term has some additional, occult, and mystic significance, then its employment is detrimental to the progress of physiology, exerting as obstructive an influence upon the growth of our science as the conception of special creation exerted upon the progress of biology.

Vitalism is not the only "ism" which, perhaps unwittingly, obstructs physiological progress; it is, however, far more worthy of respect than others which I do not propose to particularise, for it is a twig of that lusty tree which, in philosophy, still claims the largest share of men's belief. The vitalist, leaving the more solid ground of physics and chemistry, enters the realm of metaphysics and there attaches himself to that distinguished circle of idealists whose pedigree extends back to Plato. If, as may be asserted with great confidence, idealism in philosophy will endure as long as thought exists, then it might be expected that vitalism in physiology will never entirely cease. The history of physiology, however, reveals the fluctuating extent of its influence. Potent a century or more ago, vitalism nearly disappeared between 1850 and 1870 under the pressure of the application of physical and chemical methods to physiology; it revived again towards the century's close, the ripple of a wide-spreading wave of idealistic philosophy. Materialism and idealism have been described by Huxley as appearing in the history of philosophy like "the shades of Scandinavian heroes eternally slaying one another and eternally coming to life again." As a physiologist, I do not venture to touch however lightly upon this metaphysical duel, since I frankly admit my own incapacity to do so and the particular applicability to my own powers of the words of Gibbon that "it is much easier to ascertain the appetites of a quadruped than the speculations of a philosopher." It is therefore without any intention of casting any suspicion of doubt upon the confidence felt as to the persistence of idealism in philosophy that I suggest that neo-vitalism in physiology bears upon its surface the signs of its own decay. One such sign is the circumstance that even its most ardent exponents refuse to follow the lead of this *ignis fatuus*, but assiduously investigate living processes by the most improved chemical and physical methods; another is that when any so-called vitalistic aspect of some physiological phenomenon is rendered explicable on physical and chemical lines, the vitalist abandons in this instance his peculiar standpoint. Neo-vitalism has of late thus lost its corrosive character; it now spreads as a thin but tenacious film over physiological conceptions and is in this way mildly obstructive, but its obstructive viscosity is continually yielding to the accumulating mass of the more precise knowledge which it endeavours to obscure. Research along physical and chemical lines into physiological processes is its uncompromising opponent, so that there is every reason for believing with Huxley that the weight and increasing number of those who refuse to be the prey of verbal mystifications have begun to tell.

The recent history of physiological progress shows that investigations confined to the study of physical and chemical processes have been the one fruitful source of physiological knowledge. It would be impossible to give even a brief survey of the chief results which have, during the last twenty years, been thus obtained. Out of the enormous wealth of material I select one of great importance and promise. It is that of the constitution of the nitrogenous compound familiarly known as proteid, which from its close association with protoplasm, the physical basis of life, has a fundamental significance and has therefore attracted the attention of many competent investigators. Important researches have been made on this subject by physiological chemists, notably Hofmeister and Kossel, and at the present time the subject is also being studied by one of the ablest organic chemists of the day, Emil Fischer, whose previous work on carbohydrates is so illuminating.[1] In the splendid chemical laboratory at Berlin, with its unparalleled equipment, a succession of researches have been carried out dealing not only with the constitution of the simpler proteid derivatives, but also with the important and difficult problem of the synthetic grouping of these derivatives into more complex compounds. The success which has so far attended these investigations is so pronounced as to encourage the hope that the future may reveal the chemical constitution of proteid itself and thus bring us perceptibly nearer to its possible synthetic formation. We congratulate ourselves that this problem has at last attracted the earnest attention of organic chemists.

I now invite your attention to those further aspects indicated in the opening sentence of this address, which imply the presence of automatic mechanisms by which the various processes of the body organs are regulated and coordinated for the welfare of the whole organism.

Many such automatic mechanisms are now known. Some of these are of an obvious chemical type, the mechanism being the production in minute quantity of chemical substances which are conveyed to remote organs by the circulating blood. In this way adrenalin, a substance elaborated by the medullary portion of the suprarenal organs, augments the activities of the muscles, particularly those of the arterioles. From his recent researches, Langley[2] is disposed to believe that many chemical compounds which augment or diminish the activity of muscles and glands do not act by altering the differentiated tissue, but play upon a hypothetical receptive substance which lies at the junction of the tissue with its entering nerves. This middleman, so situated as to lie in the interstices of the neuro-muscular junction, bears a relation to the muscle or gland-cell somewhat analogous to that which the fulminating cap bears to the cartridge, and it is quite conceivable that it is maintained in an appropriate condition of instability or explosiveness by the direct action of chemical substances conveyed to it in minute amounts by the blood.

It is remarkable how many of these strictly chemical automatic mechanisms have been discovered in the last few years, thus substantiating the views of Brown-Séquard. The automatic character of the mechanism which determines the secretion of the pancreatic fluid was revealed by the experiments of Bayliss and Starling, which showed that definite chemical compounds are formed in the lining cells of the small intestine, and that treatment with weak acid, such as occurs in the acid chyme, liberates a substance which, absorbed into the blood, has the special function of stimulating the pancreatic cells.[3] A similar automatic mechanism has been found by Edkins to exist in the stomach, for although the flow of gastric juice is initiated by nervous channels, the subsequent peptic secretion is largely augmented through the presence in the blood of chemical substances elaborated and absorbed in the pyloric portion of the stomach wall.[4] Marshall and Jolly have recently shown that substances elaborated in the maternal ovaries, and particularly in the corpus luteum,[5] determine, when introduced into the circulating blood, the changes necessary for the proper attachment of the embryo to the uterine wall and thus the further development of the embryo during the first stages of pregnancy. The researches of Starling and Miss Lane-Claypon indicate

[1] F. Fischer, *Berichte Deutsch. Gesellschaft*, xxxviii 1905. (See also "La synthèse des matières protéiques," par L. C. Maillard. *Revue Générale des Sciences* Févr. 1906 Paris.)

[2] J. N. Langley, *Journ. of Physiol.*, xxxiii. 1905, p. 374, and Croonian Lecture. Roy. Soc., 1906.

[3] Bayliss and Starling. *Journ. of Physiol.*, xxviii. 1902, p. 325.

[4] Edkins, "On the Chemical Mechanism of Gastric Secretion," *Proc. Roy Soc.*, B. lxxvi., 1905, p. 376.

[5] Marshall and Jolly, *Phil. Trans. Roy. Soc.* London, B, 1905, p. 198.

that chemical substances formed during pregnancy in the tissues of the fœtus will, if introduced into the maternal blood, directly evoke the appropriate activities of the remote mammary glands.[1]

These are only a few instances of a class of mechanisms, strictly chemical in character, by which the activities of remote and dissimilar organs are automatically coordinated; a further class of such mechanisms, although involving a chemical substance conveyed by the blood, carries out the actual regulation by means of the central nervous system. An example of this class is afforded by the researches of Haldane and Priestley upon the carbonic-acid gas in the pulmonary air. These show that the alveolar pressure of carbonic acid in the lung spaces remains constant even when the atmospheric pressure is considerately altered in amount. The constancy is due to the circumstance that the respiratory nerve centres are exquisitely sensitive to a rise in this carbonic-acid pressure. Any such rise slightly augments the carbonic-acid tension of the pulmonary blood, which, on being conveyed to the nerve centres, arouses their greater activity, and the increased efficiency of the respiratory ventilation, thus produced, rapidly reduces the amount of the very agent which is its exciting cause.[2] The researches of Hill and Greenwood, with air pressures up to seven atmospheres, bear out the conclusion that by this automatic mechanism the air in the lung alveoli has a practically constant pressure of carbonic acid in any given individual.[3]

The introduction, in this example, of the respiratory centres and nerves raises the question whether the nervous system, which is in a very special sense the channel for the regulation and coordination of the various activities of the body, may not itself be conceived to be a supreme example of an automatic physico-chemical mechanism, the transference from one part to another taking place, not through the flow of blood containing chemical substances, but through a more subtle physico-chemical flow along the highly differentiated nervous strands of which this system consists. The nervous system is not popularly regarded in this light; on the contrary it is considered to be the special seat of vital directive forces, and it is held, even by some scientific men, that the nervous energy which it manifests is so transcendental in its essence that it can never be brought into line with those modes of energy prevailing in chemistry and physics. There is, moreover, a widespread belief, founded upon conscious volitional power, that nervous energy can be spontaneously created, and that even if its manifestations are bound up with the integrity of certain definite nervous structures, these structures only form the material residence of genii, temporarily in possession, endowed with the powers of hypothetical homunculi at the bidding of which the manifestations either take place or cease.[4]

The complexity of nervous structure and the apparently uncertain character of nervous activities furnished the older writers with plausible reasons for assuming the existence of animal spirits, but the extensive researches of half a century progressively suggest that nervous phenomena may be regarded as the sum of particular physico-chemical processes localised in an intricate differentiated structure, the threads of which are being unravelled by neurological technique. This chapter of physiology still bristles with difficult problems and obscure points, yet the unmistakable trend of the immense advances which have been made in recent years is towards the assumption that nervous processes do not in their essence differ from processes occurring elsewhere in both the living and non-living worlds.

As regards structure it is generally assumed by neurologists that the whole system is a fabric of interwoven elements termed neurons, each with a nucleated nerve cell and offshoots, one of which may be extended as a nerve fibre, whilst no nerve fibre exists which is not the offshoot of one such cell. This neuron theory is based upon developmental history and upon the suggestive fact that each nerve cell forms an independent trophic centre for its own distributed processes. It is undoubted that, like the atomic theory in chemistry, the neuron theory has proved of enormous service, enabling neurologists to disentangle the woven strands of nerve-cell processes even in such an intricate woof as that of the central nervous mass. There are, however, difficulties associated with its full acceptance in physiology, as indeed there are said to be in connection with the full acceptance of the atomic theory in chemistry; but dismissing these for the moment, I pass on to consider the presumable character of such a conception of nervous activities as would be demanded on the supposition that the nervous system is, as regards all essentials, an automatic physicochemical mechanism.

In the nerve fibres, which are undoubtedly the offshoots of nerve cells, the only demonstrable changes during the actual passage of nervous impulses are of an electrical type. These resemble the effects which would occur if there were redistributions of such electrolytes as are known to exist within and around the differentiated fibrillated core or axon of each nerve fibre. All the better-known aspects of nerve-fibre activities are in accordance with such an electrolytic conception. The exquisite sensibility of nerve to physical and chemical changes of a sudden character would be associated with the fluctuating and variable character of electrolytic distribution, this instability being characteristic of particular electrolytes in colloidal solutions; hence physical and chemical alterations primarily affecting the nerve envelope will, by modifying the electrolytic distribution, produce physico-chemical change in the internal axon itself. Such changes, when once produced at any point in the differentiated fibrillar continuum of the nerve fibre, must in accordance with the conception first propounded by Hermann be propagated or transmitted along this continuum. The redistribution of electrolytes at the seat of the external impression being itself a source of electromotive effects, electrical currents demonstrably flow from this point into the contiguous parts of the fibrillar continuum. Such flow of current must reproduce in this neighbouring continuum that electrolytic redistribution which is the fundamental aspect of nerve-fibre activity. Thus, by this comparatively simple automatic mechanism, the physico-chemical electrolytic change is successively assumed by the various portions which compose the length of the differentiated axon, and the new or active phase is propagated along a nerve fibre as infallibly as a flame speeds along a fuse when one end is ignited; in this way the conception explains how a so-called nervous impulse is brought into being. Further, the brief duration of the activity of the nerve, its rapid development and slower decline, and the circumstance that a second external change cannot arouse a second activity if it occurs very shortly after an effective predecessor, all have their counterpart on the electrolytic side, and we have convincing evidence that the electrolytic redistribution during activity cannot be again produced until the electrolytic condition has more or less returned to its original resting poise: the real peculiarity of the living tissue is its persistent tendency to re-establish the electrolytic concentration of this resting poise.[1] Finally experiments show more and more convincingly that the capacity of the nerve to respond to external changes, as well as the magnitude and duration of the aroused activities, are particularly susceptible to modification by all those agents which are most potent in affecting electrolytic aggregates, such as temperature, electrolysis, and impregnation with various electrolytes.

These electrical indications of nerve-fibre activities are fundamentally the same whether the fibres occur in peripheral nerve trunks or in the bundles which course through the central masses; and thus, if the whole system consisted of nothing but the united strands of differentiated nerve fibres, nervous phenomena would be merely the expression of the development, along appropriately distributed tracts, of similar electrolytic changes primarily started by some external physical or chemical alteration. But additional complications are introduced by the existence of nerve-fibre endings and by the interposition of the nerve

[1] Starling and Lane-Claypon.

[2] Haldane and Priestley, "The Regulation of Lung Ventilation." *Journ. of Physiol.*, xxxii. 1905.

[3] Hill and Greenwood, "The Influence of Increased Barometric Pressure on Man." *Proc. Roy. Soc.*, vol lxxvii B, 1906, p 442.

[4] Lodge, "Life and Matter" (London: Williams and Norgate, 1906). "Matter is the vehicle of mind, but it is dominated and transcended by it" (p. 123). "Contemplate a brain-cell, whence originates a certain nerve-process whereby energy is liberated with some resultant effect" (p. 168). "It is intelligence which directs; it is physical energy which is directed and controlled and produces the result in time and space" (p. 169).

[1] Gotch and Burch, *Journ. of Physiol.*, vol. xxiv. 1899, p. 410.

cells. According to the neuron theory the fibres of different nerve cells end more or less blindly, and, at any rate in vertebrates, do not demonstrably unite at their termini within the central mass; hence gaps exist at the junction unbridged by the differentiated structural continuum. But since the nervous impulse can pass from one set to the other, a physiological continuum undoubtedly exists; it is necessary, therefore, to assume either that the electrolytic change in one neuron can by mere contiguity in space arouse a similar change in a neighbouring neuron process, or that a differentiated connection actually exists, but of such structural delicacy that it cannot be microscopically demonstrated. Recently several physiologists have stated their belief in such continuity; one of these, E. Pfluger, bases his view upon the admitted intracellular nature of peripheral nerve endings in muscles, glands, epithelial cells, and electrical organs. Arguing from analogy, he infers that the central nerve endings of one neuron probably pierce and enter the cell processes of another neuron.[1] Such a connection can be actually seen, as a pericellular plexus, in the ganglia of crustacea, and has been occasionally described as observed in higher animals. Whether the central termini of neuron processes are in reality joined by extremely fine fibrillar filaments or whether they end blindly in mere juxtaposition, it is undoubted that the functional synapsis presents peculiar features. The chief peculiarities of synaptic activities as distinct from the activities of the nerve fibres are the following:—Marked retardation in the maximum rate of propagation; irreciprocity of conduction, which is favoured in the natural or homodromous direction, whilst in the unnatural or heterodromous direction it is obstructed or completely blocked; susceptibility to fatigue; special susceptibility to stimulation and impairment by definite chemical substances, by strychnine, absinthe, anæsthetics, &c.; the presence of a resistance which diminishes rapidly when subjected to the assault of a series of entering or centripetal nervous impulses even when each member of the series is alone quite powerless to force a passage. All these peculiarities are more or less demonstrable in all nerve endings, peripheral as well as central, and are presumably, therefore, related to the character of the propagation which occurs in the finely-divided non-medullated twigs or "arborisations" into which the nerve fibres break up in such endings, and possibly to some further "receptive" substance lying beyond the endings. The retarded propagation, showing itself by an apparent delay, occurs in the motor nerve endings of muscles and in the multitudinous nerve endings of electrical organs, as well as in the central nervous system. Garten's researches on non-medullated nerves suggest that it may be connected with such slowed development of the electrolytic redistribution and of its accompanying electromotive alterations as is demonstrable in these structures.[2] Irreciprocity of conduction occurs where nerve endings are continued into muscle substance, since the activity process passes from nerve to muscle, but not the reverse way. In 1896 Engelmann succeeded by means of a double muscle-bath in so modifying one end of a muscle fibre that the wave of contraction, whilst it travelled freely along the muscle fibre from the unmodified to the modified portion, would not do so the reverse way.[3] The particular modification which produced this abnormal result is an interesting one; it is the development of an abnormally sluggish type of mobility, the whole activity of the modified region being greatly prolonged by means of veratria. This suggests that difference in the duration of the active process on the two sides of a central nervous synapsis would, if present, be one factor in producing the well-known central irreciprocity. The susceptibility to fatigue may be associated with this augmented difficulty of propagation, and it undoubtedly occurs to a marked extent in muscular nerve endings; for, according to the investigations of Joteyko, it may be more pronounced in this peripheral ending than it is even in the spinal cord.[4] Even the so-called summation phenomena—that is, the ease with which a succession of centripetal impulses can force a passage as opposed to the difficulty with which a single such impulse does so—is not peculiar to the central mass, but is observed more or less in peripheral nerve endings; for instance, those of electrical organs. Finally, the results obtained by Wedenski suggest that anæsthetics have a particular affinity for nerve endings, including the peripheral ones in the muscles; and although the causation is at present imperfectly known, it does not seem improbable that they may act upon some such specific substance as that which is conceived of by Langley under the term "receptive."[1]

All the phenomena hitherto described are thus not necessarily aspects of the activity of that particular mass which constitutes the body of the nerve cell, but of nerve endings with their fine arborisations. As regards direct electrical evidence of electrolytic changes in these finer branches, it so happens that Nature has provided some nerve endings on such a magnificent scale that this evidence is readily obtained. In the electrical organs of fishes the essential structure consists of a pile of numerous discs each invaded by nerve endings, and the electric shock of the fish is the sum of all the electrical changes in this pile when an efferent nervous impulse reaches each of its component discs. Its potency is due to the number of these components, but in each single component it is of the same order as the electromotive change in a nerve, and its character is such as might be produced by electrolytic redistribution occurring simultaneously in the immense number of nerve endings which are present in each disc of the electrical organ. Although displaying the peculiarities of apparent delay, &c., just referred to, the general character of the shock of the organ is such as to warrant the belief that electrolytic conceptions of nerve-fibre activity can be extended to the activities of nerve endings.

There remains that special part of the whole neuron which is the effective source both of its development and of its maintenance, the nerve cell. Continuity with a nerve cell is essential for the integrity of both the structure and the function of a nerve fibre, but it is undoubted that, in its turn, the nerve cell is also dependent upon the existence of its processes in an unimpaired state. Thus the cell suffers a change which comes on slowly but with great certainty if any part of the neuron has been mutilated, or if the cell has been shorn of some of its offshoots. That it forms a special part of the conducting path is indicated by the occurrence of intracellular and nuclear alterations when a prolonged series of impulses travel towards it, and a further more remarkable point is that it also appears to change if the entering nervous impulses with their electrolytic concomitants are no longer able to reach it. This suggests that nerve cells, far from being spontaneous actors, are in a very real sense dependents; they form only one possible conducting portion of the whole differentiated tract, and atrophy when this tract is broken or is from any circumstance not utilised. That the cell is primarily trophic and only incidentally a conductor is suggested by Bethe's experiments upon crustacea. Owing to pericellular connections the actual nerve cell may be removed in these animals without severing the whole conducting tract, for a portion lies around but outside the cell; and since, even after such removal, the usual reflex movements of the supplied antennæ are resumed, the cell cannot in this instance be regarded as essential for the discharge of the motor impulses which evoke the antennæ movements.[2]

In higher animals such removal of the cell body has been imperfectly carried out by Steinach in the dorsal spinal ganglia, but in the central mass it is impossible to perform a crucial experiment of this kind so as to determine whether or no the substance of nerve cells can create nervous impulses. There are two particular features of reflex movements which may be cited as indicating that a motor nerve cell has at its call a store of nervous energy which it can spontaneously discharge. The first of these is the well-known fact that the character of reflex movements is such as to indicate the rhythmical discharge of groups of centrifugal nerve impulses the periodicity of

[1] E. Pfluger, "Ueber den elementaren Bau des Nervensystems," *Archiv f. die Ges. Physiol.* cxii., 1906.
[2] Garten, "Beiträge zur Physiologie der marklosen Nerven," Jena, 1903.
[3] Engelmann, "Versuche über irreciproke Reizleitung in Muskelfasern," *Archiv f. die Ges. Physiol.*, lxii. 1896, p. 400.
[4] Joteyko, "Travaux de l'Institut Solvay," Bruxelles, iii. 2, 1900.

[1] Wedenski, "Erregung, Hemmung und Narkose," *Archiv f. die Ges. Physiol.* c., 1903.
[2] Bethe, *Allgemeine Anat. u. Physiol. des Nervensystems*, 1903, p. 99.

which bears no relation to that of the centripetal ones. But it must be remembered that even in nerve fibres it is possible for a succession of stimuli to evoke a different succession of electrolytic changes and of nerve impulses, provided that some of the successive stimuli fall within the period of inexcitability which occurs during the establishment of each new electrolytic poise.[1] We have, therefore, only to assume, as is very probable, that in the central portion of the nervous path this poise is prolonged in its development, and numbers of centripetal impulses must necessarily fail; hence the emergent ones will have a special periodicity indicative of the duration of the swing of the electrolytic rearrangement which occurs when the synapses *plus* the cells are traversed by the entering impulse.

The second feature which more particularly suggests spontaneous cellular activity is the well-known fact that reflex centrifugal discharges may continue after the obvious centripetal ones have ceased. This is preeminently the case when the central mass is rendered extremely unstable by certain chemical compounds, such as strychnine, &c. There are, however, suggestive indications in connection with such persistent discharges. The more completely all the centripetal paths are blocked by severance and other means, the less perceptible is such persistent discharge, and since nervous impulses are continually streaming into the central mass from all parts, even from those in apparent repose, it would seem that could we completely isolate nerve cells, their discharge would probably altogether cease. In this connection a suggestive experiment was carried out some years ago upon the spinal cord of the mammal.[2] A portion was isolated *in situ* by two cross-sections, and a part of this isolated cord was split longitudinally into a ventral half containing the motor or centrifugal nerve cells and a dorsal half containing the breaking up of the centripetal nerves; each half was then examined for those electrolytic changes which indicate the presence of nervous impulses. It was found that, even in the strychnised animal, no electrical effects could be detected in the ventral half of the cord or its issuing roots, although such effects were marked in the whole cord, and occurred in the dorsal half which contained the centripetal nerve fibres.

This experiment indicates that even in the hyper-excitable condition produced by strychnine the spinal motor nerve cells did not discharge centrifugal impulses when cut off from their centripetal connections. It is corroborated by the results obtained by Baglioni in the frog and small mammal,[3] and, taken in connection with those previously mentioned, it affords considerable foundation for asserting that the chief *rôle* of the nerve cell is trophic, and that, as regards issuing nerve impulses, it only forms a modified part of the conducting path. The more we investigate the physiology of the nervous system, the stronger becomes our belief that for centrifugal discharges to occur centripetal impulses must be primarily started either in the peripheral sensory surfaces by changes of a physical or chemical type occurring in the external world, or at some point in the nerve continuum by local chemical or physical changes within the body, especially those due to the chemical condition of the blood. Having been thus started they course along definite structural paths, and the only direct indications of this passage consist of such phenomena as would be produced by the redistribution of concentrated groups of electrolytes—a purely physico-chemical process.

This conception places the propagation of the nervous excitatory state as the sole determining factor of nerve activities, central or peripheral. It derives additional support from the circumstance that it is in harmony with that aspect of these activities which is comprised under the term, inhibition. Any effective regulating system must be able to bring into play both incentive and restraint—the whip and the reins. The possession by the central nervous mechanism of inhibitory powers is remarkable both for its extent and its delicacy. It appears more and more probable that this is achieved by the propagation of nervous impulses of the ordinary type. Thus, recent researches by Sherrington show that the propagated impulses from a given central mass may, although normally inhibitory to the centrifugal discharge of another mass, become directly incentive if the second controlling centre has its excitability abnormally augmented by strychnine, tetanus toxin, &c.[1] As regards their fundamental characters it thus appears that both augmenting and inhibiting impulses belong to the same category. Moreover, such theories of central inhibition as embrace all the phenomena involve as their essential basis the cutting-off of the potent centripetal supply to the inhibited centre. In the interference theory this cutting-off is assumed to be caused by the arrival of other nerve impulses which, breaking into the path of normal centripetal flow, obstruct and run counter to this potent stream. In the ingenious drainage theory, propounded by McDougall, the cutting-off is an indirect one, it being assumed that the new stream enters other side-channels, and thereby opens up a short circuit through which the potent ones drain away without reaching the centrifugal centre. Even Langley's conception of receptive substances played upon by impulses must be associated with a check in the efficiency of the continuous centripetal supply.

From the foregoing it appears that the physiologist has definite grounds for believing that, as far as present knowledge goes, both the production and cessation of central nervous discharges are the expression of propagated changes, and that these changes reveal themselves as physico-chemical alterations of an electrolytic character. The nervous process, which rightly seems to us so recondite, does not, in the light of this conception, owe its physiological mystery to a new form of energy, but to the circumstance that a mode of energy displayed in the non-living world occurs in colloidal electrolytic structures of great chemical complexity. There is a natural prejudice against the adoption of this view, but such prejudice should surely be mitigated by the consideration that this full admission of physiology into the realm of natural science, by forcing a more comprehensive recognition of the harmony of Nature, is invested with intellectual grandeur.

With such questions as the essential meaning of consciousness and the interpretation of the various aspects of mind revealed by introspective methods, the physiologist, as such, has no direct concern. For his purpose states of consciousness are regarded merely as signs that certain nervous structures are in a state of physiological activity; and he thus limits the scope of physiology to the objective world. This limitation of physiology does not prohibit a treatment of the subjective world along lines calculated to display that intellectual causative array which characterises science; it merely indicates that this particular application of scientific method is not physiology, but that something else, still more profound, which is now termed psychophysics.

But if objective phenomena form the subject-matter of the physiologist, then "the legitimate materialism of science" must constitute his working hypothesis; and his "well-defined purpose" must be to adapt and apply the methods of physics and chemistry for the analysis of such phenomena as he can detect in all physiological tissues, including the nervous system. The trend of such a strictly physiological analysis is towards a conception in which the highest animal appears as an automaton composed of differentiated structures exquisitely sensitive to the play of physical and chemical surroundings.[2] The various parts of the animal body are linked by circulating fluids and by one special structure, the nervous system; in this linking of parts the physiologist detects the working of automatic chemical mechanisms of great delicacy which, once developed, are retained and perfected in proportion as they efficiently regulate the various bodily activities and co-ordinate them for the welfare of the whole organism. The

[1] Gotch and Burch, *Journ. of Physiol.*, vol. xxiv. 1899, p. 410; Boycott, *Journ. of Physiol.*, vol. xxiv. 1899, p. 144; Buchanan, *Journ. of Physiol.*, vol. xxvii 1901, p. 98, &c.

[2] Gotch and Horsley, *Phil. Trans.*, vol. clxxxii. pp. 267-526. (London, 1891.)

[3] Baglioni, *Archiv f. die Ges. Physiol.*, 1900, Supplement, pp. 198-242. (Leipzig.)

[1] Sherrington, *Proc. Roy. Soc.*, vol. lxxvi B, pp. 269-297. (London, 1905.)

[2] See Huxley, "On the Hypothesis that Animals are Automata," Evening Address, Brit. Assoc., Belfast, 1874. Re-published in "Collected Essays," vol. i. (Macmillan, 1904.)

plastic nature of nervous tissue renders it, in accordance with the principles of natural selection, particularly favourable for progressive change in this direction, and thus developments may occur which reach their highest physiological expression in the brain of man.

In conclusion, attention may be drawn to the peculiar instability of living processes and structures. The living units show that significant mutability which the physiologist describes as metabolism. This mutability appears to be encouraged or discouraged by the extent to which it fulfils a purpose, and this purpose in a living organism is the dominating law of its own development. The fulfilment of this purpose by means of physical and chemical change is such a general characteristic of living processes that a physiologist may with some confidence suggest that this fulfilment is the distinctive mark of a living thing.

SECTION K.

BOTANY.

OPENING ADDRESS BY PROF. F. W. OLIVER, M.A., D.Sc., F.R.S., PRESIDENT OF THE SECTION.

The Seed, a Chapter in Evolution.

As the subject of the first portion of my Address I propose to consider the place of the seed in the evolutionary history of plants. The seed-character is the distinctive mark of three great groups of plants—the Pteridosperms, Gymnosperms (including Cordaiteæ), and Angiosperms. Nor will it be seriously questioned that the possession of this organ has given supremacy to seed-bearing plants over groups not thus characterised in a majority of the types of environment where vegetation is able to exist. Exceptions, of course, there are, though few of them are wholly immune from the invasion of the Spermophyte. The sort of habitat, for instance, in which Zostera flourishes—sometimes to the exclusion of other forms—is held more as a result of vegetative aggressiveness than in virtue of any special power conferred by the seed-habit.

Our stock of knowledge of those plants which had attained to the seed-bearing condition in a bygone age has undergone some extension during the last few years; the seed, too, has shed its glamour over other branches of morphological inquiry, so that no serious apology is necessary for its selection as the subject of this morning's discourse.

It is generally conceded that the primitive vegetation arose in the waters, and that with the parting of the waters and the emerging of land and continents this primitive stock of plants was sufficiently plastic to take advantage of the new conditions, throwing up successive hordes which effected a footing on the land, and in time peopled the whole earth with forms adapted to the varying habitats and climates as they differentiated.

Of the character of these primæval aquatic types no direct information has been vouchsafed. It is a matter of inference that they possessed much in common with the green Algæ of to-day, which, living in a biologically stable medium, are commonly regarded as their nearest representatives. Be that as it may, the complexity of the life-history of existing Algæ and the frequent presence of neutral generations seem significant of the capacity of their progenitors to originate forms with sporophytes adapted to terrestrial conditions.

In our Liverworts and Mosses on the one hand and the Ferns and their allies on the other, two divergent evolutionary lines are represented, both fitted to existence upon land surfaces, but handicapped by the retention of a non-terrestrial method of effecting the sexual process. In the Bryophytes the physiological continuity and dependence of the sporophyte upon the gametophyte is preserved throughout, and it never rises above the status of an elaborate spore-capsule; whilst the gametophyte, though often reaching a complex vegetative differentiation, offering many analogies with the sporophytes of higher plants, is condemned to pigmy dimensions through the incubus of the inherited aquatic mechanism of fertilisation.

Though remote from the series that have culminated in seed-plants, the Bryophytes are a group offering many an instructive parallel with the main series of plants; certainly these forms have remained too long a thing apart. Haberlandt and Goebel have shown us—to name no others—how happy is the hunting-ground which the Bryophytes provide. Further work is still required, directed more especially to certain important points in the life-history.

With the regular vascular cryptogams the relations between the stages are of course different. Here we find large complex sporophytes holding the ground, but hampered by the ever-recurring necessity of dependence upon outside water for the performance of the reproductive process.

The land problem was solved on ingenious lines. The differentiation of gametophytes which accompanied heterospory rendered possible the retention of the larger spore and female prothallus. Thus retained aloft, the drawback of the double existence is overcome and the advantages of the elaborated sporophyte more fully realised. The water conditions are brought directly under the plant's control through the device of the pollen-chamber, and the way paved for the ideal seed with siphonogamy.

All the elements of the seed were present before, but combined compactly in this new way we recognise what is virtually a fresh stage intercalated in the life-history. Further elaboration came bit by bit as the possibilities were successively realised. With the evolution of the seed, the plant rose at a bound to a higher plane, and this structure in its perfected form has become the very centre of the plant's existence.

The case of Cycas and Ginkgo with motile sperms affords an extreme demonstration of the inertia of heredity, the persistence in living seed-plants of the original aquatic flagellate type.

Obsolete as they are and faced with extinction, these survivors from the middle epoch of the world's history still hold their ground in a few scattered localities. In this connection we shall listen with interest to Prof. Pearson's account of the Encephalartos-scrub of South Africa which is to occupy us during the course of the present sitting of the Section.

How the sperms became replaced ultimately by the passive cells of the pollen-tube we have no knowledge.

If the conjecture be well founded that the change came late rather than early, then the conservatism of the spermophytic line in this respect stands in marked contrast to the adaptability that is so characteristic of another phylum of aërial plants. The ready evolution of siphonogamy in the form of fertilising tubes, so common in the Fungi, perhaps finds its explanation in the close filiation of this group with primitive and plastic forms. The fertilising tube may reasonably be regarded as a special case of a general susceptibility to chemiotactic stimuli which distinguished the whole hyphal complex of the group from very early times. In the case of the spermophyte, on the other hand, the motile spermatozoid seems to have persisted through a long and complicated ancestral history, so that its elimination may have been less easy of achievement.

The seed, once evolved, became the centre of a host of accessory organs, constituting what we know collectively as the fruit and flower. By these it has been robbed, as we shall see, of many of its pristine functions, and at the same time has undergone marked structural reduction. In the highly elaborated Angiosperm more especially we find an almost stereotyped uniformity in seed-structure contrasting with an infinite diversity in the outward floral husk.

In attempting a sketch of the origin of the seed one has to admit at the outset that recent discoveries bring us no nearer to its prototype than we were a decade ago. For the seeds of the Pteridosperms are advanced structures recalling quite vividly the type long familiar in living Cycads. It would be overstating the case to say they have nothing primitive about them, but there is a long chapter in evolution to be deciphered before we can connect, say, the seed of Lyginodendron with the sporangium of any Fern at present known to us.

The great interest of the recent correlation of seeds with Coal Measure plants lies less in the structure of these correlated seeds than in the very extensive series of plant-remains which we have thus come to recognise as belonging to the earlier Spermophytes.

For the position of these plants had remained in suspense.

The elaborate anatomical investigation which their vegetative organs had received at the hands of Williamson, Scott, Solms-Laubach, and others showed them to occupy a transitional position between the Ferns and Cycads. In certain respects they showed an advance in the cycadian direction, whilst in others they were wholly fern-like. Their fructifications were unknown, and their nature remained an open question. It was for this group, or series of transitional groups, that Potonié proposed the appropriate name of Cycadofilices.

We know now that the Lyginodendreæ and Medulloseæ bore seeds attached to their fronds. The seeds have been found attached in some cases to reduced fronds consisting of a branching rachis, in others to fronds of the normal filicinean type. Indeed, so far as habit is concerned, these plants may rightly be described as seed-bearing Ferns.

As such, indeed, most people will be content to regard them—as forms, that is, having close filicinean relationship in which the reproductive method has been profoundly modified, the internal anatomy to a less extent, and the habit hardly at all. Had these Pteridosperms come to light during the lifetime of Hofmeister that master of morphology must have pounced upon them as furnishing an important link in his chain. These fossils and the spermatozoa which the Japanese botanists discovered in the seeds of Cycas and Ginkgo, indeed, afford the most convincing direct evidence of the soundness of the Hofmeisterian scheme that it is possible to conceive. Nor is that all. For by confirming the indications first revealed by the earlier investigation of the vegetative anatomy, the Pteridosperms have afforded us a striking object-lesson of the value of the anatomical method—of the significance of purely anatomical characters too long ignored by the systematist.

Not so long ago, when new examples of these Pteridosperms were turning up on every hand, some pessimists were inclined to wonder whether, after all, any groups of real Ferns existed in the Palæozoic rocks. Such sporangia as were known might well be the pollen-sacs of seed-bearing plants. All doubts on this score are happily set at rest by the detection of germinating Fern-spores in contemporary beds. Nor can I think of any more fitting tailpiece to the investigations which lead the way to the Pteridosperms than the discovery, by the same investigator, of the antidote to these rather disturbing views. However, it is needless to dwell further on these matters now, in view of Dr. Scott's address to-morrow upon the Present State of Palæozoic Botany.

But to return to the history of the seed. In the absence of direct evidence, one can only conjecture that some old generalised type of sporangium formed its prototype, something substantial, on the lines of a Botryopteris or Zygopteris, perhaps. The heterospory that was the precursor of the seed-like condition must have been a transient phase, or else it is lost in the pre-Carboniferous obscurity. Be that as it may, the passage from the dehiscent to the indehiscent monosporal megasporangium finds its analogy in every group of plants. Where there is extreme numerical reduction of the contained structures—be they spores or seeds—a multitude of cases in the Fungi, in the Algæ, and the angiospermic flowering plants show that dehiscence tends to become obsolete. The failure to dehisce does not appear to be directly correlated with any mechanical difficulty in ejaculation. It is more probably one of those obscure cases of interdependence of phenomena in which the vegetable kingdom abounds. A special investigation directed to the elucidation of this point might be expected to yield interesting results.

We now come to the consideration of a most characteristic organ of the seed—the pollen-chamber. This cavity arises at the apex of the megasporangium, above the big megaspore, and is found in all the Palæozoic seeds, with the sole exception, so far as I am aware, of the "seed-like" structures in Lepidocarpon and Miadesmia. The utility of the pollen-chamber is manifest, but its antecedents are quite unknown. Upon such a structure as this may have depended the success of the seed-method at a critical stage in its evolution. In the viviparous Selaginellas, described some years ago in America, the archegonium on the prothallus of the retained megaspore is fertilised by sperms liberated from microspores which become caught in the lips of the open megasporangial wall. This analogy suggests to us that the pollen-chamber cavity may be a relic or modification of the original place of dehiscence. If this conjecture be true, we have here what was once an exit-pore converted to the purposes of ingress, just as we find, in so many Thallophytes, tubes and beaks, once, as it is supposed, the orifices of zoospore discharge, now serving for the reception of male gametes.

A great feature in the early seed types was the complexity of the integument, and this still holds good in recent Cycads and some other Gymnosperms. Protective envelopes are so commonly associated with reproductive organs, and the nutritive conditions are so favourable to their production, that a naked nucellus strikes one as anomalous. If future research confirm the supposition that the ferns which stand in possible relation to early seed-plants were ex-indusiate, like the Marattiaceæ, recent and fossil, then no doubt the seed-coat is a new formation, having no true homology with, but merely homoplastic resemblance to, ordinary Fern-indusia. The only case of a naked nucellus that recalls itself is the rather mysterious instance of Lepidocarpon in which Dr. Scott reports the not infrequent occurrence of non-integumented megasporangia with the prothallus fully developed.

The robust nature of the seed envelope, which was often drupaceous, is in complete harmony with the whole character of the seed if you regard the habit at its inception as a xerophilous adaptation. And such no doubt it was, an improved method whereby the plant became independent of chance water at a very critical stage in the life-history. Some of the peculiarities of fossil seed-coats, especially the ribbing of the Lagenostomas and several other genera, may be attributed to a multiple origin of this structure, at any rate in some cases. The remarkable circlet of tentacles which surrounds the summit of *Lagenostoma physoides* (best known by Williamson's earlier name *Physostoma elegans*) suggests that a number of foliar lobes have been incorporated in the seed, whilst the presence of perimicropylar ridges and the septate canopy in allied forms may be taken as only a less evident indication of the same thing.

The relation between the integument and sporangial body of recent Gymnosperm seeds is found to be an inconstant character, and the same is true of the fossils. In general character the relationship recalls that which obtains between the ovary and receptacle of an Angiosperm. The Lagenostomas resemble Cycas and Pinus in having the integument free at the apex only, whilst Taxus, Phyllocladus, and Araucaria are in agreement with the Trigonocarpons and other seeds, which are generally attributed to Medulloseæ, in having an integument which rises freely from the chalaza. It is interesting to note that the fossil seeds of the latter group show an additional complexity in the wall of the nucellus. For in them a series of tracheal strands or even a mantle of tracheides is found running up from the chalaza to the pollen-chamber. It is evident that nothing was spared in these older seeds to ensure adequate access of water to the pollen-chamber where the sperms must have been liberated.

In due time the protective sheath, or testa, appropriated other functions supplementary to that of protection. Of these the most important must have been the reception of the pollen. A very striking feature in all the Lagenostomas is the way in which the tip of the nucellus (where the orifice of the pollen-chamber is situated) projects beyond the integument. In these seeds the microspores must have had direct access to the pollen-chamber without first descending a micropylar canal.

In the Medullosean seeds also the nucellus is distinguished by a long beak, as Dr. Scott and Mr. Maslen have shown recently for Trigonocarpon, and, as we know, in Stephanospermum, and many other cases. So far as we know, this beak does not extend to the surface, though it engages with the micropylar canal, and is continued some distance up.

Though it can hardly be supposed that the long beak has been inherited from the ancestral sporangium, its presence may be none the less significant of what took place when the seed method was initiated. The direct pollination in Lagenostoma may well be a survival from the old days when no proper micropyle existed. But when the micropyle closed in, the conservative nucellus would for a while endeavour to maintain direct communication with the exterior. The beak-like appendage on this view would be a new formation evolved *pari passu* with the integument.

A peculiar and distinctive, though negative, feature common to the whole range of Palæozoic seeds that have become known to us is the lack of an embryo. Occasionally small-sized seeds are met with, as in *Lagenostoma Lomaxi*, and now and then immature-looking stages, of which the best example is Renault's Cordaitean ovule, so often figured in the books. But apart from such rarities the petrifactions agree in being at a stage which, in the light of recent Cycads, is to be interpreted as corresponding to the time of fertilisation. The pollen-chamber is charged with pollen-grains, whilst in good examples the megaspore is filled with a prothallus which frequently shows indications of archegonia at its upper extremity. All these specimens will be dismissed by some as abortive, and any conclusions drawn from the negative character as invalid. Without ignoring this contingency another view is, of course, possible. The normal fall of the seed may have followed pollination at a short interval, much as is reported for Cycas and Ginkgo to-day. The "resting period" in these seeds would then perhaps coincide with the maturation of the sperms, whilst the subsequent embryonic history might have been carried through without a pause. This view gains support from the filicinean relationship, for of course the fertilised egg of a Fern continues its development without interruption. If the modification of the pteridophytic life-history that culminated in these early seeds were directed, as seems probable, to ensuring a greater certainty in bringing the gametes together under conditions favourable to their union, it would follow that the other great advantage arising from the seed-habit was of later acquisition. In other words, the ordinary seed with resting embryo was evolved by stages. There is a great lacuna in our knowledge of the early adjustment of the embryo to intraseminal existence. Whilst evidence of Palæozoic seeds with resting embryos is altogether wanting, we are confronted in the Mesozoic rocks with the Bennettiteæ, all of which possess a well-marked dicotyledonous embryo practically filling the seed-cavity. It is mere conjecture to suggest that this change has been wrought in response to some climatic stimulus, though the marked xerophilous facies of many of the Mesozoic Cycadophyta seems quite consistent with such a view. Be that as it may, one cannot fail to recognise that the resting seed with an embryo marks a great advance on the Pteridosperm, an advance hardly less important to the welfare of the plant than was the earlier type of seed on the extended life-history of the filicinean prototype.

This stage of the seed-history would be of exceptional interest if we could hope to recover any morsels of direct evidence. As yet we remain in the dark as to the morphological nature of the embryonic organs, how far we are dealing with new structures produced from a protocorm, as Prof. Bayley Balfour has suggested;[1] how far they represent the old filicinean organs adjusted to intraseminal life. What chance there may be of the solution of this difficult problem by the application of other methods may emerge perhaps from the discussion on the phylogenetic value of early seedling characters which is to be opened next Tuesday morning by my colleagues Mr. Tansley and Miss Thomas.

Reference has already been made to the view that the seed, as we find it in the majority of spermophytes with its resting embryo, shows definite adaptation to seasonal periodicity. It would be interesting to learn how far the seeds of plants long accustomed to uniform conditions, such as the rainy tropical forest, behave in this respect. The point does not appear to have been very fully investigated. Indeed, there is a rich field for both observational and experimental work upon obscure seed-problems awaiting any one who can devote continuous attention to the subject. Is there any solid foundation for the supposed "physiological dimorphism" among seeds according to which, as one reads in the older books, the earlier ripening seeds are adapted to an immediate germination, whilst the later ones are reserved for the following spring? It may be that we have here but one more illustration of the operation of temperature as the limiting factor, but in any case the matter wants clearing up. An experimental investigation of the relations of "albuminous" and "exalbuminous" seeds would probably repay the trouble involved. Does any condition or set of conditions under the control of the operator exert an influence in this connection?

The mention of the early germination of seeds brings to mind the most striking instance of all—that of the tropical Mangrove, in which, as is so well known, the seed germinates on the tree, so that the young plant is extruded, and in some instances falls, from the parent free of its envelopes.

Our interest in this type of vegetation has been revived through the researches of Mr. H. B. Guppy incorporated in his recent contribution on "Plant-dispersal in the Pacific." This volume, perhaps the most important contribution to the biology of tropical plants that has appeared since the death of the lamented Schimper, is distinguished alike for its wealth of new observations and its engaging freshness of treatment. There is one suggestion of Mr. Guppy's concerning the vivipary of Mangroves which may occupy our attention for a few moments.

As a result of his studies in the Pacific and elsewhere Mr. Guppy has arrived at the conclusion that the Mangrove type of vegetation is a very ancient one, dating back to the times when climate was more uniform and moist than we know it to-day. The viviparous habit he conjectures to have been once very general, whilst to-day this primitive condition is making its last stand along the tropical shores. Traces of vivipary still occur among inland plants, such as Crinum, whilst in other cases it reappears intermittently under conditions not fully ascertained. Mr. Guppy supposes the ordinary fruiting way of plants with caducous fruits or seeds, that germinate after an interval, to have arisen by a modification of the continuous viviparous method in the sense that the seed has come to fall earlier and earlier until the stage now characteristic of practically all Spermophytes has been reached.

Piecing the data together, this seems to be the position: The earliest known seeds appear to have remained on the plant just long enough to receive their pollen; but in time, it is reasonable to suppose, the advantage of remaining longer was realised, and the fall of the seed was postponed until fertilisation was followed by the occupation of the seed-cavity by an embryo. Here in seclusion the embryo could remain until germination was convenient. Starting at the other end, our modern seed, according to Mr. Guppy, has been evolved by the gradual retention of the viviparous embryo; or, to put it in another way, the detachment of the seed has been hastened so that it falls long before germination is due.

Well, these theories fail to meet in the middle, as they should if they are to present us with an epitome of the whole seed-history. Perhaps there were troublous times in that middle epoch, so that the continuity has become obscure! Or possibly another view may be admissible of the relation of vivipary to normal seed-production. Most botanists, I take it, have been inclined to regard vivipary as the *dernier cri* in seed-history, the ultimate stage in the way of possible reproductive advance in seed-bearing methods that the higher plants have yet attained. The Mangrove process might even be conceived as the starting-point, under certain contingencies, of a whole new race of plants with life-histories complicated by fresh alternations—homologous alternations—far beyond any of which we have knowledge to-day!

Schimper and others who have given attention to the subject found no reason for regarding vivipary as other than an adaptation to special circumstances, an extreme condition that had arisen independently in several cycles of affinity. Before the contrary can be accepted a good deal of positive evidence will be needed, drawn from the non-Mangrove representatives of groups in which vivipary occurs, to show that the relationship is other than has been generally supposed. Moreover, if the viviparous habit were formerly of wide occurrence some traces of it might reasonably be expected in the fossil record. So far as can

[1] Presidential Address, Section K, Glasgow, 1901, p. 9.

be ascertained, such have not been forthcoming, nor can I hear of any record of recent Mangroves being preserved in this way. Seeds and embryos appear to be so uniform on the whole that it is difficult to understand how they could have passed through a viviparous phase in the later stages of their evolution.

The viviparous Mangroves, on the other hand, are full of diversity in detail, and these differences would surely have left a permanent mark had the course pursued been in conformity with Mr. Guppy's very interesting suggestion. That there is a rich field awaiting detailed investigation in connection with the fascinating subjects opened up by Mr. Guppy will be admitted by most naturalists.

In glancing back at the early seed-structures one is struck with the complexity of their organisation as compared with the relative simplicity of modern seeds. The pollen-chamber, the large elaborate integument, and the complicated vascular arrangements, so characteristic of the Pteridosperm seed, have for the most part passed away, giving place to much simpler structures. Occasional exceptions no doubt occur; the seeds of Palms have remarkable integuments, whilst those of Magnolia, some Aroids, Sapotaceæ, &c., show an unusual development of vascular tissue. Most astonishing of all perhaps is the integumental tracheal sheath which closely invests the nucellus of Cassytha.[1] Though evidence of their precise function be lacking, the fact that many of these structures belong to the tropical forest makes closer knowledge desirable. For in these localities the conditions must have long been relatively stable; thus increasing the chance that the structures referred to still perform their pristine functions. These and other cases like them need elucidation, but to the broad statement that the seeds of recent Spermophytes are organised on simple lines there can be no question. This reduction in complexity may be accounted for on two grounds. In the first place fertilisation by motile sperms has been replaced by fertilisation by pollen-tubes. Instead of sperms being discharged into an internal water-chamber upon which the archegonia abutted, the male cells are carried through soft tissues to the egg in a plastic tube.

In other spheres the like befalls. If primitive man had occasion to journey from Baker Street to Waterloo, he penetrated the forest and then swam the river; to-day his descendants are projected from the one to the other with accuracy and despatch in a subterranean passage.

Just at what stage the improvisation of the pollen-chamber gave place to the newer method we have no knowledge. Perhaps some information on this point may emerge from Dr. Wieland's exhaustive researches into the extensive Yale collections of American Cycadeoideas. For the Bennettiteæ already show a simplification of the seed in certain respects; though, owing to the late stages of development usually found in European examples, this point could be cleared up.

The other cause that must have played a prominent part in the simplification of the seed was the association with it of other structures which relieved it of a part of the original load of duties that fell to its lot. The dense heads of Bennettites show us this, and the same may be said of most Coniferous strobili. But the Angiospermic ovary provides the best example of a special organ inclosing the seed or ovule, affording it protection during the immature stages and also collecting the pollen. The steps by which this came about remain hidden, and any discussion of the matter is of course premature. The carpels may have been derived from reduced sporophylls or from portions of sporophylls that were more closely associated with the seeds. The cupule of Lyginodendron is an organ rather suggestive in this connection. One is tempted to compare it with a rudimentary ovary, playing the serviceable part of a moist air-chamber for the seed during the earlier stages of its development.

However, the origin of the fruit and of the flower, with all its manifold organs, must be left to the future: they form no part of our theme. Some day a happy discovery will yield a clue, and the reproach that we are in entire ignorance of the affinities of the dominant phylum will be removed.

[1] M. Mirande, "Le dévelop. et l'anat. d. Cassythacées," *Ann. d. Sc. Nat.*, 9e sér. bot., tom. ii., 1905.

The history of the seed, as I read it from the imperfect and fragmentary data that are available, has been a series of advances spread over long geological periods. The possibilities of the seed-habit were realised only bit by bit, and the high efficiency of the modern seed depends in large degree upon the close association of other structures which cooperate in its functions. No doubt the first step, the retention of the megaspore, was the most important of all; though, that this might be effective, some contrivance for the capture of the pollen-grains must have accompanied it. Later steps in the process of seed-evolution would include the adjustment of an intraseminal embryonic stage, and in time the substitution of the pollen-tube for the liberation of sperms.

Now assuming, as I think we are entitled to assume, that seeds have come into existence along some such lines as those thus crudely blocked out, there is a great difficulty in conceiving the process other than discontinuous. Every one of the stages emphasised involves the conception of something more abrupt than mere gradual variation. And there is, of course, the old difficulty confronting us as to how the organ or mechanism came to be preserved at its inception. All these difficulties vanish when it is recognised that effective variation is of the discontinuous order, and that the successive changes involved may be considerable enough to be designated jumps. Happily such views, based upon experimental results, have been formulated by De Vries in his Mutation Theory. That theory is so well known to botanists in this country that any exposition here is quite superfluous. The least thing that can be said in its support is that it is perfectly tenable. But we may go much further than that. Apart from the Theory of Natural Selection, no modern hypothesis of evolution has been so helpful or so likely to stimulate further work. The results of continued investigations in this field, now so actively pursued, will be awaited by all biologists with a keen and sympathetic expectancy. Not the least of the advantages that follow in the wake of the Mutation Theory is the shortening of the time required for the evolutionary process. As the physicist imposes a time limit to the period during which life has been possible on the earth, a working theory that reconciles the demands of the biologist with the physical limitations is decidedly reassuring. In this connection it is very interesting to note that Monsieur Grand'Eury, one of the most active and distinguished workers in the field of palæobotany, should have found data supporting the view of mutation.[1] In tracing the passage of fossil plants through great thicknesses of rock he has been impressed on the one hand with the high degree of permanence of certain forms, and on the other with the suddenness, when the moment came, with which one species passes into another.

The collection of data of this kind from our own Coal Measures appears to me a very pressing necessity in view of the rapidity with which the coalfields are being exhausted. Indeed, the present is an unique opportunity which can never recur, and the chance of systematically utilising it is slipping away. Whatever view one may hold as to the expediency of making exhaustive collections of the recent flora, there can be no two opinions of our manifest duty to "make hay while the sun shines" in the matter of the coal fossils. Regarded as systematically arranged collections showing how the plants occur in definite localities, the contents of most of our museums, as I am assured by competent authorities, are practically worthless. That innumerable specimens of the greatest value are preserved in museums may be readily conceded; but my point is that these collections have been made without system, and that details of precise locality and horizon are frequently wanting. All this has to be done over again, and I believe local societies working in touch with a central organisation could do a memorable service which would earn them the gratitude of future generations and at the same time provide a fresh outlet to their energies.

To us the coal industry, with its vast resources, is a convenient mechanism for making fossil plants accessible. The colliery proprietor may be relied on to afford all reasonable facilities for the acquisition of select examples

[1] Grand'Eury, *Comptes rendus*, tom. cxlii p 25.

from these superabundant and embarrassing waste products. Should he incline to go further and contribute towards the modest funds necessary to carry out the undertaking worthily, he would increase the debt which science owes to industry. The thousandth part of the revenue arising from the export tax on coal would amply suffice for the purpose. Indeed, I can think of no more appropriate way of celebrating the abolition of that burdensome impost.

If I have dwelt to-day on the seed to the exclusion of other features, it is because I am convinced of its supreme importance. The evolution of the seed must have been one of the most pregnant new departures ever inaugurated by plants. The revelations of the last few years afford us, it is true, but the merest glimpse of the first stage reached, the rise of the Pteridosperms. The conquest of the world must have been slow then as it is now. The great forests of Lepidodendrons and Calamites were not reduced to mere Lycopodiums and Equisetums all at once. In this prolonged struggle, even if the Lycopods never produced a race to share the spoils, as some suppose, there is the evidence of Lepidocarpon that their reproductive methods underwent a certain if ineffectual modification in the same direction as their eventual supplanters. Probably the seed plants asserted themselves wherever physical changes overwhelmed old habitats. The rise and fall of the land, so great a feature in Carboniferous times, would favour the younger group. For as new ground became available for colonisation there would be opportunity of competing on at least equal terms with the effete types that cumbered the forest land. Nor should we forget that the seeds were well equipped with dispersal-mechanisms almost as varied as they are to-day.

A somewhat similar struggle is now in progress between the Angiosperms and Gymnosperms, but so slowly that we hardly notice it. A future age may have to be content to know its Gymnosperms from dwarf forms like those which the Japanese are so fond of producing in their pot-cultivations! But perhaps all calculations will be upset by the more effective intervention of the human race. On present indications the vegetation of the future should consist of cultivated crops and the weeds that accompany them; that is, unless the Chemist comes to our aid and solves the problem on other lines.

Botany in England.

I now turn to other matters. The period of twenty-five years that has elapsed since the British Association last met in this City all but includes the rise of modern botany in this country. During the middle decades of last century our botanists were preoccupied with arranging and describing the countless collections of new plants that poured in from every quarter of an expanding empire. The methods inculcated by Linnæus and the other great taxonomists of the eighteenth century had taken deep root with us and choked out all other influences. Schleiden's "Principles of Botany," which marked a great awakening elsewhere, failed to arouse us. The great results of Von Mohl, Hofmeister, Nägeli, and so many other notable workers, which practically transformed botany, were at first without visible effect.

It was not that we were lacking in men capable of appreciating the newer work. Henfrey, Dr. Lankester (the father of our President), not to mention others, were continually bringing these results before societies, writing about them in the journals, and translating books. But the thing never caught on—it would have been surprising if it had. You may write and talk to your contemporaries to your heart's content, and leave no lasting impression. The schools were not ready. No movement of the sort could take root without the means of enlisting the sympathies of the rising generation. It was only in the 'seventies that effective steps were taken to place botany on the higher platform; and the service rendered in this connection by Thiselton-Dyer and Vines is within the knowledge of us all. Like the former in London, so the latter at Cambridge aroused great enthusiasm by his admirable courses of lectures. Great service, too, was rendered by the Clarendon Press, which diffused excellent translations of the best Continental text-books—a policy which it still pursues with unabated vigour, though the need of them is, I hope, less urgent now than formerly. Already at the time of the last meeting in York (1881) a select band of Englishmen were at work upon original investigations of the modern kind. The individuals who formed this little group of pioneers in their turn influenced their pupils, and so the movement spread and grew. It would be premature to enter fully into this phase of the movement, so I will pass on with the remark that modern botany was singularly fortunate in its early exponents.

Whenever the history of botany in England comes to be written, one very important event will have to be chronicled. This is the foundation of the Jodrell Laboratory at Kew, which dates from the year 1876. Hidden away in a corner of the Gardens this unpretentious appendage of the Kew establishment has played a leading part in the work of the last twenty-five years. Here you were free to pursue your investigations with the whole resources of the Gardens at your command. I suppose there is hardly a botanist in the country who has not, at some time or other, availed himself of these facilities, and who does not cherish the happiest memories of the time he may have spent there. Certainly Jodrell displayed rare sagacity in his benefactions, which included, in addition to the laboratory that bears his name, the endowments of the Chairs of Animal Physiology and Zoology at University College, London.

Sir William Thiselton-Dyer, who has so recently retired from the Directorship of Kew, had every means of knowing that his happy inspiration of founding a laboratory at Kew was a most fertile one. It would not be surprising if the future were to show that of the many changes inaugurated during his period of service this departure should prove by far the most fruitful.

Another incident belonging to the early days ought not to be overlooked: I refer to the notable concourse of Continental and American botanists at the Manchester meeting of the British Association in 1887. The genuine interest which they evinced in our budding efforts and the friendly encouragement extended to us on that occasion certainly left an abiding impression and cheered us on our way.

We are not forgetful of our obligations. We regard them in the light of a sort of funded debt on which it is at once a pleasure and a duty to pay interest. The dividends, I believe, are steadily increasing—a happy result which I am confident will be maintained.

But I should be lacking in my duty did I permit the impression to remain that botany is anything but a sturdy and natural growth among us. The awakening, no doubt, came late, and at first we were influenced from without in the subject-matter of our investigations. But many lines of work have gradually opened out, whilst fruitful new departures and important advances have not been wanting. We still lean a little heavily on the morphological side, and our most urgent need lies in the direction of physiology. As chemists and physicists realise more fully the possibilities of the "botanical hinterland," one may expect the conventional frontier to become obliterated. As Mr. F. F. Blackman has pointed out in a recent interesting contribution,[1] the chemist's point of view has undergone a change with the growth of the science of physical chemistry, and is now much more in line with that of the biologist than was formerly the case. This natural passage from the problems of the one to those of the other should be the means of attracting into our body recruits possessing the necessary chemical equipment to attack physiological problems.

As the position gains strength on the physiological side, it will become possible to render more effective service to agriculture and other branches of economic botany.

This is of importance for a variety of reasons. Among others it will bring public support and recognition which will be all for good, and it will provide an outlet for our students. It will also afford unrivalled opportunities for experiments on the large scale. Even should economic conditions, which compel us to import every vegetable product, continue to prevail in this country, this will not be so in the Colonies. As time goes on, one may reasonably expect an increasing demand for trained botanists, ready to turn their hands to a great variety of economic problems.

[1] "Incipient Vitality," *New Phytologist*, vol. v. p. 22.

From this rough sketch we see that the prevailing school of botany has arisen very independently of that which preceded it. The discontinuity between them you might almost call abrupt. All through the middle parts of the last century we were so busy amassing and classifying plants that the great questions of botanical policy were left to solve themselves. Great herbaria became of the order of things: they received Government recognition, and they continue their work apart. Those who built up these great collections neglected to convince the schools of the importance of training a generation of botanists that would use them. The schools were free, and they have gone their own way, and that way does not lie in the direction of the systematic botany of the herbarium. So long as this tendency prevails the herbaria must languish. When I say languish, I do not mean that they will suffer from inefficient administration—their efficiency probably has never been greater than at the present time. But the effort involved in their construction and upkeep is altogether disproportionate to any service to which they are put. Work, of course, comes out of them; it is no question of the devotion or ability of individuals. It is the general position, the isolation of systematic botany, to which attention should be directed with a view to its alleviation.

If things are left to take their course there is the fear of atrophy through disuse. The operation of the ordinary economic laws will no doubt serve to fill vacancies on the staff as they arise, but the best men will be reluctant to enter. Of course the pendulum may begin to swing the other way, though no indication of such a change is yet apparent.

Let us now attempt an analysis of some of the causes which have led to this condition of affairs.

In the first place, our two national herbaria (Kew and the British Museum) stand apart from the ordinary botanical current. They are administered, the one as a portion of the Kew establishment under the Board of Agriculture, the other as a department of the British Museum under a Board of Trustees. Neither has any connection, direct or indirect, with any university organisation. The Keepers and Assistants as such have no educational functions allotted them; I mean positions in these herbaria carry no teaching duties with them. There are no facilities for teaching; there are no students. No machinery exists for training recruits or for interesting anybody in the ideals and methods of systematic botany. A recent event illustrates my meaning better than any words. My friend Dr. Rendle accepted the Keepership of the Botanical Department at the British Museum a few months ago. Previously, as Assistant, he had held a lectureship at a London college. One of the first consequences of his new appointment was his retirement from the teaching post. Now that was bad. Under the conditions which one would like to see there would have been no resignation. On the contrary, the Keepership should have entitled Dr. Rendle to promotion to a full professorship. I do not mean a great post, with elementary classes, organisation, and so on, but one in which he would be occupied with his own branch, giving a course for advanced students, let us say, once a year during the summer months. Nor is that all. Such are the vagaries of our university organisation in London that we run some risk of losing Dr. Rendle from the Board of Studies in Botany. Automatically he ceases to be a "recognised teacher," and unless some loophole can be found the connection will be severed.

Next we come to the question of routine duties. These are heavy in herbaria, and must include a great many that could be satisfactorily discharged by handy attendants. As in the case of those who work in laboratories, half a man's time should be at his own disposal for original investigations. It is important, for a variety of reasons, that the members of the staff should take a leading part in advancing systematic botany.

Then there is another way in which a great economy could be effected in effort, time, and money. This is the transfer of the collections and staff of the Botanical Department from the Museum to Kew. This is a very old proposal, first seriously entertained some fifty years ago after the death of Robert Brown. There must be endless files of reports and Blue Books in official pigeon-holes dealing with this question. The most recent report of a departmental committee is known to all interested in the matter. From the character of the evidence tendered it is not surprising that no action has been taken. I am at a loss to find any adequate reason for the continuance of two separate herbaria. It has been urged, no doubt, that botany would suffer if unrepresented in the Museum collections at South Kensington, and that the dried collections and herbarium staff are a necessary adjunct to the maintenance of a botanical museum. But there is little force in the contention. The specimens that go to make a herbarium are not proper subject-matter for museum display; nor is there anything about herbarium work which intrinsically fits the staff to engage in the arrangement of museum cases. The function of a botanical museum is to interest, stimulate, and attract. It should convey an idea of the current state of the science, and particularly of the problems that are to the front, in so far as it is possible to illustrate them. It requires a curator with imagination and ideas, as well as an all-round knowledge of his subject. He must also be an artist. Logically there is no reason why a museum should be part of the same organisation as systematic collections. There is, indeed, a danger of making the museum too exhaustive. I am speaking, of course, of a teaching museum, which belongs really to the province of a university, or university extension if you like. Systematic collections kept exposed under glass are luxuries. All the world agrees that the museum side is admirably done at South Kensington, and most people attribute this success to the systematic element which is paramount behind the scenes. But, as we have seen, this is a fallacy, and the "museum argument" for keeping the herbarium at South Kensington may be ignored.

By the fusion of the herbaria at Kew one would look for increased economy and efficiency, more time for original work as distinguished from routine duties, and a more complete specialisation.

We now approach another aspect of the question. Much has been said on the value of anatomical characters in classification, and it is pretty generally conceded that they ought to be taken into consideration, though, like other characters, they are beset with their own special difficulties. As Dr. Scott—who has always urged their importance—says:[1] "Our knowledge of the comparative anatomy of plants, from this point of view, is still very backward, and it is quite possible that the introduction of such characters into the ordinary work of the herbarium may be premature; certainly it must be conducted with the greatest judgment and caution. We have not yet got our data, but every encouragement should be given to the collection of such data, so that our classification in the future may rest on the broad foundation of a comparison of the entire structure of plants." This passage was written ten years ago and we are still awaiting its realisation.

It is perfectly true that in the case of a recent proposal to found a new natural order of flowering plants anatomical characters find due consideration; still, on the whole, we are content to rely on the traditional methods that have been transmitted from Linnæus and the old taxonomists. So much material is always passing under the hands of our systematists that they cannot devote the time for the elaboration of a fresh method. In particular there are the new things which require docketing and provisional description. Circumstances, as ever, place obstacles in our way and tend to make us unprogressive.

Now it seems to be of the first importance that reform should come from within; that these problems, which are systematists' problems, should be solved by taxonomic specialists.

I am sanguine enough to believe that much might be done by a redistribution of duties, especially if this were accompanied by the fusion of the great herbaria, to which reference has already been made. But the greatest hope, I think, must lie in the possibility of some form of alliance or understanding between the authorities responsible for the administration of the herbaria on the one hand and the local university on the other. For directly you give the Keepers or Assistants in the former a status in the latter, you place at the disposal of the systematists a considerable

[1] D. H. Scott, Presidential Address, Section K, Brit Assoc. (1896).

supply of recruits in the form of advanced students possessing the requisite training to carry out investigations under direction. And if this be true of the herbaria, it holds equally in all the branches of knowledge represented in the National Museum. Really I fancy our Museum is rather anomalous in its isolation. In am confident that any understanding or arrangement that might be reached would be attended with great reciprocal advantage. Nor am I speaking without some data before me. The movement towards a closer relation between the museum and the university has already entered the experimental stage. For on several occasions during the last few years members of the Museum staff, from more than one department, have given courses of lectures in connection with the university schemes of advanced study. From all I hear, the experiment may be regarded as distinctly encouraging.

Before leaving this subject it may be appropriate to recall that the English edition of Solereder's great work on Systematic Plant-anatomy is rapidly approaching completion, and should be available very shortly. Its appearance cannot fail once more to arouse discussion as to the importance of anatomical characters. I hope the result produced may reward the devotion and labour with which Mr. L. A. Boodle and Dr. Fritsch have carried out their task.

In another and even more fundamental branch of systematic work the future seems brimful of promise. We are beginning to recognise that a vast number of the species of the systematist have no correspondence with the real units of nature, but are to be regarded rather as subjective groups or plexuses composed of closely similar units which possess a wide range of overlapping variability. That such might be the case was apparent to Linnæus, but the proof depends on the application of precise methods of analysis.

In the year 1870 our great taxonomist Bentham happened to meet Nägeli at Munich, and, as we find recorded in Mr. Daydon Jackson's interesting life, "had half an hour's conversation with him on his views that in systematic botany it is better to spend years in studying thoroughly two or three species, and thus really to contribute essentially to the science, than to review generally floras and groups of species." Bentham does not appear to have been convinced, for his comment runs: "He is otherwise, evidently, a man of great ability and zeal, and a constant and hard worker." At the time of this interview Bentham was seventy years old, Nägeli being seventeen years his junior. The views of the latter are now bearing fruit, as we see in the important results already obtained by De Vries and others, who are following the methods of experimental cultivation with so much success.

The supposed slowness of change has been a difficulty to many. This was one of the "lions" left by Darwin in the way, and it has driven back many a "Timorous" and "Mistrust." Now, as we are gradually perceiving, it is only a chained lion after all; a thing to avoid and pass by. The detection of the origin of species and varieties by sudden mutation opens out new vistas to the systematist, and along these he will pursue his way. It will take many years of arduous work this reinvestigation of the species question. The collections of our herbaria form the provisional sorting-out from which we must start afresh. In the long run it may be that our present collections will prove obsolete, but that will not deter us. The scrap-heap is the sign and measure of all progress.

The Garden thus becomes an instrument of supreme importance in conjunction with the herbarium, and that is another reason for the transfer of South Kensington to Kew. The resources of the latter could then be directed more fully than ever to the advancement of scientific botany, and the Gardens would be revealed in a new light. For the operations and results of experimental inquiries would form a new feature, very acceptable to the specialist and public alike. And, as I am on the subject, it may not be out of place to remark that we all look forward eagerly to the time when the multifarious activities of Kew will permit the development of other features of which traces are already discernible. The arrangement of the living collections is at present based largely on horticultural convenience, geographic origin and systematic affinity, happily subordinated to an artistic or decorative treatment. In time we shall go further than that and attempt in some degree to reflect current botanical ideas in the grouping of our plants. Let me illustrate my meaning by a good example. The Succulent House is generally conceded to form one of the most interesting and stimulating exhibits to be seen at Kew—not merely from the weird and grotesque forms assumed by the individual plants, but chiefly because here you have assembled together plants of the most varied affinity having the common bond of similar adaptations to a like type of environment. The principles that underlie the arrangement of the best sort of museum may be applied with advantage in the case of a garden, and with tenfold effect; for is not a live dandelion better than a dead Welwitschia? This feature, introduced as it would be with moderation and discretion, would immensely enhance the value of the Gardens both to the student and general visitor.

But to return from this digression: on the whole the time seems ripe for the new departure. Fresh lines are opening up in systematic botany that call for special provision. Now it was evident from the circumstances of the botanical renaissance twenty-five years ago that when it acquired strength some readjustment between the old and the new would have to be made. The thing was inevitable. The administrative acts of recent years all point in the same direction. The founding of the Jodrell Laboratory, the enhanced efficiency of the Gardens, the great extension of the Herbarium building, all help to pave the way. But more is wanted. Reference has been made to the advantages that would attend the migration from the Natural History Museum. But it is most important of all to devise a mechanism for securing a flow of recruits to carry on the work. This would follow in the wake of a *rapprochement* with the schools on the lines already sketched out. Difficulties, no doubt, will be encountered in the initial stages of a reorganisation, but these are inseparable from our bureaucratic system. A very hopeful sign is the readiness which the Government has shown in instituting inquiries in the past. That nothing has come of them may be attributed primarily to the attitude of botanists themselves. If they can unite on any common policy, there should be no serious delay in giving it effect.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE resignation of Dr. A. E. Dolbear, professor of physics at Tufts College since 1874, is announced.

DR. KUNO FISCHER has resigned the professorship of philosophy at the University of Heidelberg in consequence of ill-health.

SIR WALTER LAWRY BULLER, F.R.S., has left on trust 1000*l*. to found a Maori scholarship, to be called the Buller scholarship, tenable by Maoris, but not by Europeans or half-castes.

DR. A. G. RUTHVEN, who is at present collecting reptiles and studying their field relations for the American Museum of Natural History, has been appointed curator of the museum of the University of Michigan.

THE Physical Society, Frankfurt a. M., has fitted up an electrotechnical instructional and experimental institution in which young people after finishing their apprenticeship may go through a further course in order to qualify themselves as works managers, &c.

DR. J. K. H. INGLIS, of University College, London, has been appointed principal lecturer in chemistry at University College, Reading; and Mr. F. J. Cole, of the University of Liverpool, has been appointed principal lecturer in zoology at the same institution.

PLANS are being prepared for a building for operative surgery and experimental pharmacy, and for the new university hospital in connection with the college of medicine and surgery, the University of Minnesota, this having been made possible by the recent bequest by Dr. A. F. Elliott of 30,000*l*.

THE Austrian Government has sanctioned the granting of the title of "Doktor der Bodenkultur" to be conferred upon those students of the Vienna High School for Agriculture who pass a satisfactory examination, which shall consist of the preparation of a scientific thesis and a *viva voce* ordeal of not more than two hours.

THE "Craggs" research prize will be awarded by the London School of Tropical Medicine in October next to a past or present student of the school who during the year (October, 1905, to October, 1906) has made the most valuable contribution to tropical medicine. The competing essays must reach the medical tutor of the school on or before October 1.

PROF. G. S. BOULGER has accepted the post of honorary professor and external examiner for the diploma at the Royal Agricultural College, Cirencester, in succession to the late Dr. W. Fream, and Mr. W. Hunting has accepted the position of honorary professor and examiner for the diploma of the same institution in succession to the late Sir G. Brown, C.B.

ACCORDING to *Science*, the General Education Board, endowed by Mr. J. D. Rockefeller with 2,000,000*l*., has made the following appropriations to nine institutions on condition that the sums in question be augmented three times in value from other sources:—Coe College, Cedar Rapids, Ia., 10,000*l*.; Washburn College, Topeka, Kan., 5000*l*.; Tulane University, New Orleans, 15,000*l*.; Wofford College, Spartanburg, S.C., 5000*l*.; Furman University, Greenville, S.C., 5000*l*.; Wake Forest College, N.C., 7500*l*.; Howard College, Birmingham, Ala., 5000*l*.; South-western University, Jackson, Tenn., 5000*l*.; and Mississippi College, Clinton, Miss., 5000*l*.

THE number of students attending the twenty-one German universities during the summer semester just ended is given as 45,630 matriculated students and 4566 non-matriculated students, 665 of these being at Berlin University. Among the matriculated students there were in Freiburg, Heidelberg, Leipzig, Munich, and Tübingen taken together 182 women, whilst the number of non-matriculated students included 1536 women. The number of science students (including mathematics) at these universities, that is, apart from the technical high schools, is given as 6323, as against 6125 in the corresponding semester of 1905; the number of pharmaceutical students is stated to have been 1767, against 1481 in 1905.

PROF. RÖNTGEN having declined the offer of the physics chair at Berlin University in succession to the late Prof. Paul Drude, the direction of the physical institute has been temporarily placed in the hands of Prof. W. Nernst, the director of the neighbouring physical chemistry institute. The designation "Physikalisch-Chemisches Institut" was only recently granted to Prof. Nernst's institution, which had hitherto been known as the "II. Chemische Institut"; it may also be observed that the equipment of the institute has been extended on the electrical side by means of a grant of 10,000 marks, so that the various workplaces have easy access to direct current of voltages of 10, 110, and 220 volts, and a low-voltage alternating current for electric furnace work.

THE following appointments have recently been made:—Dr. Wilhelm Deecke, professor of mineralogy in the University of Greifswald, as successor to Prof. Steinmann in the University of Freiburg i. B.; Dr. Johannes Walther as ordinary professor of mineralogy in the University of Halle; M. R. A. Raiss as extraordinary professor of scientific photography in the Lucerne University; Dipl.-Ing. Johannes Galli, technical director of the Annen Steel Works, Ltd., in Westphalia, as successor to the late Prof. A. Ledebur in the professorship of metallurgy in the Mining School, Freiburg, Saxony; and Dr. Karl Hintze, professor of mineralogy in the University of Breslau, has been offered an appointment in the University of Bonn, in succession to Prof. Dr. Laspeyres, retired.

THE calendar of the Merchant Venturers' Technical College, Bristol, for the session 1906–7, contains an interesting section dealing with the attempts being made in Bristol to secure the cooperation of employers in the work of educating apprentices and artisans suitably. The plans which certain firms adopt to secure this object are enumerated. Some firms pay the fees of students attending classes relating to the industry in which they are engaged; they also in some instances provide the necessary books and instruments, or they offer prizes for the best student in their employ. Other employers increase the wages of those of their servants who attend specified classes and pass the examination held at the end of the course. The time spent at evening classes is allowed to count in reduction of the working hours of apprentices by a third class of employer. Every plan which tends to bring home the importance of technical training to the manufacturers and their workmen deserves commendation, and it is to be hoped that the Bristol experiments will be tried in other large centres of industry.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 6.—M. H. Poincaré in the chair.—The iodomercurates of sodium and barium: A. **Duboin.** The author has isolated crystals of the double iodide of sodium and mercury, having the composition $2NaI,HgI_2,4H_2O$, and of the corresponding barium compound, $BaI_2,HgI_2,5H_2O$. The latter crystals were remarkable for their length, approaching 2 cm.—The borostannates of the alkaline earths: the reproduction of nordenskiöldine: L. **Ouvrard.** Calcium borostannate, possessing crystallographic characters identical with those of the natural mineral, was obtained by heating precipitated calcium borate with tin dioxide to a white heat in a slow current of hydrogen chloride.—The influence of the temperature of dehydration of alabaster on the setting of the plaster obtained: E. **Leduc** and Maurice **Pellet.**—The causes of the appearance of so-called anomalous forms in plants: P. **Vuillemin.**—Researches on the gaseous exchanges of a green plant developed in the light in the absence of carbonic acid, in a soil to which amides have been added: Jules **Lefèvre.** Under the above conditions it has been found that a green plant can develop, increasing its dry weight three times, without any oxygen being given off.—The action of the X-rays on the ovary of the dog: M. **Roulier.** Contrary to the results obtained with rabbits, atrophy of the ovary is very difficult to obtain, in spite of the production of serious lesions of the skin.—Experimental *nagana*. The variations in the number of the trypanosomes in the blood of the dog. The intravascular trypanolysis and trypanolytic power of the serum: A. **Rodet** and G. **Vallet.**

CONTENTS.

THURSDAY, AUGUST 30, 1906.

THE LATE DUKE OF ARGYLL.

George Douglas, Eighth Duke of Argyll, K.G., K.T. (1823–1900). Autobiography and Memoirs. Edited by the Dowager Duchess of Argyll. Vol. i., pp. xi+602; Vol. ii., pp. vii+635. (London: John Murray, 1906.) Price 36*s*. net.

THE last Duke of Argyll was unquestionably one of the most conspicuous and interesting men of his time. Inheritor of an ancient peerage, chief of a great Highland clan, head of an illustrious house that had played a prominent part in the history of his country, possessor of wide estates and surrounded by a numerous and thriving tenantry, he had every advantage which worldly position and hereditary distinction could confer. That he owed much to these gifts of fortune he himself was well aware, and fitly acknowledged. Yet even without them his strong character and vigorous intellect would have assuredly made him a prominent figure in any walk of life that he might have chosen. It will be for ever recorded to his honour that he turned his social advantages to the highest uses. The most accomplished orator of his day in the House of Lords, he held successively various posts as Cabinet Minister, took an active share in the political life of the country, both inside and outside of Parliament, and gained the respect and esteem of all parties in the State. Possessing literary tastes, he became the personal friend of many of the best writers of his time, and having, as he says of himself, "an inborn tendency to write," he showed by the vigour and elegance of his style that he had solid claims to literary eminence. From early youth he was an attentive observer of nature, so that he was led to follow with the keenest interest the developments of modern science, and having ample self-confidence he did not hesitate to take part in the scientific discussions of his day. Whether on public platforms, in periodical literature, or in separate volumes, his tongue and his pen were always busy, either in trenchantly denouncing assertions which he believed to be erroneous or in standing up stoutly for opinions and interests which he felt sure were just and true. But he was ever the high-bred gentleman, who, though a keen controversialist, did not lose sight of the dignity of his order.

The biography of such a man could not fail to be full of interest. It has been edited by his widow, the Dowager Duchess of Argyll, and is comprised in two volumes, whereof the first and about a sixth part of the second consist of an autobiographical fragment. Only begun so late as 1897, this autobiography occupied the writer's leisure hours during the last three years of his life. At his death in 1900, he had brought his narrative no farther than the close of 1857, when he was thirty-four years of age, so that the story of the longest and most active part of his career remained untold. The great blank thus remaining has been to some extent supplied by means of extracts from his speeches, letters, and published writings, but these naturally lack much of the personal revelation which gives a charm to the Duke's own tale. The extracts, as well as a large part of the later chapters of the autobiography, deal in great measure with politics, any reference to which would be out of place here. We shall therefore confine this notice of the book to the scientific side of the Duke's career.

No parts of the autobiography are more delightful than those wherein the writer reveals the intensity of his love of nature. Even to those readers who have had most acquaintance with his published writings, but who never came into personal contact with him, this revelation may perhaps be a surprise. His childhood and youth were spent amid country surroundings on the shores of the Firth of Clyde, and being much alone he was brought face to face with birds and trees and flowers, and the ever-changing aspects of sea and sky and mountain. All through life he was delighted to escape from the din and turmoil of politics to find rest and refreshment among his own Highland hills and glens, the ever varying mood of which under sunshine or cloud, from hour to hour, and from season to season, he watched with the most ardent devotion. Nor did he confine himself to the manifold attractions of his environment at Inveraray. For many years he spent a part of each summer yachting among the Western Isles, with most of the rocks and bays of which he became familiar, and over the endless beauties of form and colour of which he lingered with enthusiastic admiration. He had a keen artistic sense, which found expression in many a coloured sketch of the scenes that fascinated him, and has manifested itself in many passages of vivid description in his autobiography. His poetic temperament likewise received constant stimulus from the same marvellous panorama of sea and sky, mountain, islet, and cliff. He had steeped his mind first in the poetry of Wordsworth and then in that of Tennyson, and from time to time the exuberance of his feelings found relief in verse.

From his earliest years the Duke was passionately fond of birds, watching them in their haunts, noting their habits, and in this way acquiring an intimate knowledge of the bird-life of his native country. As an instance of the hold which this pursuit had upon him, he tells how, when he first looked out for a house of his own in London, he went to see one on Campden Hill, with some four acres of land about it. There were various objections to the place, but when he saw a flock of starlings on the lawn, nuthatches climbing the trees, fly-catchers and warblers darting around, "all doubts and difficulties vanished; the birds settled everything"; and he returned to town to instruct his agent to make the purchase. In this way he chose the charming residence which became his London home up to the end of his life. Besides observing the forms and ways of birds, he specially studied their various kinds of flight as a scientific

T

problem to which he often directed attention in his writings.

Within the domain of science his chief interest, however, lay in geology. Many of the questions with which geology deals relate to familiar aspects of the outer world, and do not require much technical knowledge for their comprehension, though in spite of their apparent simplicity they may demand much knowledge of that nature for their adequate solution. Amid the surroundings of the Duke's boyhood and youth there were many features to attract the notice of anyone with a geological bent. He does not appear, however, to have seriously considered the subject until he was seven-and-twenty years of age. In 1850, when on one of his usual visits to his estates in Mull, he received from a villager at Bunessan some specimens of fossil leaves which had been broken off from the face of a neighbouring sea-cliff. He ascertained that these leaves, evidently of a terrestrial vegetation, came from a stratum intercalated between the sheets of basaltic lava which cover so much of that region. His curiosity being thus thoroughly roused, he sent specimens to the Jermyn Street Museum for examination. Eventually he was encouraged by De la Beche to give an account of the discovery in a paper to the Geological Society, while at the same time Edward Forbes described the leaves, which proved to be of Tertiary age. These papers, published in the summer of 1851, showed for the first time the comparatively late date of the basalt plateau in the west of Mull, and thus fixed an important epoch in the volcanic chronology of this country. So auspicious a beginning might have been expected to become the starting-point of a successful geological career. But the Duke never followed it up. So far as the numerous calls on his time and thought allowed, he tried to keep himself in touch with the progress of research in some of the wider branches of geology, and from time to time, as the result of such intervals of leisure, he wrote articles or gave lectures on the subject. But these efforts of his could hardly be regarded as fresh and solid contributions to the advance of the science.

The Duke of Argyll's interest in facts seemed always to be limited by the extent to which he perceived, or thought he could perceive, their meaning, connection, and causes. Fundamentally, he lacked the patience and restraint that characterise the true man of science. His lively imagination was apt to see in the facts what he expected or wished to see, and he was tempted to group and explain them in accordance with some conception he had formed regarding them, and to leave out of sight as irrelevant those other facts which did not fit in with his interpretation. Thus, in regard to geological theory, he had early in life adopted the belief of the old Catastrophist school that the inequalities on the surface of the land have been mainly determined by gigantic earth-movements, and, shutting his eyes to all the arguments of those who pointed to the proofs of the enormous share taken by denudation in the shaping of that surface, he continued to maintain the same belief up to the last. Again, having in his younger days adopted what was long the prevalent opinion that some of the latest touches to the landscapes of this country were given by icebergs and floes during a time of submergence, he stoutly adhered to this doctrine, and lost no opportunity of ridiculing the conclusions of those who maintained that the phenomena in question could only be explained by the observed action of land-ice. But ridicule was not argument. Neither on this subject nor on that of the origin of scenery does the Duke appear ever to have studied the detailed evidence on the ground and grappled with it in a careful and candid examination of the facts. To use one of his own phrases, which he applies to some ecclesiastical tendencies of Gladstone, there was "a fundamental indelibility in his opinions" on scientific problems regarding which he had once made up his mind.

The Duke began his public career by a series of pamphlets and other writings on the ecclesiastical matters which at that time were agitating Scotland. In these publications he showed that he possessed no small share of the logical and metaphysical habit of mind so common among his fellow-countrymen. In his writings on scientific subjects, wherein he was often rather the keen critic than the sympathetic advocate, he found scope for the manifestation of the same mental characteristic. His three volumes, "The Reign of Law," "The Unity of Nature," and "The Philosophy of Belief," may be particularly cited as illustrations of his treatment of scientific questions. A period of thirty years intervened between the appearance of the first and that of the last of these books, which, in their author's words, represented his opinions on "the greatest of all subjects—the philosophy of religion in its relations with the philosophy of science." Even where scientific men differed most widely from him in his dealing with the problems which he discussed, they could not but recognise the intense earnestness and obvious loftiness of his purpose, the vigour with which he plied his arguments, and the fearless and sometimes acute criticism to which he subjected some of the generally accepted opinions of the evolutional school of the day.

Nevertheless, it must be admitted that the general impression made on the minds of the Duke's opponents by his declamation in these controversies was that he hardly ever had a doubt about any statement which he propounded. Scientific readers of his articles and books would express their amusement at what they styled his cocksureness, even in questions of difficult research regarding which he had no direct and first-hand knowledge. Such readers when they turn to his Autobiography may well rub their eyes when they meet there with the following statement:—

"I have never had any tendency to a dogmatic temperament. On the contrary, I have always had an ingrained liability to doubt."

He affirms that it was only where he had reached "the most assured convictions" that he deemed it "not only justifiable but a positive duty to express such convictions with all the certainty that is felt." The "certainty," however, extended to so many subjects that he might well remark that "some, perhaps many, of my contemporaries in my later years have thought me very confident in my opinions, and very aggressive in my expression of them." He complained of Huxley's aggressive style of writing, but when he penned his strongly-worded articles and letters he seems to have been unconscious that the same complaint might not seldom be brought against himself.

There is no intimation in these volumes to what, if any, extent the author of the Autobiography had journals or letters to rely upon in writing it. The preface states that "memory was invoked to bring back from the storehouse of the past all that had specially impressed him." That he had a tenacious memory can well be believed, but it has undoubtedly played him false in a number of instances, some of which are to be regretted. Thus he misdates certain transactions by a whole year. He refers to Lady Lyell, whom he intimately knew and admired, as "a sister of Leonard Horner, a man of whom much had been expected by his college friends, from his eminent abilities." Lady Lyell, however, was the daughter, not the sister, of Leonard Horner, and the Duke confounds two brothers. It was Francis Horner who passed away comparatively young; Leonard, who wrote an excellent memoir of his brother, lived until 1864, when he died in the seventy-ninth year of his age.

A more extraordinary mistake occurs on p. 289 of the Autobiography in the following sentence:—

"It does seem a marvellous fact that no knowledge of the wonders of Staffa had ever reached the world till it had been visited and described by a scientific Englishman, Sir Stamford Raffles."

Now Staffa, though not belonging to the Duke of Argyll, lies near to his favourite island of Iona, and opposite to his estates in Mull. He had been intimately familiar with it during many cruises among the isles, and must be supposed to have been acquainted with that classic of Scottish geographical description, Pennant's second "Tour in Scotland," in which so much of the scenery, natural history, and antiquities of the kingdom was for the first time described and figured. That volume was published in 1774, and one of its distinguishing features was the appearance in it of the earliest account of the wonders of Staffa, communicated to the author by no less a personage than Joseph Banks, afterwards the distinguished president of the Royal Society, who likewise contributed a number of excellent drawings of the cliffs and caves of the island, which were reproduced by Pennant, and form some of the best plates in his book. Sir Stamford Raffles, who spent his life in the East, was not born until 1781, seven years after the account of Staffa had been given to the world. He and Banks were both "scientific Englishmen" and great travellers, though how the Duke came to confound the one with the other is difficult to understand.

Another error, more serious than a mere lapse of memory, is to be found on p. 350, where it is gravely asserted that

"Smith of Jordanhill was the real founder of the Glacial Theory, which has played so great a part in recent geology. It is commonly assigned to Agassiz, but he did not visit this country till 1840."

No one would for a moment wish to disparage the importance of the discovery made by James Smith in 1839, when he found among the extinct shells of the Clyde basin a number of northern forms, and concluded from them that "it seems probable that the climate of Europe was colder during the newest Tertiary than during the Recent period." But he did not venture to propound a "theory" of any kind, nor did he refer to ice in any form. Agassiz, however, though he did not visit this country until 1840, had already spent some years in the study of glacial phenomena among the Alps, and as far back as 1837 had announced his opinions as to the former greater extension of the ice of central Europe and of the northern hemisphere. When he came to Britain he was able to demonstrate the existence here of the same types of glaciation as are found in Switzerland, and he thus produced further overwhelming evidence in favour of the views which he had already published. The Duke has here suffered his antagonism to these views to blind him to the historical facts of the case, and the same spirit of opposition has led him to conclude his reference to the subject with a characteristically sarcastic allusion to the "fads and faddists" that have followed in the track of the great Swiss naturalist.

It is in many ways a misfortune that the Duke of Argyll did not live to carry his Autobiography down through the central and later parts of his life, and to review in the calm of his old age the controversies, scientific and other, in which he had been engaged. The din of conflict had long ceased, and many of those with whom he had crossed swords had passed away. It would have been interesting and instructive to learn from his own pen how the questions in debate looked to him after the long lapse of years; to discover whether time had modified the confident assurance with which he used to do battle, or had left him in the same convinced and defiant frame of mind in which he fought. Up to their close, his chapters reveal not the slightest symptom of the mental enfeeblement of old age. Indeed, he never wrote more vigorously or with more apparently voluble ease than in this Autobiography. It contains many passages which might be collected as examples of an admirable style of composition, and among his varied contributions to literature it will not be surprising if this latest effort of his pen shall outlast in general acceptance any of his previous writings.

The chapters which follow the Autobiography give a most inadequate picture of what the Duke was in his prime and of what he did. The chapter on his science is particularly disappointing. It consists almost wholly of disconnected excerpts from letters to or from correspondents, interesting enough in themselves, but embodying no connected review of his relations to science, and leaving the reader very much in the dark as to what these relations really were. The truth is that, what with politics on the one side and the management of his estates on the other, the Duke had but little time for other occupations. Science was to him not so much a serious study as a refreshing relaxation. Even had he undergone the training and possessed the special mental gifts which go to make the successful man of science, he could hardly have found room for their exercise in his busy life. His mind, however, was so active, that such intervals of leisure as he could secure sufficed to enable him to keep himself informed of what was being done in various important lines of investigation. And it was this course of interrupted reading and the thoughtful reflection that accompanied and followed it, rather than any original inquiry of his own, that blossomed out into the lectures, addresses, articles, and books which came in such a crowded procession from his pen. His death left a blank in society which has been filled by no one of his contemporaries. Few men of his class were endowed with so remarkable a mental versatility and took such an eager interest in all kinds of intellectual pursuits. He will be remembered as an illustrious example of a type too rare among us, wherein the *grand seigneur*, the statesman, the man of letters, and the lover of nature and of science are blended in one noble character.

CHEMISTRY AND THE DETECTION OF CRIME.

Lehrbuch der gerichtlichen Chemie. Zweite gänzlich umgearbeitete Auflage, bearbeitet von Dr. Georg Baumert, Dr. M. Dennstedt, und Dr. F. Voigtländer. Vol. ii. Pp. x+248. (Brunswick: F. Vieweg and Son, 1906.) Price 9 marks.

In addition to cases of alleged poisoning, there exist a number of crimes in the detection of which chemical and physical science can render special aid to the dispensation of justice. Thus, in proving the falsification of documents, in demonstrating a forgery, in the identification of bloodstains or other body-secretions, and in the discovery of evidence confirming a charge of incendiarism, the results of a capable scientific examination will often furnish a direct proof, where otherwise the verdict would depend upon a mere balancing of probabilities.

The second part of Dr. Baumert's "Lehrbuch" deals exhaustively with the foregoing problems. Particular attention is devoted to the photography involved, and in the investigations described much use is made of this adjunct. In fact, the expert in criminological chemistry, if he is to render all the assistance possible, must be not merely a chemist, but a combination of photographer, microscopist, and detective as well.

About three-fifths of the volume is devoted to the methods of discovering and demonstrating fraudulent alterations of documents. The treatment is very complete, embracing as it does not only the microscopical examination of the written characters, the chemical testing of the ink and paper, and the indications of erased or altered letters brought out by photographic enlargement, but also the consideration of pencil marks and "secret" inks.

Some fifty pages are assigned to the examination of blood-stains, and include a careful description of the conditions which should be employed in carrying out the "biological" test for the characterisation of human blood. The authors think, in opposition to Uhlenhuth, that, given the requisite knowledge of bacteriology and physiology, the analyst rather than the medical man should be entrusted with this experiment. A good plate shows the absorption spectra of hæmoglobin and its congeners, and, indeed, a word of praise is due to the excellent photographic reproductions with which the book generally is furnished. Next follows a short chapter on the examination of suspected articles for the presence of human spermatozoa, whilst the last thirty pages deal with the evidence of incendiary origin which the chemist may find on closely scrutinising such objects as may have been left undestroyed where a fire has broken out.

Throughout the book careful directions are given for conducting the various operations, and numerous pitfalls which beset the unwary are indicated. As is befitting where serious charges are concerned, clear distinctions are drawn between the results which constitute proof and those which, however strongly confirmatory, are not in themselves decisive. The general impression left by a perusal of the volume is that in the solution of the crime-problems dealt with the guidance afforded is admirably practical and safe.

C. S.

NERVOUS DISEASE.

The Management of a Nerve Patient. By Dr. A. T. Schofield. Pp. ix+267. (London: J. and A. Churchill, 1906.) Price 5*s*. net.

We cannot congratulate Dr. Schofield on the title he has selected, for a book written, as the author tells us, for the use of students and practitioners requires no such popular designation as "The Treatment of a Nerve Patient." Further, the writer does himself an injustice, for many medical men would not trouble to read a book the title of which suggests some words of advice for a nurse or layman.

Now we consider this little manual well worthy of a careful perusal, for although we do not agree by any means with all that the writer tells us, nevertheless it is a book full of valuable suggestions and advice. We agree with the statement that "many physicians do not sufficiently recognise the influence of mind over body," but Dr. Schofield, in his desire to emphasise his point, is apt at times to state his case too strongly.

We cannot by taking thought dispel disease; the influence of the patient's mind over his body is powerful, but is it "almost all-powerful"? The consumptive patient is usually full of hopefulness to the last, but unless other means are taken to promote recovery his light-heartedness is of little avail. The writer later greatly modifies his original statement regarding the influence of mind over body by stating (p. 29) that "there are many diseases not cured by the mind alone"; in fact, he might add that quite few maladies can be so treated. Nevertheless, we agree with the statement that "in every case of disease the condition of the mind is an important factor."

We cannot concur with the writer's distinction between "madness" and "hysteria" (p. 21). Hysteria is a disease with definite physical symptoms, and, in addition, the patient exhibits some mental aberration. Now if this mental disturbance becomes more marked, the patient is usually considered to have passed from the realm of physical disease into a state commonly spoken of as "madness," and yet the disease is the same in both cases, only in one instance the physical symptoms are the more prominent and in the other the psychical. Dr. Schofield writes that "a person whose conscious mind is unsound is suffering from madness: one whose unconscious mind alone has gone astray suffers from neuromimesis or hysteria; and the distinction is good." Now a few pages previously the writer tells us that "there is but one mind." Clearly, then, the mind is either sound or unsound, for the whole cannot be what a part of it is not. Further, we are told that "the recovery of the patient from disease depends more upon the efficiency of the *vis medicatrix naturae*, in other words, unconscious mind, than upon any other agent." Therefore it would appear that in hysteria the apparatus which is all-powerful in cure is itself diseased; thus if this statement is true it is a factor which must greatly influence the prospect of recovery.

Dr. Schofield speaks in no uncertain manner concerning the tendency of some persons of the present day to mix up a "very exaggerated psycho-therapy with a pseudo-Christianity." We entirely agree with his remarks, and consider that he has stated the case none too strongly. In the chapter entitled "The Diagnosis," we would specially commend to the student the advice the writer gives of the "importance of cultivating tact." There is probably no attribute of greater value to a physician, and no opportunity should be lost for developing it. The writer makes some very sound remarks concerning the personality of the "doctor." Some persons may consider that too much detail is given, and that some advice is almost too trivial to be recorded; but with this view we should disagree, for undoubtedly the strength of this book lies in the attention which is bestowed on detail.

This book supplies a want, and certainly deserves a place on the bookshelf of the young physician.

OUR BOOK SHELF.

Traité d'Exploitation commerciale des Bois. By A. Mathey. Tome i. Pp. xviii+488. (Paris: Lucien Lavens, 1906.) Price 15 francs.

THIS volume will rank high among the many excellent Continental books which deal with forest utilisation. The author gives a great amount of important and practical information concerning the commercial exploitation of timber from every possible point of view. The work is profusely illustrated by well drawn and excellently reproduced figures, numbering no fewer than 377, and to these must be added eight beautiful chromo-lithographic plates. The volume is divided into five parts.

Part i. deals with the general properties of wood. The anatomical features are also described. The macroscopic characteristics of the various home and exotic deciduous and coniferous species are gone into, and the diagnostic features are brought out very clearly by an excellent series of figures, which show specimen blocks of the various woods cut in transverse and longitudinal sections. The numerous chemical and physical properties of timber are treated in detail. This part finishes with an excellent account of the effect of soil and climate on the growth and texture of the wood.

Part ii. deals principally with defects in timber, such as abnormality of growth, knots and wounds of all kinds, which may be caused by physical agencies. The different kinds of rot arising from the attack of fungi are exhaustively dealt with. This part is extremely well illustrated by means of the coloured plates already referred to, which should greatly facilitate the recognition of these maladies that are only too frequently ignored in this country. The various forms of white and red rot being due to specific organisms greatly increases the danger of sound timber being contaminated by diseased timber; hence the importance of recognising those diseases in order, if possible, to prevent their future occurrence and spread.

Part iii. of the work deals fully with the important subject of seasoning and storing timber, and the different artificial methods of rendering wood antiseptic by means of immersion in, and injection with, the various kinds of preservatives. The artificial methods of seasoning and preserving timber are now receiving considerable attention as the price of wood increases and the supply diminishes, so that this part of the book should be of the greatest interest to all concerned in the production and use of wood.

In part iv. the felling and conversion of timber is adequately considered. The different instruments used are also fully described and figured. In the last part is given an exhaustive account of almost every possible means of timber carriage and transport. On the whole, the author is to be congratulated on the production of this excellent work.

Illustrations of British Blood-sucking Flies. With Notes by Ernest Edward Austen, Assistant, Department of Zoology, British Museum (N.H.). Pp. 74; 34 plates. (Printed by Order of the Trustees, 1906.) Price 25*s*.

GNATS and other blood-sucking flies have always been a great pest in most countries, but it is only within the last few years that their active agency in the dissemination of many of the most serious diseases which afflict both men and the higher animals has been fully recognised. In England, however, modern drainage and sanitary regulations have so far diminished their numbers that whenever gnats are exceptionally troublesome many people jump to the conclusion that there has been an invasion of "mosquitoes" (not knowing that the terms gnats and mosquitoes are applied indiscriminately to any biting species of Culicidæ), and, what is more important, the gnats belonging to the genus Anopheles, though far from extinct in England, have ceased to disseminate ague as formerly.

Mr. Austen informs us that there are practically only six families of blood-sucking flies in England, Chironomidæ (midges), Culicidæ (gnats or mosquitoes), Simulidæ, Tabanidæ (horse-flies), Muscidæ, and Hippoboscidæ. In Chironomidæ and Muscidæ the habit is exceptional, occurring in a few species only, and, except in the Muscidæ (and perhaps the Hippoboscidæ), the habit is confined to the females. Mosquitoes, however, are also capable of subsisting on the juices of plants.

The illustrations in the present work are considerably enlarged, and with few exceptions represent only females. The originals have been prepared for exhibition in the north hall of the Natural History Museum. The letterpress consists of a brief general account of each family, and a notice of the chief characteristics, habits, and localities of the various species figured, technical descriptions, however, being omitted. Little has been done in England to popularise the study of Diptera, and there are very few illustrations of the species; so we welcome this excellently arranged and illustrated book as a useful contribution to our knowledge of the British Diptera.

W. F. K.

Gehirn und Rückenmark. Leitfaden für das Studium der Morphologie und des Faserverlaufs. By Dr. Emil Villiger. Pp. vii+187; illustrated. (Leipzig: W. Engelmann, 1905.) Price 9 marks.

THERE is no department of medical science in which greater advances have been made within the last twenty-five years than in that of diseases of the central nervous system. This is mainly a result of increasing precision in our knowledge of the complicated labyrinth of the various groups of nerve-cells and nerve-fibres which compose the essential mechanism of the nervous system. The complexity of the subject renders it a task of some difficulty to the medical student, whether he be undergraduate or post-graduate, who is desirous of acquiring that thorough grasp of nervous anatomy on which the successful solution of diagnostic problems must of necessity depend. To such students as are able to read German we can cordially recommend Dr. Villiger's book. Within the compass of 177 pages the author discusses in lucid style the main facts of the morphology of the brain and spinal cord, and describes all the more important tracts of nerve-fibres. An excellent series of illustrations, many of them original, illuminate the text, whilst we are glad to observe that the author evidently describes the gross anatomy as if demonstrating the actual brain, using the diagrams as accessories. In this way the practical value of the book is undoubtedly enhanced.

Commencing with an account of the embryological development of the nervous system, the author proceeds to discuss in detail the naked-eye anatomy of the brain and spinal cord, with their surrounding membranes. An interesting historical account is given of the successive stages in the methods of neuro-histology, but we are surprised to find no reference to Marchi's well-known osmic acid method of staining recently-degenerated nerve-fibres, a method which since its introduction more than ten years ago has done more than any other to clear up our knowledge of nerve-tracts. Nor is any reference made to the still more recent methods of Cajal and of Bielschowsky for the staining of neurofibrils. Doubtless these omissions will be rectified in a future edition.

An excellent description is given of the microscopic characters of the various regions of the cerebral cortex, the basal ganglia, the cerebellum, pons, medulla, and spinal cord. The cranial nerves are discussed with remarkable clearness, the diagrams illustrating this part of the book being particularly good. Finally, there is a concise account of the main sensory, motor, and association systems of fibres in the central nervous organ. The book is well indexed.

Dr. Villiger is to be congratulated on having produced an excellent book. Not only does it amply fulfil its avowed scope of serving as an introductory guide to the student, but it will be read with pleasure and profit by many neurologists.

Naturkonstanten in alphabetischer Anordnung. By Prof. Dr. H. Erdmann and Dr. P. Köthner. Pp. 192. (Berlin: Julius Springer, 1905.) Price 6 marks.

THIS handy little work is a book of constants intended for the use of chemists and physicists. It differs from others of its kind chiefly in the fact that the information in it is arranged alphabetically, with a marginal thumb index for rapid reference.

The work of the compilers has on the whole been very well done. Only one value of each constant is given, and usually no reference is made to the source or author. The work of the last ten years has, however, been incorporated to a much greater extent than is usual in books of this kind, and even data only published during the past twelve months are included. The plan adopted by the compilers should conduce to a considerable saving of time in looking up information. We think the book should be of especial value to chemists, as the data necessary in quantitative analysis are dealt with in a specially complete manner. There are also tables giving for each element and its most important compounds the atomic or molecular weight, density, melting point, boiling point, thermochemical constants, &c., together with a five-figure logarithm table for computation purposes. Details as to the most important spectroscopic features of each substance are given in a very handy form, the conditions as to the particular spectrum being clearly specified. Another very useful table containing data not often easily accessible is that of the electrochemical equivalents of the metals.

It is difficult in the time possible for a reviewer to spend on a book of this kind to detect many of the errors nearly inevitable in a first edition. The plan adopted by the writer has been to put the work for a while on his reference shelf, and turn to it frequently when looking up constants, verifying from other sources the data thus obtained.

Obvious slips are the value of $\frac{1}{4}\pi$, given on p. 114 ten times too small, the E.M.F. of the Clark cell, given on p. 40 as 0.60735 volt, and several misprints among the tables of English weights and measures, where the gallon is included under measures of surface.

Other inaccuracies are the value for the melting point of palladium, given as 1950° C. instead of 1525° C. ± 25, of nickel, given as 1500° C. instead of 1427° C., and of wrought iron, given as 1600° C. instead of 1500° C.

One rather unfortunate tendency of the work is to deal in a multiplicity of units. There is, for example, no need to speak of "hektowatts," and it is certain that some of the subdivisions of the millimetre dealt with in the chapter on units are only confusing and rarely met with in practical work. Then, also, the units other than metric given in the book as at present in use in various countries are not always those ordinarily adopted. In Japan, for example, the present standard of mass is the "Kwan," prototypes of which were recently standardised at Sèvres.

We can, however, cordially recommend the book, which should prove very useful. J. A. H.

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.]*

Thermodynamic Reasoning.

In the address delivered by Principal Griffiths at York, which is printed in your issue of August 9, I read: "Prof. Armstrong remarks that it is unfair to 'cloak the inquiry by restricting it to thermodynamic reasoning, a favourite manœuvre with the mathematically minded.' He adds that such a course may satisfy the physicist but 'is repulsive to the chemist.' The inquiry, 'Why is the application of thermodynamic reasoning repulsive to the chemist?' naturally suggests itself."

This statement shows a strange misapprehension of my position. I have taken exception *to the restriction of the inquiry* to thermodynamic reasoning, not in any way to the mere application of thermodynamic reasoning. My objection was to formula worship. I still and shall ever object to it, for it is the bane of progress. As I said at York, physicists too nearly resemble the visitors to London who walk along the Strand and Shaftesbury Avenue and are content to look at the theatres from outside; they resemble those who admire the British Museum building but have no desire to examine the treasures within it.

If I did not misunderstand him, Mr. Whetham implied at York that it was enough for him that a certain thermodynamic expression was valid: what the condition termed osmotic pressure really is—whether a true pressure or whether, as I suggested, a negative pressure or thirst—mattered not a jot. A certain mathematical thermodynamic picture being painted, no other artist need apply. This does not seem to me to be the attitude a scientific inquirer should adopt. Whether I represent the opinion of chemists matters little: personally I am not willing to remain outside the Museum: I shall go inside, if possible, trusting that in some faint degree I may be able to appreciate the wonders within it.

At present, progress is not a little hampered by the fact that chemists and physicists cannot wander through the museums of nature looking eye to eye in complete sympathy with one another: surely we are destined to be the closest of friends; more should be done to cultivate an understanding; a confusion of tongues has arisen which keeps us apart: we must both strive to speak a simpler language. Together

> "Let us inspect the lyre and weigh the stress
> Of every chord and see what may be gain'd
> By ear industrious and attention meet."

HENRY E. ARMSTRONG.

It is the strength and weakness of thermodynamical reasoning that it connects different phenomena without the aid of theories about the mechanism by which the connection is effected.

In the discussion at York, Prof. Armstrong put forward certain arguments in favour of the view that solution is a chemical phenomenon, and osmotic pressure due to an attraction of the nature of chemical affinity. He used these arguments in an attempt to invalidate van 't Hoff's thermodynamic theory, which shows that, from the observed solubility phenomena of volatile substances, it follows that the ideal osmotic pressure of a number of particles of such substances in a dilute solution must be equivalent to the pressure which the same number of particles would exert as a gas occupying the same space.

In my reply to Prof. Armstrong I pointed out that the thermodynamic theory is quite independent of the particular view we may adopt as to the fundamental nature of solution, and the *modus operandi* of osmotic pressure. Osmotic pressure may, as van 't Hoff himself supposed, be due to the impacts of the dissolved molecules; it may, as Prof. Armstrong believes, be caused by chemical affinity; it may be produced by some other undiscovered cause. The thermodynamic reasoning avoids all such hypotheses, and connects directly the experimental facts of the solubility of gases with the osmotic pressure they would exert against a perfect semipermeable membrane in dilute solution.

I have never suggested that the ultimate nature of solution was a matter of no interest. It is the question of most supreme importance now outstanding in these subjects; but let us clear the issue before attacking it. We must recognise clearly that the relations indicated by thermodynamics and confirmed abundantly by experiment are among the established facts to be explained by a theory of the nature of solution.

It is for this recognition of the true position of the problem that I contend. The thermodynamic reasoning which connects the ideal osmotic pressure with experimental phenomena is not in question. That reasoning is confirmed by measurements of actual osmotic pressures and of freezing points. It can only be invalidated by a general attack on thermodynamic theory, such as that which was foreshadowed in Mr. Campbell's recent reconnaisance-in-force. I do not think any such attack has much chance of success. Osmotic phenomena seem to me to be entrenched in the strongest part of the vast lines occupied by the science of thermodynamics.

Cannot Prof. Armstrong agree to accept the thermodynamic reasoning as confirmed by experiment, and pass on to the further problem? Personally, I think that the evidence at present available is on the whole in favour of the chemical theory of solution and osmotic pressure —the theory which Prof. Armstrong supports; but there is work to be done before such a conclusion can be taken as established. May we not agree that it is better both for physicists and chemists to do such work than to waste their energies in attacking with inadequate artillery the well-fortified citadel of thermodynamics?

W. C. D. WHETHAM.

High Borrans, Westmorland, August 21.

The Iron Arc.

WHILE carrying on some experiments with the electric arc between iron electrodes, one of my students, Mr. H. D. Arnold, noticed that there was a certain critical P.D. at which an abrupt change took place in the conditions of the arc. Subsequent investigation has shown that the effect is closely analogous to the "hissing point" of the carbon arc. How close the analogy is may be seen from the following remarks. If the iron arc is started with a large external resistance and maintained at such a length that the current is well below one ampere, it burns with little or no sound, and its appearance in the neighbourhood of the anode is very diffuse and ill-defined. As the external resistance is gradually decreased, the P.D. falls and the current rises until a certain critical value, depending on the length of arc and size of electrodes, is reached. At this point a very small decrease in external resistance suffices to cause a sudden increase in current and drop in P.D., precisely as with the carbon arc. At the same time the arc contracts, a bright spot appears on the anode, and a characteristic hissing sound begins. Further increase of current is accompanied by a *continued decrease* in P.D. The hissing stage, in fact, begins at quite a different point on the P.D.-current diagram from that in the case of the carbon arc. If the experiment is carried out in the reverse order, starting with a large current, the discontinuity is encountered again, but not until the current has been diminished beyond the value that it had at the beginning of the hissing stage. Indeed, with arcs of 6 mm. and more, the current on the hissing stage can with care be decreased until it is smaller than its previous largest value on the quiet stage. Thus there are two possible values of P.D. for the same current and length of arc, one corresponding to the quiet, the other to the hissing stage.

How closely the physical cause of this discontinuity resembles that in the case of a carbon arc is still in doubt, though investigations bearing on this question are under way. With the iron arc there seems to be no sharply defined crater, for each electrode terminates in a viscous, incandescent globule of what seems to be magnetic oxide of iron, from which the discharge takes place. Thus we have to do, properly speaking, not with an arc between iron electrodes, but with one between electrodes of Fe_3O_4. Even when the arc is hissing strongly, the discharge seems to take place from only a small area on the surface of the globule. Moreover, a large increase in diameter of electrodes is accompanied by only a small increase in the value of the critical current, which varies between 0·8 ampere and 1·5 ampere over a wide range of values of length of arc and thickness of electrodes. On the other hand, I have found no positive evidence that the discontinuity is not due to the presence of oxygen around the anode. A test with an exploring electrode showed that the effect is confined mainly, if not entirely, to the anode. Given an arc burning on the quiet stage in the neighbourhood of the hissing point, the hissing can be precipitated by shortening the arc, just as in the case of the carbon arc.

After the current has been increased somewhat beyond the hissing point, the arc begins to rotate rapidly, so that on the anode a ring instead of a spot of light appears. This is accompanied by a high-pitched squeak or whistle, which, as the current is still further increased, degenerates into a sputter, and this in turn into a steady, strong hiss, the ring meanwhile having disappeared. At the beginning of the "whistling stage" the arc has a curious tendency to jump back into the quiet stage, so that for an instant the hissing ceases, the current falls abruptly, and the P.D. rises several volts. If one begins to diminish the current immediately after one of these abrupt changes, the quiet stage can sometimes be maintained steadily, even though the current is far greater than that at which hissing normally occurs. It is not impossible that slight irregularities in the supply E.M.F. may in certain circumstances serve to precipitate the change from the one stage to the other, even though the current be not that at which the change normally takes place.

In conclusion, the question may be raised whether Lecher's observation of the discontinuous nature of the arc discharge between iron electrodes was not made on the hissing stage alone, and whether, as with the carbon arc, the discharge may not be perfectly continuous when the current is made sufficiently small. It is planned to repeat Lecher's experiment, making tests on both the quiet and the hissing stages of the iron arc.

Middletown, Conn., August 9. W. G. CADY.

Volcanoes and Radio-activity.

IN the *Popular Science Monthly* for June Major Dutton has an interesting article on the above subject, which was noticed in a recent issue of NATURE. Having been occupied lately with the study of volcanoes in connection with a more general inquiry into the cause of earthquakes, it occurs to me to point out that Major Dutton has overlooked the recognised distribution of volcanoes about the sea coast, which seems completely to invalidate his theory. If radium, which the researches of the Hon. R. J. Strutt have shown to be so abundant in typical rocks of the earth's crust, such as granite, were an exciting cause of volcanic activity, we should expect to find an abundance of active volcanoes in the interior of continents, such as the United States, Europe, Asia, Africa, Australia, and Brazil, which is contrary to observation.

T. J. J. SEE.

Naval Observatory, Mare Island, California, August 10.

The Radio-activity of the Chemical Elements.

IN connection with the emission, from the radio-active elements, of corpuscles with velocities below the critical velocity necessary for the ionisation of gases, it has occurred to me that such a form of radiation is possibly a fairly general property of the chemical elements. It is, I think, usually accepted that "γ" radiation always accompanies the projection of "β" particles, and the extreme penetration of the "γ" rays seems to be directly due to the very high velocity of the average "β" particle. As the efficiency of the "X" rays is due to the sudden negative acceleration of the unit electrical charges (*i.e.* the corpuscles) as they strike the anti-kathode, it appears quite possible that corpuscles, moving with comparatively low velocities, may yet be capable of causing a form of "γ" radiation of feeble penetrating power. The fact that the kathode stream, which can hardly penetrate the glass of the tube, is still able to set up very penetrating X radiation when given a sudden negative acceleration by impact with the platinum anti-kathode may perhaps be given as an instance in support of this idea. It seems probable that the photographic action of a beam of corpuscles (deviated away from the "γ" radiation by a magnetic field) may be chiefly due to a form of "γ" ray set up on contact with the plate itself. The several mysterious instances of the fogging of photographic plates left in certain conditions for considerable periods may be caused by a very feeble form of "γ" radiation set up by the impact of slow-moving corpuscles on the surrounding matter. Such evidence of these slow-moving corpuscles may be somewhat meagre and doubtful, but I think that, so far as the ordinary chemical elements are concerned, the emission of such corpuscles may be very much greater than the measured activities would lead us to suppose.

C. W. RAFFETY.

Streatham Common, August 25.

THE OXIDATION OF ATMOSPHERIC NITROGEN IN THE ELECTRIC ARC.

IN the year 1775 Priestley published his "Experiments and Observations on Various Kinds of Air," in which he showed that when a series of sparks was passed through air, the air became acid. The experiment was carried out by means of a glass tube, having one end closed with wax through which a wire was fixed, the open end being placed over a solution of blue litmus. Sparks were passed between the solution and the wire, and in a short time the blue litmus turned red. He further noticed the important fact that the water gradually rose up towards the wire. The observations of Priestley were shortly afterwards substantiated by Cavendish, and in 1893 Lord Rayleigh, with better apparatus and appliances, repeated the experiments which ultimately led him to the discovery of argon. Priestley attributed the acidity to the formation of carbon dioxide, but Cavendish, on repeating the work, proved it to be due to the formation of nitric and nitrous acids.

After the successful experimental work of Lord Rayleigh, attention was turned towards the production of nitric acid from atmospheric nitrogen. But it was undoubtedly due to Sir William Crookes, who as president of the British Association in 1898 directed attention to the gradual depletion of the world's store of nitrogenous products, that the importance of the fixation of atmospheric nitrogen was recognised by the scientific and commercial world. At the present time about 1·5 million tons of Chili saltpetre are annually exported, but those who have studied the question consider that at this rate of exportation the Chilian beds will be, at the latest, depleted by 1940. But as the population of the world increases, the quantity of nitrogenous material required for fertilising purposes advances in equal ratio. Sir William Crookes pointed out in 1898 that the world's growth of wheat was about 163,000,000 acres, which at the average of 12·7 bushels per acre gave 2,070,000,000 bushels. "But thirty years hence the demand will be 3,260,000,000 bushels. . . . By increasing the present yield per acre to twenty bushels, we should with our present acreage secure a crop of the requisite amount." In order to give this increase, about 1·5 cwt. of nitrate of soda would be required to be applied annually to each acre, that is to say, 12,000,000 tons would be needed. As at present situated the world is not in a position to supply this vast amount of nitrogenous product. Since Crookes sounded this note of warning many attempts have been made to oxidise atmospheric nitrogen on a commercial scale, but until within the last fifteen months no process based upon electrical oxidation has been an actual commercial success. It yet remains to see whether the process of Drs. Caro and Frank, which depends upon the formation of calcium cyanamide, will be able to compete in the first place with natural nitrates and ammoniacal products, and, secondly, with the electric process of Birkeland and Eyde, which, as we will shortly show, appears to have solved the problem of the fixation of atmospheric nitrogen. Drs. Caro and Frank found that by passing nitrogen over heated barium carbide barium cyanide was produced thus,

$$BaC_2 + N_2 = Ba(CN)_2,$$

but that when calcium carbide was employed calcium cyanamide and not calcium cyanide is formed,

$$CaC_2 + N_2 = CaCN_2 + C.$$

When the cyanamide is heated with water under pressure it is decomposed with formation of ammonia and calcium carbonate,

$$CaCN_2 + 3H_2O = CaCO_3 + 2NH_3.$$

This process is stated to take place slowly when the cyanamide is distributed on the soil. Although the manufacturers state that cyanamide is stable and does not deteriorate on keeping, some at least of the users say it is unstable and deteriorates considerably as a fertiliser when kept.

An electrical process—that of Bradley and Lovejoy—which was almost a success, was worked for about eighteen months at Niagara. They employed a continuous current with a potential of 10,000 volts. As it is very difficult to keep steady discharges at this high voltage, a slowly rotating framework with projecting electrodes was employed. As it rotated, the electrodes, which were of platinum, approached other projecting electrodes; discharges were thus provoked, but immediately interrupted. In an apparatus of only 5 kilowatts as many as 414,000 arcs were produced per minute. The working of such an apparatus on a technical scale was, as might be supposed, of great difficulty, and although considerable quantities of nitric acid were produced per kilowatt year, it did not prove commercially successful.

In May, 1905, a factory was started at Notodden, in Norway, for the manufacture of calcium nitrate from air and limestone by means of the electric arc flames. A photograph of the factory as it is at present is shown in Fig. 1. In the Birkeland-Eyde process, which is worked at Notodden, a high-tension arc flame is produced between two pointed copper electrodes. The electrodes are attached to a high-tension alternator, and are placed equatorially between the poles of a powerful electromagnet, so that the terminals of the electrodes are in the middle of the magnetic field. An electric disc flame is thus produced which is shown diagrammatically in Fig. 2, and a photograph of the actual flame in Fig. 3. The photographed flame, which represented about 250 h.p., was produced between water-cooled electrodes made of copper tubing.

The working potential employed is 5000 volts, the current is an alternating one of 50 periods per second, and the distance of the terminals apart is about 8 mm. As already mentioned, the electrodes are copper tubes which are water-cooled, and are in the form of a narrow, elongated U; even with flames of 750 kilowatts at 5000 volts the same form of electrode can be employed. By cooling the electrodes, about 7·5 per

FIG. 1.—View of nitric acid factory at Notodden.

cent. of the electric energy employed between the electrodes is removed as heat by the water.

Prof. Birkeland explains the formation of the disc-flames in the following way:—"At the terminals of the closely adjacent electrodes, a short arc is formed, establishing an easily movable and ductile current conductor in a strong and extensive magnetic field, *i.e.* from 4000 to 5000 lines of force per sq. cm. in the centre. The arc then moves in a direction perpendicular to the lines of force, at first with an enormous velocity which subsequently diminishes; and the extremities of the arc retire from the terminals of the electrodes. As the length of the arc increases, its electrical resistance also increases, so that the tension is increased until it becomes sufficient to create a new arc at the points of the electrodes. The resistance of this short arc is very small, the tension of the electrodes therefore sinks suddenly, with the consequence that the outer long arc is extinguished. . . . In an

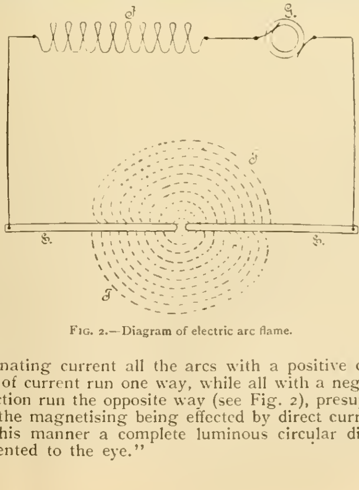


FIG. 2.—Diagram of electric arc flame.

alternating current all the arcs with a positive direction of current run one way, while all with a negative direction run the opposite way (see Fig. 2), presupposing the magnetising being effected by direct currents. In this manner a complete luminous circular disc is presented to the eye."

It is interesting to note that the flame, considering its high electrical power, is not particularly luminous, as it is quite possible to look directly at it with the naked eye at a distance of about 1 yard, and it is not easy to snapshot it.

The alternating-current disc flame is enclosed in special furnaces which are lined with firebrick and enclosed with metal casing. The fire-chamber of the furnace is narrow in the direction of the lines of force—from 5 cm. to 15 cm. wide—and made partly of perforated firebrick, the air being conveyed to the flame in an evenly distributed supply through the walls. The magnetic system is composed of two powerful electromagnets, the extremities of which are turned in towards the fire-chamber. The air is driven into the central region on both sides of the flame by gentle pressure from a Roots blower; it must not be blown too rapidly, otherwise the flame is extinguished. Fig. 4 shows three of the furnaces, each furnace taking 500 kilowatts. The volume of air at present treated is 75,000 litres per minute, which after passing through the furnace contains about 1 per cent. of nitric oxide. The gases leave the furnace at a temperature of 600° to 700° C., and are first passed through a steam boiler, the steam from which is employed in the further manufacture of calcium nitrate. After passing from the boiler the temperature is about 200°, and by passage through a cooling arrangement the temperature is reduced to 50°.

FIG. 3.—Photograph of electric arc flame, showing water-cooled electrodes.

FIG. 4.—Photograph of three 500-kilowatt furnaces at Notodden.

The gases now pass into two large oxidising chambers with acid-proof lining, where the oxidation of the nitric oxide formed in the furnaces takes place with production of nitrogen peroxide. It is then conducted into an absorption system consisting of five towers, two being of granite and two of sandstone, filled with broken quartz over which water trickles, nitric acid thus being produced. The fifth tower is filled with broken bricks over which milk of lime trickles and which absorbs the now rarefied nitrous gases with formation of calcium nitrate and nitrite. In the plant at Notodden there are two such series of towers. The liquids from the fourth tower, which consist of 5 per cent. nitric acid, are raised to the top of the third tower by compressed air, those from the third to the second, and from the second to the first. The acid, on leaving the third tower, is of 15 per cent. strength, on leaving the second 25 per cent., and it leaves the fourth tower with a strength of 50 per cent.

Some of the acid produced is used to decompose the calcium nitrite obtained from the fifth tower and to convert unchanged lime into nitrate. The oxides of nitrogen produced by the decomposition of the nitrite are carried back to the system of towers. The solution resulting is run, together with the rest of the stored-up acid, into another series of granite tanks, where it reacts with limestone, thus producing neutral calcium nitrate. This solution is evaporated down until the temperature rises to 145°, answering to a concentration of 75 to 80 per cent. of calcium nitrate. The solution is then run into 200-litre drums, where it solidifies, and it appears on the market in this form. It is, however, found that for fertilising purposes it is better to use the basic nitrate owing to the extremely hygroscopic properties of the neutral salt. The ground-up basic nitrate can, as it is not hygroscopic, be readily scattered with a sowing machine.

Numerous manuring experiments have been made with calcium nitrate at different agricultural institutes. The results show that lime saltpetre is quite as good as Chili saltpetre, and on a sandy soil is even superior.

The yield of anhydrous nitric acid by the Birkeland-Eyde process is between 500 and 600 kilograms per kilowatt year. The cost of calcium nitrate containing 13·2 per cent. of nitrogen is about 4*l.* per ton, and the selling price about 8*l.* per ton. New works of 30,000 h.p. are now nearly completed, and it is hoped that the new factory will be very shortly in active operation. To an Englishman it is of interest to notice that *all* the pioneer work was carried out in this country. In this connection it should be remarked that even if the final stage—the application of the flame electric arc—had been tried in this country, it could not have been a commercial success. To be a commercial success it is *absolutely* essential that very cheap power should be at the disposal of the manufacturers. At present we have not this cheap power, and it is very improbable that we shall have it in the near future; unless, indeed, some engineer can show us how to harness the tides. But if we cannot manufacture nitric acid from the atmosphere there is a problem, probably a very difficult problem, the elucidation of which would be of almost untold value, and that is the fixation or utilisation of the nitrogen in sewage, which at present is almost entirely thrown with happy abandonment into the sea. As a consequence, the mouths of rivers are polluted, fish are destroyed, and, what is perhaps more serious, disease is often disseminated.

F. MOLLWO PERKIN.

THE ELECTRICAL SIGNS OF LIFE AND THEIR ABOLITION BY CHLOROFORM.[1]

As it was not possible to show the actual experiments, Dr. Waller illustrated his lecture by diagrams, and introduced his method of presenting them on the screen by placing in the lantern smoked plates on which he sketched in view of the audience diagrams of the apparatus (battery, induction coil, electrodes, galvanometer) employed in the experiments, and showed the methods by which the photographic records were obtained.

The physiologist is engaged in the task of learning how plants and animals absorb, transform, distribute, and dispense the energy stored in food and manifested in each act of life—in a word, of studying the signs of life; and in the electrical change which accompanies all chemical change we have the most delicate means of addressing two questions to living matter: Are you alive? How much are you alive?

Tissues survive the death of the animal or plant. Six objects were chosen as representative examples of living matter—muscle, nerve, retina of the eyeball, a green leaf, a flower petal, and a seed. The characteristic of life is perpetual change, metabolism—building up and breaking down—anabolism, and katabolism. From the records shown of the electrical responses to excitation of muscle and nerve, it was deduced that isolated nerve, by reason of its showing no fatigue, but giving perfectly regular responses, is a favourable symbol of living matter on which to study the effect of drugs and reagents. From these experiments was proved the fact that chloroform is eight times more powerful than ether, and that 2 per cent. vapour of chloroform is the safe dose. Dr. Waller attributed deaths from overdose of chloroform to inattention to the great scientific principle of measurement.

FIG. 1.—Negative variation of nerve compared with electrical effect of light on Iris leaf.

Records were shown of the electrical effects produced by a series of illuminations of the eyeball, and of similar effects produced by pressure on the eyeball and by electrical excitation; Dr. Waller at first thought these latter effects were the same as those produced by light on the retina, and called them "blaze currents," but afterwards found they were characteristic of all living tissues. The petal of a flower and living seeds give blaze currents.

Dr. Waller described his records of the electrical effects of light on a green leaf; sunlight and the arc light were used; it seemed natural that the vegetable retina should be sensitive to light; the response is a double one, first negative then positive, dissimilation then assimilation; the carbonic acid function of the green leaf is probably attended by electrical effects; positive or assimilative effect is far more pronounced in vegetable than in animal protoplasm (see Fig. 1). A leaf of Nicotiana was illuminated for five minutes at intervals of ten minutes, and gave a deviation of the magnet of

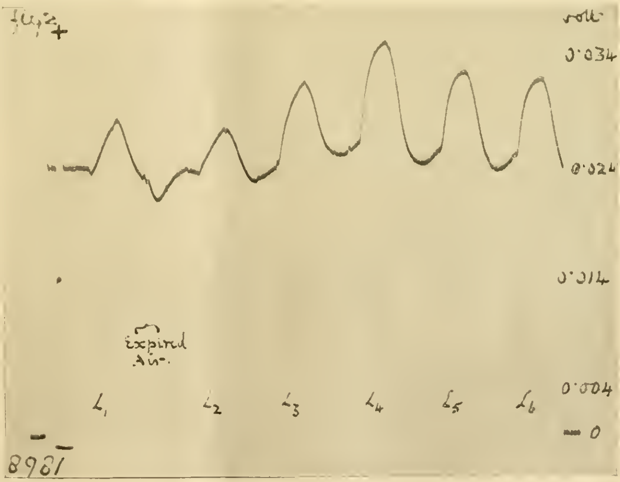


FIG. 2.—Increase of the electrical effects of light on leaf of Nicotiana caused by 4 per cent. CO_2.

[1] Abstract of lecture delivered by Dr. Augustus D. Waller, F.R.S., to the members of the British Association at York.

the galvanometer amounting to $-2/100$ volt, followed by a deviation of $+2/100$ volt; it was then subjected to an excess of CO_2, which caused temporary intoxication, from which it afterwards recovered. Small quantities of CO_2, such as 4 per cent., exhibited to the leaf cause increased electrical effects, which are a galvanometric expression of increased chlorophyll action (see Fig. 2); that is, the more assimilation, the more the electrical sign of assimilation. The photographic records indicate dissimilative effects in the minus direction and assimilative action in the plus direction.

METEOROLOGICAL KITES IN INDIA.

THE India Meteorological Department has recently given in a number of its Meteorological Memoirs (vol. xx., part i.) "an account of the preparations made for determining the conditions of the upper air in India by means of kites." The Government of India, acting on a strong recommendation by the Royal Society, about three years ago sanctioned the inclusion of the exploration of the middle and higher atmosphere by means of kites and balloons as a part of the scheme of operations of the Meteorological Department. Two officers were deputed to Germany to study the methods employed by the Aeronautische Observatorium des Königlich Preussischen Meteorologischen Instituts. The first part of the memoir gives a description of the instruments employed, and the results obtained from the first preliminary ascents. The place selected for these was in Lower Sind, about six miles W.N.W. of Karachi, a mile from the sea and ten miles from the Hala Range on the west, forming the boundary between Lower Sind and Baluchistan.

The ascents were made in the last week of August and first fortnight of September, 1905, shortly before the withdrawal of the south-west monsoon current from Upper India.

In order to appreciate the results, it is necessary to bear in mind that during the wet monsoon in India an area of minimum pressure stretches from Upper India to the Soudan, in which pressure is absolutely lowest in Sind. The intensity and position of this varies considerably during the season. The observations were hence made in the south-west quadrant of this area of minimum pressure, where the lower cyclonic air movement is probably light and irregular, due to the obstructive action of hill ranges of moderate elevation.

The observations showed that a humid current (approaching saturation) obtained on the average up to an elevation of about 2500 feet (from about W.S.W.), and that above this was a very dry current from west with slight northing, the intermediate region of transition from the humid to the dry being probably less than 1000 feet in thickness. The accompanying table gives selected data from the two most satisfactory ascents.

The very dry current represents indraught from the Baluchistan plateau to the Sind low-pressure area, which, however, as a result of the presence of hills, entered it at a considerable elevation, exceeding on the average 2500 feet. The most remarkable feature is the large increase of temperature in passing from the lower humid current into the upper dry current, of 4° C. to 7° C. in amount, and of the comparatively slow rate of decrease for some distance above that plane of transition. Almost equally remarkable is the sudden and comparatively abrupt change of the relative humidity from saturation to values of 5 and 6 only. Mr. Blanford many years ago established that in drought years in North-Western India

Date of ascent	Elevation, metres	Temperature, C.	Humidity: Rel.	Humidity: Absolute. Grams per cub. m.	Wind direction
Aug. 28	Surface	28·6	70	19·5	S. 70 N.
—	795	21·1	100	18·2	,,
—	1000	25·9	24	5·8	West with slight northing
—	1285	28·7	5	1·4	,,
—	1380	27·3	6	1·6	,,
Sept. 12	Surface	28·1	85	23·0	S. 60 W.
—	635	21·9	100	19·1	,,
—	900	25·6	42	9·9	West with slight northing
—	1015	25·4	19	4·4	,,

this dry current from Baluchistan descends to the level of the plains in Sind and extends southwards and eastwards to very considerable distances, and is an important factor in determining the intensity of the drought in North-Western India, and perhaps of conditioning it. Another point of interest is the comparatively rapid variation, even in short periods, of the lower level of this dry current. Mr. Field, who carried out the observations, says that "a nearly saturated stratum of air from the sea extended from the ground surface (10 metres above the sea) upwards to a level which rose from 500 metres on August 27, through 800 metres on August 28, to 1130 metres on August 31. From that day onwards until September 9 its limiting height was not reached by the kite, but probably exceeded 1000 metres. Its upper limit fell again to 600 metres on September 12."

The observations give valuable and interesting information of what may perhaps be termed an outlying portion of the south-west monsoon current. They suggest that the extension of the work will give most important information respecting the south-west monsoon circulation, and perhaps on the causes of the variation of the intensity and extension of the south-west monsoon rainfall, one of the great problems which for some time past has engaged the earnest attention of the Meteorological Department at the instance of the Government of India.

NOTES.

WE deeply regret to announce the death, at the age of seventy-four years, of Mr. C. Baron Clarke, F.R.S., which took place at Kew on Saturday last, and, at the comparatively early age of fifty-two years, of Prof. H. Marshall Ward, F.R.S., which occurred at Babbacombe, Torquay, on Sunday last. Prof. Ward, who had been ill for some months, had filled the chair of botany at the University of Cambridge since 1895.

ON August 20 there passed away at his beautiful country seat, Coles Park, near Buntingford, Herts, in his eightieth year, one who is well known to mineralogists as joint author with the late Mr. W. G. Lettsom of the "Manual of the Mineralogy of Great Britain and Ireland," and whose name will ever be linked with perhaps the finest private collection of minerals which was ever brought together in this country. Mr. Robert Philips Greg as a young man took great interest in the fine collection which his father, a noted economist and antiquary, had purchased from the executors of its previous owner, Mr. Thomas Allan, F.R.S., and spent considerable sums of money in acquiring new specimens and bringing the collection up to date. After the publication of his "Manual" in 1858 he appeared to take little active interest in minerals, and two years later, in 1860, the Allan-Greg collection was purchased by the trustees of the British Museum. For many years afterwards he still devoted himself to the study of meteorites, from both the astronomical and mineralogical points of view, until paralysis of the legs rendered it difficult for him to move about. The "Manual" referred to was published nearly half a century ago, and probably few mineralogists will realise that one of the authors has died so recently.

The death of M. Alexandre Herzen, professor of physiology in the University of Lausanne, and author of many books dealing with physiology and allied subjects, is announced in the *Temps*.

Science announces the death of Prof. S. L. Penfield, head of the department of mineralogy in the Sheffield School of Yale University; also of Mr. G. W. Lehmann, chemist of the United States Government since 1878, and chief chemist of the Baltimore Board of Health since 1890.

The death is announced from Tangier of M. Georges Salmon, leader of the French scientific mission to Morocco.

A movement has been set on foot in Germany to raise a memorial fund for the benefit of the widow and children of the late Dr. Schaudinn, and an English committee consisting of Prof. Clifford Allbutt, F.R.S., Sir Michael Foster, F.R.S., Mr. Jonathan Hutchinson, F.R.S., Prof. Ray Lankester, F.R.S., Sir Patrick Manson, F.R.S., Prof. Osler, F.R.S., Mr. John Tweedy, and Prof. Sims Woodhead has been formed to cooperate with the German promoters of the scheme. Subscriptions may be paid to Mr. Adam Sedgwick, F.R.S., treasurer of the fund, New Museums, Cambridge, or direct to the Schaudinn Memorial Fund at Messrs. Barclay and Co.'s Bank, Cambridge.

A conference of the International Geodetic Association will be held in Budapest on September 20 next, when, according to the *Temps*, the principal topics to be considered will be the accurate surveying of mountain chains subject to earthquake, with a view to ascertaining whether these chains are stable or whether they rise and sink, and the taking of measures of gravity so as to throw light upon the distribution of masses in the interior of the earth and upon the rigidity of the earth's crust. The drawing up of preliminary reports on these two questions has, says our contemporary, been entrusted to M. Lallemand, director of the general survey in France, and Sir George Darwin, K.C.B., F.R.S.

The King of the Belgians has shown his practical interest in the study of sleeping sickness by offering a prize of 8000*l*. for the discovery of a remedy for the malady, and by placing a credit of 12,000*l*. in the Congo Estimates for the purpose of prophylactic research; he also recently received representatives of the Liverpool School of Tropical Medicine, and having heard their views as to the necessity of preventing the further spread of the disease, asked the school to submit to him a scheme of preventive measures. The King bestowed the Order of Leopold upon Prof. Ronald Ross, C.B., F.R.S., Prof. Boyce, F.R.S., and Dr. J. L. Todd.

Further slight shocks of earthquake are reported from Valparaiso and Santiago; slight shocks have also been felt at Carcoar, twenty-five miles from Bathurst, New South Wales.

An earthquake shock is stated to have been felt at 5.55 a.m. on Monday last at Matlock and other parts of Derbyshire. The shock, which was very slight, was accompanied by a sound like distant thunder, and lasted three or four seconds.

The Wellman Polar Expedition has been abandoned for the present, its leader having decided not to attempt the voyage northward this year on account of defects in the mechanical equipment of his airship. Mr. Wellman is to return to Europe in the middle of next month, and will leave a small party of men behind to guard the headquarters of the expedition.

A Royal Commission has been appointed to inquire into the lighthouse administration of the United Kingdom. The terms of reference are: "To inquire into the existing system of management of the lights, buoys, and beacons on the coast of the United Kingdom by the three general lighthouse authorities, and as to the constitution and working of these authorities, and to report what changes, if any, are desirable in the present arrangements."

A Health, Electrical, and Gas Exhibition is to be held at Portsmouth from November 5–27 next.

The Latin-American Medical Congress will be held at Monte Video in January next.

The fourth Portuguese Congress for the Prevention of Tuberculosis will be held at Oporto from April 4–9 of next year.

According to the *Electrical Review*, an international competition has been organised by the Association des Industriels de France for the invention of a primary cell and a storage cell satisfying certain conditions. Both cells are to develop the maximum power or contain the maximum energy possible per unit of weight and bulk, and they must be free from risk of every description to the users, easy of transport, installation, and maintenance. The samples submitted must not weigh more than 20 kg. Complete descriptions of the cells must be forwarded by the competitors before the end of the present year to the president of the association, 3 rue de Lutèce, Paris, with drawings, and the actual cells must reach the examiners by April 1, 1907. The prize money, amounting to 8000 francs, may be awarded as a lump sum or divided at the discretion of the association.

The Legislature of the Berne Canton has sanctioned the project for the construction of a new trunk line—the Lötschberg—with electricity as the motive power, which will pass through the Bernese Alps and connect at Brig with the Simplon. The new line will be 56 kilometres in length, of which $13\frac{1}{2}$ kilometres will be tunnel. It will serve as the most direct means of communication between northern Italy and the district lying to the north and northwest of Switzerland, shorten the approach to the Simplon, and compete with the Gothard tunnel railroad. The work, which is to be begun at once, is estimated to require five and a half years to complete.

The Australian correspondent of the *Lancet* states that the Federal Government has issued a proclamation prohibiting the importation of the microbe of hæmorrhagic septicæmia, by which it was proposed to destroy the rabbit pest, except upon the condition that the packages containing the microbes be handed unopened to the State bacteriologist of New South Wales, and retained by him unused until the Minister gives permission to use them. Under the Noxious Microbes Act of 1900 of New South Wales it will also be necessary for the State Government to pass a regulation sanctioning experiments before anything can be done in the way of rabbit extermination. In the meantime only laboratory experiments will be carried on.

WE have received a copy of the meteorological observations made at forty-four secondary stations in the Philippine Islands during 1903. The observations are published for four-hourly intervals from 2h. a.m., and occupy 1128 large octavo pages; the records have been carefully examined under the superintendence of Father Algué. He points out that the Philippines are preeminently agricultural, and that most of the inhabitants are engaged in tilling the soil; consequently temperature, sunshine, and rain are the chief factors to be considered. Rain is the most important element, as sunshine and temperature are generally quite uniform and favourable. 1903 was a bad year for agriculture; drought was prevalent during the first half, while there was considerable rainfall during what is usually considered the dry season. Owing to the drought, the havoc wrought by locusts was terrible; time after time swarms swept over the land devouring the standing crops, and leaving the country-side bare and dreary.

WE have received a copy of the meteorological chart of the Indian Ocean and Red Sea, issued by the Meteorological Office, for September. This valuable publication gives important information for seamen, including the routes recommended, under steam and sail respectively, between several of the principal ports. The wind roses, which are drawn generally for areas of 5° of latitude by 5° of longitude, show the average conditions for the month from records extending over a period of fifty years, and the direction and rate of the ocean currents are indicated in the usual way, from the results of observations obtained during a period of sixty-five years. In addition, any facts of recent date likely to be of interest are made known, among which we may mention a telegram from the Indian Meteorological Office, dated August 10, with reference to the south-west monsoon between Aden and Bombay, and to the unusually quiet weather conditions in the Bay of Bengal.

WE learn from an article in the August number of the *Popular Science Monthly* that the Government of the United States intends to repeat so much of the triangulation of the coast and geodetic survey as lies within the area affected by the earthquake of April 18 last, and to carry the work far enough eastward to connect the re-determined points with stations that may safely be regarded as quite beyond the effect of the recent disturbance.

THE flora of New Zealand presents many exceptional features, and it has been Dr. Cockayne's service to describe various strange vegetable productions of these and adjacent islands in his charming and graphic writings. In a series of ten articles that were printed in the *Lyttelton Times* during May he has provided a general account forming an epitomised survey of the ecology of New Zealand. Discussing the history of the plants, he adduces evidence obtained from the distribution of such plants as *Veronica elliptica* in favour of a former land connection with South America. Referring to the forests, he enumerates several types, of which the filmy ferns and epiphytic lilies are extraordinary. On the shore is found the tiny buttercup *Ranunculus acaulis*, bearing only three small, succulent leaves and its small yellow flower above the sand. The arborescent speedwells and species of Sophora showing peculiar juvenile forms are noteworthy among the shrubs. In the mountain meadows a striking feature is the prevalence of white and yellow rather than blue flowers. *Phormium tenax*, the plant furnishing the valuable fibre known as New Zealand flax, grows in the swamps. Finally, there are numerous plants eminently suitable for cultivation, to mention only the Veronicas, Senecios, and Olearias.

IN choosing bamboos for the garden it is necessary to take into consideration the power of resistance offered by different varieties to frosts. In *Le Bambou* (July) the editor, M. Lehaie, contributes some notes on the subject, quoting from his experience in Belgium. Among the hardiest varieties he places *Henonis, Quilioi, viridi-glaucescens*, *pubescens*, and *aurea*, all species of Phyllostachys, *Sasa paniculata*, and *Arundinaria Japonica*. He also provides a list of bamboos cultivated in Europe during 1906, with their synonyms. An interesting communication by Prof. F. A. Forel points to the identity of *Phyllostachys Henonis* with *Phyllostachys puberula*. Among the economic uses of bamboos, M. J. Nogués makes special reference to the pulp for the manufacture of paper.

ANOTHER pamphlet on the rubber-tree *Ficus elastica*, compiled by Mr. E. M. Coventry, of the Indian Forest Department, was recently published as Forest Bulletin No. 4 of the Government of India. The chief factor determining the distribution of the tree is said to be excessive humidity of the atmosphere. For propagation, cuttings and gooties have been given up in the plantations to which reference is made. New plants are obtained from seedlings raised in seed-beds and transferred to a forest nursery that requires to be surrounded with a stockade to keep out deer. Tapping is effected by making horizontal cuts about half round the tree with a V-shaped gouge. The excess of rubber is allowed to fall on mats placed on the ground; this and the rubber collected from the cuts and bark form three grades. Results tend to show that trees should only be tapped every second or third year.

BY an Act passed in 1903, the New Zealand Institute and the Colonial Museum were placed on a new footing. In the Colonial Museum Bulletin, of which the first number has just appeared, a sketch of the history and present position of the museum is found which contains much information as to the progress made in forming a collection of Maori antiquities; it is worthy of note that the natives themselves are deeply interested in the scheme, and have made valuable donations. The number also contains an important article on the marine mollusca of New Zealand, and an excellent series of photographs of carvings and weapons recently acquired by the museum. It is unfortunate that in the mother country we are too parsimonious to spread abroad in this way the knowledge of our national treasures.

THE *Ceylon National Review*, No. 2, contains an illustrated article by Ethel M. Coomaraswamy on old Sinhalese embroidery, illustrated by a collotype plate and sketches of the different kinds of stitches employed. Nowadays specimens are rare; formerly many objects were thus decorated, especially betel bags, which have been preserved in fair numbers. The colours employed were three, red, blue, and the undyed thread; the designs were geometrical, or taken from plants or animals. Most of the work was done with the chain stitch, and the knowledge of it is now confined to the old men in out-of-the-way villages.

IN *Biologisches Centralblatt* for August 15 Dr. J. Gross concludes his paper on the relationships between heredity and variation. According to the author, there may be two lines of development, fluctuation and mutation, the three stages of the former resulting respectively in the production of races, species, and genera, while the first stage of the latter corresponds to De Vries's and the second to Mendel's mutation. The Rev. E. Wasmann, in the second article, discusses the comparatively recent development of new species of "commensural" beetles of the family Staphilinidæ in the nests of ants and termites. In the black and red beetles of the genus Dinarda, for example, there are races or species corresponding to the various races or species of ant with which they are associated, and as the differentiation of the ants appears to be comparatively recent, that of the beetles must, *a fortiori*, be still more so. In the third article Maria Countess von Linden describes certain very remarkable variations in the shape and colour of the wing-scales of the swallow-tail butterfly *Papilio podalirius* during the pupa-stage as the effect of external influences. It is noticeable that the scales on the orange spot differ from those of the rest of the wing. The basilar membrane in the ear of parrots, in connection with Helmholtz's resonance-theory, forms the subject of the concluding article, by Mr. A. Denker.

The contents of Nos. 1 and 2 of vol. xxviii. of Notes from the Leyden Museum are largely devoted to the description of new genera and species, a number of these being described by Mr. G. Ulmer in a paper on non-European trichopterous insects. Of more general interest is the description, by Dr. E. D. van Oort, of a new bird-of-paradise (*Neoparadisea ruysi*) from New Guinea, representing a generic type by itself, and also Dr. Jentink's separation of the large duiker antelope of Rhodesia from the West African *Cephalophus sylvicultor*, under the name of *C. coxi*.

The New Zealand fern-bird (*Sphenoeacus punctatus*) forms the subject of the first article, by Mr. J. C. M'Lean, in the July issue of the *Emu*, while in the second paper Mr. H. S. Dove gives notes on a number of New Zealand birds, inclusive of introduced species. In a later communication Mr. E. Scott contributes some interesting information with regard to Dampier's observations on Australian birds made during the voyage of 1689. Mystery attaches to the meaning of the term "gladdens," which the great navigator employed to designate certain birds associated with oyster-catchers and cormorants.

The whole of vol. xxvii. of Notes from the Leyden Museum is occupied by Miss C. M. L. Popta's description of the fishes collected during Prof. Nieuwenhuis's expeditions to central Borneo in 1898 and 1900. The collection contained a large number of new forms, which have, however, for the most part been named in previous communications. The more important species are illustrated by photographs from original specimens.

Seaside natural history, illustrated with a number of excellent photographic plates (in some cases reproduced from Johnston) of zoophytes, &c., occupies a prominent position in the July issue of the *Museum Gazette*. The addition of a large education museum to the "garden city" at Letchworth is strongly advocated.

In its report for 1905, published in the August issue of *Nature Notes*, the Selborne Society takes occasion to refer to the necessity for more active workers and larger funds if its objects are to be fully and efficiently carried out. The enclosure at Ealing for the protection of birds is reported to have been a marked success during the nesting season.

A paper by Mr. David Heron "On the Relation of Fertility in Man to Social Status, and on the Changes in this Relation that have taken place during the last Fifty Years" has been published in the series of Drapers' Company Research Memoirs (Studies in National Deterioration). Mr. Heron takes as his starting point the legitimate birth-rate for the different districts in London for the years 1851 and 1901, and proceeds to calculate for each year the correlation between this and various measures of their social and economic conditions. By this method he shows conclusively that in both these years a low birth-rate is associated with satisfactory conditions and a high one with poverty and improvidence, but that in 1901 this coincidence is far more strongly marked than in 1851, and that whereas in the middle of the last century it could be more than accounted for by the fact that the wives of the upper classes marry at a later age than those of the lower, at the present time this factor is only responsible for about half the difference. It is perhaps unfortunate for Mr. Heron that his paper has appeared after two others dealing with the same subject (Newsholme and Stevenson, and G. U. Yule, Journal of the Royal Statistical Society, vol. lxix., part i.), as his methods are very different from, and his conclusions quite independent of, either of them. But owing to the striking way in which these three important papers confirm and supplement one another, it may be to the advantage of the public that they should have appeared in the same year, for warnings of this nature have more chance of obtaining a hearing when they are given simultaneously from different quarters.

In the Journal of the Franklin Institute of Philadelphia (vol. clxii., No. 1) Mr. Clifford Richardson gives an exhaustive series of analyses of the petroleums of North America, and compares the character of those of the older and newer fields.

A very simple and convenient method for calibrating thermometers for use in the determination of freezing points of aqueous solutions is described by Messrs. Richards and Jackson in the *Zeitschrift fur physikalische Chemie*, 1906, lvi., 362. The thermometer to be tested is immersed in a mixture of powdered ice and water contained in a Dewar vessel, and hydrochloric acid is then added until the requisite temperature has been attained. The true temperature is determined by the concentration of the acid solution in equilibrium with the ice, and this can be ascertained from the table given by the authors, in which acid concentrations corresponding to temperatures between 0° C. and −5° C. are recorded.

In a previous measurement of the relative proportion of radium and uranium in radio-active minerals, a neutral solution of radium bromide was employed as standard. It has since been observed, however, that such neutral solutions gradually deposit some of the active substance on the walls of the containing vessel, and this has made a new determination of the proportion of radium to uranium necessary. The number now found by Rutherford and Boltwood (*American Journal of Science*, iv., 22 [127], pp. 1–3) for the quantity of radium associated with 1 gram of uranium is $3{\cdot}8 \times 10^{-7}$ gram, which is about one-half that obtained in the first experiments.

In the *Journal of Physical Chemistry*, 1906, vol. x., p. 445, Messrs. Carveth and Magnusson give an interesting account of the evolution of the apparatus for the determination of the boiling points of solutions for the purpose of molecular weight measurements. The advantages and disadvantages of the various types are discussed, and a new form of apparatus is described, the distinctive features of which are a separate boiling flask and a return condenser provided with a mercury trap. With this apparatus measurements can be made very quickly, and the parts liable to break are easily replaceable.

In the same journal Mr. R. C. Snowdon shows that metallic lead can be electrolytically deposited in a satisfactory and adherent condition from an acidified solution of lead acetate. This result is attained by employing a rapidly rotating kathode and a virtual current density of 1·5 amperes per square decimetre, and adding about 1 gram of gelatin to a litre of the solution. In an investigation of the behaviour of ferromanganese anodes in solutions of caustic soda, Mr. G. R. White finds that permanganate is formed irrespective of the current strength and the concentration of the solution. Metallic manganese yields permanganate at high current densities, but manganous hydroxide is only oxidised to dioxide. The electrolytic formation of permanganate is therefore a direct reaction, the lower oxides not being formed as intermediate products.

We have received from Messrs. Adam Hilger, Ltd., a copy of their "List A" of spectroscopes and spectroscopic accessories. This list contains descriptions and illustrations of the numerous specialities manufactured by the firm, and should be consulted with interest by all workers in spectroscopy. The spectroscopes, spectrographs, and accessories of especial interest are too numerous to be referred to here, but mention may be made of the fact that the firm is now prepared to supply the strips of plane parallel glass, up to 300 mm. by 40 mm., used in the Lummer and Gehrcke parallel plate spectroscope described in the *Annalen der Physik*, vols. x. (1903) and xx. (1906). These strips may be used with any ordinary spectroscope of suitable size, but the firm will be pleased to quote prices for specially designed instruments.

The new edition of the Japanese Pharmacopœia, which has been in preparation for some considerable time, has now been completed, and will be issued shortly. Among the alterations in it is the substitution of Japanese characters for the names of drugs and chemicals for the Chinese forms hitherto used.

A new magazine, entitled the *University Digest*, is announced for publication by the University Research Extension of Chicago. Its aim (to quote from the prospectus issued) is "to keep before its readers the ideal phenomena that distinguish the modern, the greatest of world-epochs," and the intention of its promoters is to represent the results of scientific research in religion, philosophy, and the social and natural sciences. The periodical will be issued at monthly intervals from September next, excluding the months of July and August.

The Proceedings and Transactions of the Nova Scotian Institute of Science for the session 1903–4, just received, contains many papers of value. The address of the president—Dr. H. S. Poole—dealt with the progress of the institute and the application of science to mining, and among other communications in the volume we notice the following:—the earthquake of March 21, 1904, in Nova Scotia, by Prof. J. E. Woodman; swim bladder of fishes a degenerate gland, by Prof. E. E. Prince; and determination of elements of terrestrial magnetism at Halifax, Nova Scotia, August, 1904, by Prof. S. M. Dixon.

The official year-book of New South Wales for 1904–5 has just reached us. It is edited by Mr. W. H. Hall, acting statistician to the State of New South Wales, and is a mine of information, containing as it does papers on the discovery of "Terra Australis," the physical configuration, the geological formation, the meteorology, vegetation, timbers of commercial importance, fish and fisheries, and fauna of New South Wales, besides much information of statistical importance. The volume is illustrated by some twenty-eight well-executed figures, and should be seen by all who are specially interested in the State under review.

The twenty-sixth annual report of the Manchester Microscopical Society, which has just been issued, tells of continued progress. The address on precious corals delivered by Prof. S. J. Hickson, F.R.S., as president, is to be found in the volume, as is also an illustrated paper by Mr. M. L. Sykes on animal coloration.

The seventh annual report of the Museum and Art Gallery of Plymouth is of an encouraging nature. During the year ending with March last many interesting additions were made; the public lectures on subjects connected with the work of the museum were, it is stated, on the whole decidedly successful. The museum and gallery were visited during the period under review by 30,760 persons.

A new (the second) edition of "The Geology of the English Lake District, with Notes of the Minerals," by Mr. J. Postlethwaite, has just been issued by G. and T. Coward, Carlisle. The little book has been revised and additional lists and plates of fossils have been added, and the section on the Mollusca of the Skiddaw slates has been rearranged.

The current number of the *Monthly Magazine* contains a very readable account, by Mr. H. W. Strong, of the evolution of the turbine, entitled "The Coming of the Turbine"; it has also an interesting paper by Mr. A. W. Rees on a moorland sanctuary.

OUR ASTRONOMICAL COLUMN.

Astronomical Occurrences in September:—

Sept. 1. 14h. 42m. to 15h. 46m. Moon occults ι Aquarii (mag. 4·3).
2. 15h. Saturn in conjunction with Moon. Saturn 0° 34′ N.
4. 13h. Mercury in conjunction with Mars. Mercury 0° 10′ S.
,, 15h. Saturn in opposition to the Sun.
8. Predicted date of perihelion passage of Finlay's comet.
9. 14h. 27m. to 14h. 43m. Moon occults α Tauri (Aldebaran, mag. 1·1).
10. 10h. 47m. Minimum of Algol (β Persei).
,, Vesta ½° N. of star 105 Aquarii (mag. 4·7).
11. Vesta (mag. 6·5) in opposition to the Sun.
15. Venus. Illuminated portion of disc =0·514; of Mars =0·989.
16. Saturn. Major axis of outer ring =44″·33, minor axis=4″·15.
20. 10h. Venus at greatest elongation, 46° 29′ E.
23. 11h. Sun enters Libra, Autumn commences.
29. 11h. 29m. Transit (egress) of Jupiter's Sat. III. (Ganymede).
30. 12h. 30m. Minimum of Algol (β Persei).

Discovery of a New Comet (1906*e*).—A telegram from the Kiel Centralstelle announces the discovery of a new comet by Herr Kopff at the Königstuhl Observatory on August 22.

Its position at 14h. 17m. (Königstuhl M.T.) on the day of discovery was R.A.=22h. 49m. 32s., dec.=+10° 23′, and the amount of its daily movement was found to be −44s. in R.A. and −2′ in declination. Unfortunately no idea of the comet's brightness is given.

A second telegram from the same source states that the comet was observed at Hamburg by Herr Graff on August 23, its position at 13h. 11·3m. (Hamburg M.T.) being R.A. = 22h. 48m. 53·5s., dec. = +10° 21′ 7″.

From this it is seen that the comet is apparently in the constellation Pegasus, a little to the north of σ Pegasi, and is moving in a south-westerly direction. This position crosses our meridian at about 12 o'clock midnight

FINLAY'S COMET (1906*d*). This comet will arrive at its perihelion, according to M. Schulhof's elements, on September 7·5.

As shown by the following extract from the ephemeris published in No. 4109 of the *Astronomische Nachrichten*, the comet is now apparently travelling through the extreme north-eastern corner of Orion towards Gemini, which it will enter on September 9. On September 7 it will pass about 1° south of 71 Orionis, and on September 13 about 2° 36′ north of γ Geminorum. On the latter date the comet will rise about five hours before sunrise, *i.e.* about 12·30 a.m.

Ephemeris 12h. (Paris M.T.).

1906	α (app.) h. m.	δ (app.) ° ′	1906	α (app.) h. m.	δ (app.) ° ′
Sept. 1	5 40	+16 37	Sept. 9	6 17	+18 27
3	5 50	+17 9	11	6 25	+18 47
5	5 59	+17 39	13	6 33	+19 4
7	6 8	+18 4	15	6 40	+19 19

GREENWICH SUN-SPOT NUMBERS.—An innovation which is likely to be found a great convenience by everyone who has to discuss sun-spot observations appears in the August number of the *Observatory*.

Up to the present such workers have had to wait until about the middle of the next year before the serial numbers allotted to the sun-spots of any one year by the Greenwich authorities became available for general use. Now, with the sanction of the Astronomer Royal, Mr. Maunder proposes to publish these numbers month by month.

The first instalment, giving the numbers for the quarter January–March, 1906, appears in the current *Observatory*. Next month's issue will contain the data for the second quarter, and after that each month will be given separately, so that the numbers for July will appear in October, and so on.

Other data, *e.g.* the duration and the latitude and longitude of each spot-group, are also given, but, as they are determined from simply a preliminary examination, these are not to be accepted as final values.

THE ORIGIN OF THE ZODIACAL LIGHT.—Some interesting observational results, and deductions therefrom regarding the origin of the zodiacal light, appear in a brochure written by Mr. Maxwell Hall, of Montego Bay, Jamaica, and issued as a reprint from the *Monthly Weather Review* for March, 1906.

Mr. Hall's observations were made at Jamaica in 1899 and 1901, and determined the breadth of the light and its boundaries at different distances from the sun. On reducing the observed latitudes according to their longitudes, or distances from the first point of Aries, Mr. Hall obtained striking evidence which tends to show that the light is parallel to the invariable plane of the solar system, evidence which was apparently confirmed by the results obtained by other observers.

On these grounds Mr. Hall arrives at the conclusion that the zodiacal light is caused by the reflection of sunlight from masses of meteoric matter still contained in the invariable plane, which may be considered as the original plane, of the solar system.

If this conclusion is correct, and the phenomenon is astronomical in its origin, the light should be seen better and more frequently from observing stations situated in high altitudes, and the editor of the Review especially commends its observation to workers located at such stations.

A MODIFIED FORM OF SOLAR EYE-PIECE.—From Prof. Ceraski, of Moscow, we have received a brief description of a solar eye-piece which he is using, and has found to be most effective, for the detailed study of sun-spots. This eye-piece is analogous to one described by Dawes in vol. xxi. of the Memoirs of the Royal Astronomical Society, but as no one seems to have used this for the study of minute details in sun-spots, Prof. Ceraski describes the one he is now using.

The apparatus is furnished with a positive eye-piece and a copper plate pierced with circular apertures of various diameters, thus forming an adjustable diaphragm. This copper plate is protected by a disc of asbestos which contains a central aperture slightly larger than the largest in the diaphragm. The dark glass is a combination of black mica and blue glass.

Using this eye-piece with the full aperture of the Pulkowa 15-inch refractor, Prof. Ceraski was surprised at the amount of detail seen.

PHYSICS AT THE BRITISH ASSOCIATION.

THE proceedings of the Mathematical and Physical Section (A) commenced on Thursday, August 2, with the delivery of the presidential address by Principal E. H. Griffiths, F.R.S. This address has already appeared in full in these columns (August 9, p. 356).

The chief interest of the meetings in this section arose in connection with several discussions which were arranged and taken up with avidity. On August 2 the Earl of Berkeley described his experiments on the measurement of osmotic pressure, both directly and indirectly from measurements of vapour pressure. The two methods give results agreeing to within 5 per cent. Mr. W. C. D. Whetham followed, and treated the same subject from the standpoint of thermodynamics and the dissociation theory, thereby stimulating Prof. Armstrong to make a vigorous attack on everything connected with thermodynamics and dissociation. In Prof. Armstrong's opinion the secret of osmotic pressure is to be sought in a thirst of complexes of water molecules. He laid stress on the importance of recent work in America, which proved that Boyle's law was satisfied for much greater strengths of solution than was shown by Lord Berkeley's results. In the course of discussion it seemed, however, that the difference was rather one of interpretation of results than of the experimental results themselves. Mr. Whetham, in his rejoinder, declared also in favour of a "thirst" hypothesis, but differed in regard to the mechanism of it.

On Friday, August 3, two important discussions took place. The former was opened by Mr. Frederick Soddy, the subject being the evolution of the elements. Mr. Soddy outlined the subject from the earliest times to the most recent developments in connection with radio-active changes. Uranium gradually changes to radium, radium to its emanation and several other successive products, until in all probability it becomes lead. Lead in turn suffers a gradual transmutation into silver. These changes proceed spontaneously, setting free energy as they occur. With regard to active attempts at transmutation in the reverse direction, which, of course, require a correspondingly large supply of energy, Mr. Soddy considers that success will be found first in a nearly complete vacuum carrying an electric discharge. Here there is very little matter carrying a large amount of energy, so that the necessary conditions would seem to be supplied. The Hon. R. J. Strutt laid stress on the fact that in radio-active changes helium was the only non-valent element produced, while in our atmosphere argon was largely preponderant. Had argon been formed by other transmutations? Dr. O. W. Richardson and Dr. H. A. Wilson discussed the apparent disappearance of matter in vacuum tubes, alluding to quantitative experiments made in the Cavendish Laboratory. Prof. Schuster emphasised the nearly complete indifference of radio-activity to temperature changes, the only temperature effect yet discovered being a small one found by Mr. W. Makower working in his laboratory. He had experiments in progress on the influence of high pressures with the aid of apparatus designed by Mr. Petavel. With this apparatus a pressure of 2000 atmospheres can be obtained; no change in radio-active charge brought about thereby had yet been detected, but the experiments were not yet complete. Prof. S. P. Thompson, in reference to the Cavendish experiments, pointed out that it was well known that gases were *absorbed* by the walls of vacuum tubes. The Rev. A. L. Cortie, speaking from the astronomical standpoint, was able to declare that radium had not been detected in extra-terrestrial bodies, although helium, which is produced during its decomposition, is discovered in the sun. The idea of a primitive substance is very ancient; it is simply the *materia prima* of Aristotle. A considerable part of the discussion turned on the use (or misuse) of the term *atom*, a term which Prof. Tilden, speaking as a chemist, was unwilling to give up. Undoubtedly the term has lost its original etymological signification, but its use has become too fixed to expect a change to be readily made. The discussion proved so interesting and stimulating that Mr. Soddy's paper, which gave rise to it, has been directed to be published in full in the report. A more immediate consequence was that the programme for the day was completely upset; a large number of papers had to be held over in order that the next discussion arranged might be taken. The subject was the notation and use of vectors, and Prof. Olaus Henrici opened it. He explained the various notations which have been proposed for vector and scalar products, and proceeded to give examples of their use. He showed how the operator ∇ might be defined without reference to analytical geometry from the relation $dU = d\rho . \Delta U$, where U = any scalar function of position, and $d\rho$ = length of displacement of the representative point. He then applied the properties of the operator ∇ to the deduction, with great simplicity and elegance, of results connected with the theory of partial differential equations. Dr. C. G. Knott followed, and deplored the substitution of vectors for quaternions, and objected that neither scalar nor vector product was really a true product. He advocated a return to the methods of Sir W. Hamilton. He pointed out that Hamilton does not speak of a vector or a scalar product, but of the vector of a product and the scalar of a product. With regard to the change of the usual negative to the positive sign suggested by certain vectorists, he explained that it had compelled Gibbs to introduce a third kind of product, and more recently Jahncke had introduced a third in order to be able to treat of strains. Prof. W. M. Hicks criticised Henrici's use of brackets to denote vector and scalar products on account of liability to confusion. Prof. Henrici, in an eloquent reply, showed how easily all quaternionic results could be derived from vector analysis.

On Monday, August 6, an important discussion took place on radio-activity and the internal structure of the earth, opened by the Hon. R. J. Strutt. From the examination of a large number of rocks, both igneous and sedimentary, he had come to the conclusion that there is much more radium in all of them than would be needed to maintain the earth's internal heat if the earth were constituted of rock throughout. Hence he concludes that the interior of the globe does not contain radium, and that in all probability its composition is quite different in other respects also from that of surface materials. The thickness of the radio-active crust is estimated at forty-five miles at most, which corresponds to an estimated temperature of 1500° C. at its interior surface. The inside nucleus would be at this temperature throughout just as a loaf of bread which has been in an oven long enough takes up a steady temperature equal to that of the oven. In reply to the possible objection that a gram of radium diffused through an enormous volume of rock may not develop nearly so much heat as it would do if concentrated, it was argued (1) that the rate of emission of alpha particles of pitchblende (to which particles the heat is mainly due) is exactly what might be expected on the view that the radium atoms contained in the mineral are as energetic as they would be if they were all collected together, and (2) direct measurements made by Pegram on uranium and thorium have shown that these feebly active elements give about the amount of heat which their activity would lead one to expect. Prof. J. Milne, who followed, directed renewed attention to the bearing on the problem of the three phases of earthquake tremors. The first, for stations connected by small chords, travels at a slow, nearly constant rate, but for chords penetrating to a depth greater than twenty miles the velocity increases to about 12 kilometres per second, indicating that the wave is carried by something more rigid than the outer crust. Prof. J. W. Gregory, speaking as a representative of the Geological Section, considered that Strutt had struck a blow at the theory of contraction by cooling. We are no longer bound to believe in very high temperatures in the past history of the earth. Arrhenius's theory may now be dismissed. He suggested the importance of mapping a small area completely in regard to the radio-activity of the rocks comprised in it. Sir W. Crookes declared his belief that radium inside the earth may not be so radio-active as at the surface. Pitchblende in thick masses behaves much the same as in thin layers. An experiment in which 50 mg. of radium were sealed in a glass tube and deposited in a cavity in ice, and an exactly similar tube containing 50 mg. of silica was similarly deposited, showed that neither sank as much as one-thousandth of an inch during prolonged observation. Sir G. Darwin directed attention to the work of Gilbeck, Putnam, and Hayford, of the United States Coast Survey, who had fixed a limit of about seventy miles to the thickness of the crust. Sir Wm. Ramsay suggested that Mr. Strutt should make a special examination of sulphides with the object of finding whether they contained radium. He further queried whether alpha particles give out all their energy as heat—a query which must most probably be answered in the negative.

Mr. R. D. Oldham (also representing the Geological Section) gave distinct evidence, derived from earthquake phenomena, that there must be a central core, the radius of which is about 0·4 of the earth's radius, having rather less resistance to compression than the main body. Prof. H. Lamb threw out a warning against laying too much stress on arguments based on observation of earthquake velocities. Too little is known as to effects of pressure and temperature.

Mr. Soddy showed that another explanation of the apparent absence of radium heat might arise from processes of upbuilding going on which may depend upon a possible concentration factor. Prof. Hicks emphasised Mr. Soddy's suggestion, and pointed out that even cooling might be produced by such building-up processes. He also suggested that the reason temperature does not usually affect radio-active changes is that time comes in as a factor, and he would like to see experimentally whether a very long application of a low temperature would not produce some effect. Mr. Fearnsides indicated that in the most radio-active rocks elements of high atomic weight were associated with those of low atomic weight.

The last organised discussion was held on Tuesday, August 7, the subject being the nature of the radiation from gas mantles. Unfortunately Mr. Swinburne, who was to open it, was unavoidably absent; his paper was therefore read by the recorder. It consisted of a spirited outline of the various theories that had been proposed to account for the high luminous efficiency of the Welsbach burner, with a declaration in favour of the simple temperature explanation. Low emissivity allows the mantle to approach the temperature of the flame; a substance of greater emissivity could not rise so high in temperature, and consequently the radiation which the latter would give out would not be so rich in luminous qualities. "Though this simple explanation may be ample it does not follow that there may not be all sorts of curious things, such as selective emission, luminescence, catalytic action, resonance, unstable oxidation and other occurrences whose names are as impressive as vague." Dr. H. Rubens, of Charlottenburg, followed with an account of the experiments which he has recently conducted, and which have been described in Drude's *Annalen*. Ceria for radiations in the immediate infra-red is a very poor radiator, while for luminous and the extreme infra-red radiations it behaves much more nearly as a perfectly black body. On the whole, the thoria-ceria mantle has poor emissivity, and its temperature approaches 1600° C., while the nature of the radiations from the added ceria confers additional richness on the proportion of luminous rays emitted. An experiment which Dr. Rubens showed to the section is of great importance in connection with the interpretation of the phenomena. Light from an electric lantern is focused upon a cold Welsbach mantle, and after reflection therefrom is re-focused upon a white screen. A blue cell is interposed to isolate the blue portion of the radiation. If now the Welsbach burner be itself lighted so as to heat the mantle, the image on the screen grows fainter; *the mantle is a poorer reflector for blue light at high than at low temperatures,* and it is therefore a better radiator when hot. Indeed, a temperature can be found at which it emits as much blue light as a perfectly black body. When the experiment is made with red light the reflected light increases with the temperature. Thus the fact that a Welsbach mantle is white when cold tells one nothing as to the character of radiation it will emit when hot. In the open discussion which followed Prof. S. P. Thompson considered that Dr. Rubens had demolished statements made by Mr. Swinburne in a previous paper. Prof. Callendar put in a word on behalf of Mr. Swinburne, whom he considered to be essentially in the right, though he had probably not laid sufficient stress upon the importance of the selective character of the radiation of ceria. Dr. Rubens expressed himself also as sharing Mr. Swinburne's views. Sir Wm. Ramsay directed attention to Urbain's recent work on phosphorescence, while the recorder of the section emphasised the distinction between the opposing schools by pointing out that, according to the "temperature" school, the radiation of the mantle is the sum of the radiations which would be given out by the thoria and ceria if separated and still at the same temperature, while according to the "chemical" school there is present an additional radiation arising from interaction between the constituents of the mantle. Dr. Rubens did not seem willing to admit that the radiation is wholly of this additive type, although it is so in the main. The discussion was enlivened by the president reading replies which Mr. Swinburne had sent ready for use against those with whom he had previously engaged in controversy.

We will now turn to the papers in connection with which no discussion had been organised.

Mr. W. G. Duffield read a paper on photographs of the arc spectrum of iron under high pressures. The apparatus by which the pressures were obtained was designed with the help of Mr. Petavel. The photographs which were shown demonstrated clearly that several lines not merely widen out, but undergo an actual shift towards the red.

Major E. H. Hills and Prof. J. Larmor communicated a paper on the irregular motions of the earth's pole, being a preliminary graphical analysis of their causes. In the ensuing discussion Mr. R. D. Oldham asserted that the amount of matter transferred in a recent Indian earthquake was at least 10,000 times that assumed by the authors. Prof. Schuster was inclined to question the accuracy of the observations themselves owing to their minuteness; the whole shift of axis under discussion amounts only to about 20 feet. Besides, the yielding of the earth owing to the shift of its axis might be the determining cause producing the earthquake, and not *vice versâ*.

Prof. H. H. Turner read a note on a possible effect of vibration on zenith distance observations, with special reference to the tremors which threaten the Royal Observatory at Greenwich. The special effect referred to is similar to one observed long ago in Ireland due to the Ulster railway. If the telescope is set and a train passes the adjustment is found afterwards to be upset. The tremor of the passing train causes a release of any existing strain. Even if at each passage the release of strain may not produce a visible effect, yet the continued action of tremors will be to produce a gradual settling down of the instrument at a different rate from that at which it would proceed if tremors were absent. In the discussion the Astronomer Royal for Scotland declared that in his observatory they were probably free from any tremors, except those caused by their own lathes. The following papers on cosmical physics were also read:—the Astronomer Royal for Scotland, spectroscopic observations of solar eclipses; Prof. Schuster and Prof. H. H. Turner, a note on rainfall; the Rev. A. L. Cortie, the connection between disturbed areas of the solar surface and the solar corona; Miss C. O. Stevens, telescopic observations of meteorological phenomena; the Right Hon. the Earl of Rosse, the measurement of lunar radiation; Mr. J. E. Clark, the York rainfall and sun-spots; and Dr. W. J. S. Lockyer, some barometric and rainfall changes of an oscillatory nature.

In the department of general physics, Mr. C. E. S. Phillips described a glass of low electrical resistivity consisting of thirty-two parts of sodium silicate to eight parts calcined borax, to which 1·25 parts Powell's flint glass is added in order to increase the stability. This glass is intended to be used for the windows of electrostatic instruments which require to be electrically shielded. Its electrical conductivity is about 500 times that of the most conducting glass hitherto made. When powdered and fused on to clean copper, it adheres well without cracking. The change of resistivity with heat is being examined. In the discussion Mr. Rosenhain mentioned that glasses of the general composition of this one were not unknown in the trade. Dr. Erich Ladenburg gave an account of his researches on nearly pure gaseous ozone. This has a dark blue colour in a thickness of 30 cm. In the absorption spectrum were discovered five new bands which do not belong to ozone, but which always appear when the liquid ozone is allowed to vaporise. The gas to which they belong can be separated from ozone. The change of volume which occurs when the new gas is transformed and the value of the density indicate that the new gas is a more complex form of oxygen. In the discussion Dr. Rubens, in whose laboratory the research had been conducted, expressed his belief that it consists of hexatomic oxygen. Mr. Herbert Stansfield showed a series of photographs of thin liquid films in which the two kinds of grey and the three kinds of black are sharply distinguishable from one another. A paper by the Rev. B. J. Whiteside was communicated and read by Prof. F. T. Trouton, the subject being the rate of decay of the phosphorescence of Balmain's paint. The photometer employed depended upon the inverse square law. The standard light which was emitted through a small hole could be moved to various distances from an opalescent screen placed adjacent to the surface of luminous paint in a box. The distance was adjusted so as to maintain the intensity of the two illuminations the same, and the times corresponding to equal shifts of the standard were recorded on a revolving drum. The law of variation of intensity was found to be capable of representation by the formula $I = 1/(a+bt)$, where t is the time reckoned from that at which the paint ceased to be exposed to the exciting light. This result is of great interest, inasmuch as the same law arises in connection with the recovery of overstressed bodies, and this correspondence suggests that the mechanism involved may be similar in the two cases.

Sir Wm. Ramsay and Dr. J. F. Spencer described experiments on the chemical and electrical changes induced by ultra-violet light. These were in some cases confirmatory of what had previously been done in connection with this interesting subject. The result of greatest novelty and importance is that the fatigue of the surfaces was found to vary in a peculiar way. The rate of falling off when plotted against the time yields a curve presenting obvious breaks. In the case of dyad metals there are two of these breaks, and two places of constant rate of tiring; for tetrad metals four of these stages are observed. The paper was read by Dr. Spencer, and Sir Wm. Ramsay followed with an extended statement showing how the electronic theory of matter accounts for the photoelectric effects observed. Dr. O. W. Richardson mentioned that Dr. Smolochowski in some unpublished experiments had succeeded in showing that in a high vacuum the decay phenomena cease to take place.

An important paper was contributed by Mr. F. Soddy on the positive charge carried by the alpha particle of radium C. The substance of this paper has already appeared in the form of a letter in NATURE for August 2. Is or is not the alpha particle charged when it commences its separate existence? Mr. Soddy thinks he has proved that it is not so charged, and, assuming the validity of this conclusion, he considers that possibly too much stress has been laid on the importance of electricity in connection with radio-active changes. Papers by Prof. E. H. Barton and J. Penzer and by Prof. W. F. Barrett were taken as read in the absence of the authors.

In the department of mathematics, Prof. A. C. Dixon read a paper on expansions in products of oscillatory functions, being an extension of a paper published recently by the author in the Proceedings of the London Mathematical Society. It deals with the expansion of a function of two variables $f(x, y)$ in the form $\Sigma\Sigma\phi_m(x)\psi_n(y)$, where ϕ and ψ are functions of given type. Prof. W. H. H. Hudson described an analytical investigation of the curves traversed by a particle in a cyclonic storm. The curves appear to agree fairly well with observation, thus justifying the assumptions on which they are calculated. Lieut.-Colonel A. Cunningham gave some new properties of certain high powers of 2 called hyper-even numbers. Prof. A. R. Forsyth gave an interesting account of a revised theory of the solution of Lagrange's linear equation $Pp+Qq=R$. He showed that the solution hitherto accepted as the most general, viz. $\psi=f(u, v)$, where $u=a$, $v=b$ are any two independent integrals of the equations $dx/P=dy/Q=dz/R$, is not in reality the most general, and that other solutions exist which cannot be put in the usual form. Major P. A. MacMahon read a paper on two new symmetric functions which showed certain very interesting reciprocal relations between two sets of algebraic quantities. Papers by Mr. H. Hilton, on finite groups; by Prof. T. J. I'A. Bromwich, on multiple series, giving a new test for the convergence of a double series of positive terms; by Mr. A. R. Richardson, on many-valued functions of real variables; and by Prof. Alfred Lodge, on a new method of computing Bessel functions for high values of the argument, were read by Dr. L. N. G. Filon in the absence of the authors. The last paper was the means of the creation of a new committee with a small grant for the purpose of the further tabulation of Bessel functions.

Besides these papers there were the usual reports of committees, which contain much interesting matter. This is especially the case with the seismological report. Unfortunately the programme of the section was so full that the reading of these and of other papers had to be cut down. In order to indicate how full the programme was, it may be mentioned that on the Tuesday morning meeting the section met in three departments simultaneously, as well as at the same time sending representatives to two other sections where joint discussions were being held. In spite of this segregation the separate departments were very well attended. Altogether great interest was taken by the committee and members of the association in making the meetings a success. A. W. P.

ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

THE Anthropological Section met this year in the Victoria Hall, York, under the presidency of Mr. E. Sidney Hartland.

The president delivered his address on Thursday morning, August 2, taking for his subject recent research in the origin of magic and religion. After tracing the universal belief held by savage peoples that objects, animate or inanimate, are endued with a life and personality which is not confined to any particular object, but to all alike, Mr. Hartland showed how this personality was not only endowed with qualities, but by virtue of these very qualities possessed a potentiality and atmosphere of its own. This potentiality is known among some tribes by the name *orenda*, among others by the name *mana*, but by whatever name it is called the idea is substantially the same. In this *orenda* is found the root of all magic and religion. "Magic is primarily an application of *orenda*. By his *orenda* a man bewitches his enemy . . . causes rain or sunshine . . . divines the cause of sickness and cures it, raises the dead, spells out the future." His incantations and spells would be useless without this. Similarly, prayer is an application of *orenda*; in fact, this belief in a man's supernatural power and the efficacy by which the supernatural can be used to benefit man is the foundation of religion. The medicine man, shaman, or priest is merely the possessor of a more powerful *orenda* than his neighbour. It might be objected that this theory was upset by the Australians, and especially the Arunta, who are supposed to be in a state of primitive atheism; but not one of the Australian tribes is, strictly speaking, primitive, and in none of them is the idea of religion entirely absent, and what ideas they have are not at variance with, but complementary to, the theory here suggested.

The remainder of the morning was taken up with papers on general ethnology.

Messrs. T. A. Joyce and E. Torday communicated a paper, notes on the ethnography of the Ba-Yaka. These people, who live between the Inzia and Kwango rivers, tributaries of the Kasai, in the Congo State, have not previously been described, and the paper was consequently of unusual interest and value. Their culture, which is distinctly allied to the primitive West African type, proves them to be closely connected with the tribes on their southern and western borders. The men are small but well built. They do not practise cannibalism, but eat practically every other kind of flesh. They are skilled in handicrafts, but they have never heard of stone implements. The tribe is ruled by one paramount chief, but each village is immediately governed by a petty chief. The dead are buried in a sitting position, and the people believe that the soul leaves the body at death and visits the living in dreams. In the case of important persons it is thought that the soul is transferred to the body of a large animal.

Mr. F. W. Knocker read a paper on the aborigines of Sungei Ujong, who inhabit the hills to the north and northwest of Negri Sembilan, in the Malay States. The people are short but well built, with thick black hair and dark brown eyes. They have no birth, marriage, or death ceremonies, no religion or belief in an existence after death, nor do they practise any form of magic or witchcraft. Their chief weapon is the blow-pipe, with poisoned darts.

In a short discussion several speakers expressed themselves as very sceptical as to the absence of religious beliefs among the people, and Mr. Knocker, while stating that he had made every possible inquiry, admitted that the natives were extremely reticent when questioned on such matters.

Mr. S. S. Buckman communicated a paper on marriage and mating, in which he contested the views of Mr. Lang and Dr. Westermarck; and the morning's work was concluded by a paper on the Bushmen of Basutoland, by Mr. S. S. Dornan, in which he had collected all that is at present known about these interesting people.

In the afternoon the report of the committee appointed to explore the lake village at Glastonbury was taken. The work on this site is now nearing its completion, and in the past season a large area situated in the north-west corner of the village was explored. During the exploration another dwelling site, hitherto unrecognised, was brought to light, bringing the total number up to eighty-three. The finds were well up to the average of former years.

Dr. A. C. Haddon then gave an illustrated lecture on the ethnology of South Africa, in which he dealt chiefly with the manners and customs of the tribes whom he came across during the visit of the association to South Africa last year.

On Friday, August 3, the papers were generally of an archæological character.

Major P. Molesworth Sykes exhibited a collection of bronze weapons and implements found near Khinaman, in south-east Persia. The find consisted of five bowls, two pins, two knives, two javelin heads, two armlets of ordinary penannular form, two axe-heads, two rods with curved ends, and some clay vessels.

Notes on the collection were communicated by Canon Greenwell. The objects are undoubtedly grave goods, and are of the utmost interest on account of the light they throw upon the early metallic culture of the country. The bowls are of hammered copper, and one of them is provided with a handle or spout. It is difficult to say what the rods represent, but they may be symbols of authority. The axes are the most important part of the find. They were not weapons, as the method of fastening the handles precluded them being used for cutting. They must either have been made expressly for the purpose of burial or were for ceremonial use. Both are double-ended and are ornamented, while one has, in addition to an incised ornament, two figures of beasts, one standing over the top of the socket, the other on the curve of the sharp end.

The paper led to an interesting discussion. Sir John Evans considered the axes ceremonial, and in some respects similar to Egyptian and Mesopotamian examples. He thought the pottery was of no great antiquity, but beyond that would make no attempt at dating. Prof. Ridgeway considered the objects were of a date within the Christian era, possibly the first or second century, but perhaps even later. Prof. Petrie felt certain that the axes were ceremonial. He hazarded the suggestion that the curved rods might have been models of polo sticks, on the analogy of games found in Egyptian burials. He considered the date of the find to be either late B.C. or early A.D.

Mr. E. M. Andrews communicated a note on the Webster ruin, Rhodesia. So far as is known the ruin is unique, as it is situated within a sacred enclosure containing a large number of graves. The building was probably intended to be circular. Immediately in front of the entrance, which is rounded, are pairs of monoliths, apparently to guard it. Other monoliths are distributed among the graves. The building appears to have been a royal tomb.

Prof. Ridgeway read a paper on the origin of the guitar and fiddle. He argued that these instruments were developed from the shell of the tortoise, as there was a tradition that Hermes made such an instrument, and Pausanias speaks of tortoises existing in Arcadia. There can therefore be little doubt that instruments with a tortoiseshell sounding-board existed in Greece. The waist of the instrument developed from the slightly narrowing waist of the shell. Guitars of tortoiseshell are still in use in some parts of the Mediterranean basin.

Prof. R. C. Bosanquet gave an account of the excavations undertaken at Sparta by the British School at Athens. The wall of the Acropolis was traced, and general conclusions were drawn as to the extent and disposition of the town at different periods. The famous sanctuary of Artemis Orthia was examined, and although its complete examination will take at least another season, many interesting finds have already been made, including geometric pottery and ivories, some of which show interesting affinities to those discovered by Mr. Hogarth in the Artemisia at Ephesus. These Spartan ivories were associated with spiral fibulæ and other bronze objects, lead figurines and masks, some undoubtedly intended to be worn. These masks point to the existence of some dramatic performances connected with the temple, and, in fact, in the third century A.D., a theatre-like building was constructed in the *temenos*, the proscenium of which was the front of the temple.

Mr. T. E. Peet communicated a paper on the prehistoric civilisation of southern Italy, with especial reference to Campania. The object of the paper was to discuss Prof. Pigorini's interpretation of the discovery of a well-marked *terramare* settlement in Scoglio del Tonno. The general conclusion arrived at was that the culture of Campania derived its Villanovan elements from the north, and that Scoglio del Tonno was the result of an isolated raid of *terramare* people, not a representative of a widespread culture of Italic type.

In the afternoon Miss L. F. Pesel read a paper on the evolution of design in Greek and Turkish embroideries. The materials on which the paper was based were collected in Greek lands round the shores of the Ægean. The embroideries are of various ages and styles; the earliest can be dated 1760, but the designs show the influence of Byzantine art modified by contact with Oriental styles from Asia Minor and Persia and with Italian art of the Middle Ages and Renaissance.

On Monday, August 6, the papers were again archæological, and, with the exception of two, dealt with the early antiquities of England.

Messrs. F. W. Rudler and W. H. Dalton communicated a paper on the "red hills" of the east coast salt marshes. The hills are low mounds of burnt earth, and are scattered along the estuarine marshes of the east coast. They have been the subject of much speculation and controversy, but no satisfactory conclusions have been arrived at, except that they appear to be of Roman date.

A paper was communicated by Dr. E. Cartailhac entitled "Découverte archéologique," which recorded the discovery, in the grotto at Gargas, of hands painted in red on the walls of the cavern. These hands have distinct affinities with similar paintings found in Australia. It is noticeable that at Gargas left hands predominate.

Miss Nina F. Layard read a paper on the Palæolithic site at Ipswich, supplementary to two papers laid before the association at former meetings. The finds of implements have, on the whole, been up to the average of former years, but the most important result was the discovery that the two layers of the pit, which seemed to point to two distinct and widely separated dates, are in reality one, and have been separated by a layer of mud silting in. This would account for the occurrence of tools of a similar type in the upper and lower gravels, and tends to show that the pit must be dated from the highest position in which the implements were found.

Miss Layard also read a paper on an Anglo-Saxon cemetery at Ipswich. Thirty-three graves were found from which numerous relics were taken, the most important being fibulæ of a type rarely met with in England, one being cruciform with a stud in the bow. Remnants of garments, consisting of a loosely-woven plaited fabric with a dress of coarse material above, were found adhering to one of the brooches.

An account of excavations in another Anglo-Saxon cemetery, at South Cave, Yorkshire, was given by Mr. T. Sheppard. Several skeletons were found, and with one, a female, was associated an exceptionally fine series of ornaments which appear not to have been previously worn, but to have been new when interred. The relics consisted of amber and glass beads, annular and other fibulæ, a pair of girdle hangers, and brooches. With a male skeleton several iron objects were discovered.

Mr. Sheppard also gave an account of some Roman and other remains from South Ferriby, on the Humber, now in the Hull Museum. The collection consisted of coins, fibulæ, rings, &c., mostly of bronze, as well as of specimens of Samian ware and other pottery. The objects were probably from the site of a small Roman camp and cemetery.

A collection of pygmy flint implements from Lincolnshire and Yorkshire, made by the Rev. R. Scott-Gatty, was exhibited by Dr. G. A. Auden.

Two important reports of committees were taken as read. The first, on the age of stone circles, chronicled the results of diggings at the Stripple Stones in Cornwall, with the result that the date of the circle is shown to be not earlier than late Neolithic or later than early Bronze age times. The other report, of the committee to conduct explorations on Roman sites in Britain, gave some account of recent excavations at Caerwent, Melandra Castle, Newstead near Melrose and Silchester.

Mr. D. G. Hogarth gave an account of the recent exploration on the site of Ephesus, and of the discovery of the primitive Artemisia.

In the afternoon Dr. T. Ashby, jun., described the excavations now being conducted at Caerwent. During the first part of the season the inner side of the south gate was cleared, and the inner arch was found to be to a great extent still preserved. The rest of the season was spent on work in the northern half of the town. Five buildings were excavated, one of which appears to have been the public bath. Of the other buildings, one possessed a colonnade, while in another remains of painted plaster were found on one of the walls, which was preserved for a height of more than 10 feet. Two wells were also excavated, and yielded a number of plant remains.

Dr. Ashby also gave an illustrated lecture on recent discoveries in the Roman Forum, in which he detailed the results obtained during the past year in the excavations. These included the discovery of the Lacus Curtius, of the tribunal prætorium, and of the position of the rostra. The place where Cæsar's body was burnt and the base of the equestrian statue of Diocletian were also found.

The work on Tuesday morning dealt exclusively with physical anthropology, and the papers led up to a discussion on the physical characters of the races of Britain.

Dr. F. C. Shrubsall gave a demonstration of the methods of determining racial characters, in which he explained the meaning of the various terms used in craniology, and showed the distribution of the various races in Europe.

Dr. G. A. Auden exhibited a collection of crania, all from the neighbourhood of York, and to a great extent from the collection of the Yorkshire Philosophical Society. The exhibit included specimens of Celtic, pre-Roman, and Roman skulls, while one series showed the great change in head form which took place in York after the Norman conquest. Some of the Roman skulls had a sentimental interest, as they were from coffins unearthed in York and the names and ages of the persons were known.

A paper by Messrs. H. Brodrick and C. A. Hill on a recently discovered skeleton in Sooska cave was then read. The bones, which all belong to one individual, were found under a layer of stalagmite. The skeleton is that of a female Celt, and the skull is brachycephalic. Above the right mastoid process is an irregularly shaped hole, evidently the cause of death. The height appears to have been about 5 feet 3 inches.

Mr. J. R. Mortimer communicated a paper on the relative stature of the men with long heads, short heads, and those with intermediate heads in the museum at Driffield. Some doubt was thrown on the correctness of the figures, but if correct the paper was most important, as it entirely reversed the accepted theories as to the height of the Neolithic peoples of Britain, showing that the long-headed Neolithic man was taller than the broad-headed Neolithic and Bronze age man.

Mr. J. Gray read a paper on England before the English, in which, after stating the present condition of our knowledge of the subject, he argued that Neolithic man corresponds with the present Mediterranean race, and that the Anglo-Saxons and other fair races of northern Europe are a variety of Neolithic man with somewhat broader heads. The Bronze age race, which subsequently settled in Britain, was brachycephalic and tall, and came by sea from the eastern Mediterranean and Asia Minor.

At the conclusion of the papers Dr. W. Wright opened the discussion on the physical characters of the races of Britain. After quoting Cæsar to show that the coastal area was occupied by the Belgic Gauls and the interior by another race, he argued that all the evidence pointed to the fact that a mixed race came to Britain in Neolithic times, and that the population was not a pure broad- or a pure long-headed one.

Dr. Shrubsall urged the necessity of knowing exactly where skulls were found, considering that as careful evidence was required as in geology. He thought it a mistake to deal only with the length and breadth of the skull, and felt that the proportions of the face were just as important. Also all work required revision on biometric lines. As to coloration, which was very important, he pointed out that the Anglo-Saxons never called the Welsh dark, and felt that it was by no means certain that the Britons were a dark people. He also considered it quite possible that there was a Teutonic element in the population before Roman times.

Prof. Ridgeway insisted that all classical references speak of the Celts as a fair or rufous and tall race, and considered that there was no evidence of a pre-Celtic language in Britain.

Mr. J. L. Myres urged Prof. Rhys's view as to there being a non-Aryan structure in Welsh and Irish, and also protested against the practice of arbitrarily drawing conclusions from skull measurements.

Prof. Petrie considered that a *prima facie* case had been made out for an invasion of Britain, even in pre-Brythonic times, by a mixed race, but felt that much more material was needed before any definite conclusions could be drawn.

Dr. C. S. Myers threw doubt on the "Crania Britannica" records as perhaps affected by the collection of type skulls, and Mr. H. Fleure gave some account of the anthropometric work at present in progress in Wales.

The general conclusion to be drawn from the discussion was that it is of paramount importance that the existing material should be revised by improved methods, and that a better comparison with Continental data is essential.

In the afternoon Prof. Petrie gave an illustrated lecture on the Hyksos and other work of the British School of Archæology in Egypt. The most important work was the excavation of a great camp of the Hyksos or Shepherd Kings. The camp consists of an earth bank faced on its outer slope with white stucco, and with a slope, more than 200 feet long, serving as an entrance. This slope does not pierce the wall, but goes over it. Flanking walls were added to command this entrance, and the whole scheme of defence proves that archery was the only arm employed. Some sixty years later a wall of limestone was built outside the bank. There seems little doubt that the place is Avaris, and the account in Manetho's chronicle agrees with the arrangement of this site. The people appear to have been Semites from Syria and Mesopotamia. Other work resulted in the discovery of the city of Raamses, built by the Israelites, and of the town and temple of Onias, under whom the Jews founded a settlement in the second century B.C.

The work of the section concluded on Wednesday morning, August 8. Mr. J. L. Myres read a paper on early traces of human types in the Ægean. The population of the Ægean area as far back as the beginning of the Bronze age, before which there is no evidence, was not a purely Mediterranean type of dolichocephalic man, as brachycephalic individuals occur sporadically over the whole district. Ægean culture, therefore, cannot be the exclusive production of "Mediterranean" man. This evidence for brachycephalic types in the Ægean, when compared with the evidence as to the existence of a very pure brachycephalic race in the Balkan and Anatolian highlands, makes it probable that these latter people were established in these highlands at least as early as the beginning of the Ægean Bronze age, and were in competition with dolichocephalic "Mediterranean" man. Intruders from the north cannot have been brachycephalic, as the steppe of southern Russia was inhabited from Neolithic to Classical times by a dolichocephalic population. It seems improbable that the brunet dolichocephalic type of the southern Ægean could have arrived by a land route, owing to the presence of a brachycephalic type in the Balkan and Anatolian highlands, while its brunetness precludes affiliation to the dolichocephalic peoples of the north. This type, therefore, must be considered an immigration by sea from North Africa, and its littoral habits are a strong argument in favour of this view.

Dr. T. Ashby, jun., and Mr. D. Mackenzie communicated a paper on the ethnology of Sardinia.

Two papers were then read by Dr. W. H. R. Rivers. The first, entitled "A Survival of Two-fold Origin," dealt with the relation between a man and his maternal uncle. This connection, although in most races a survival from mother-right, in India originates, in many cases, in the regulation that the children of a brother and sister should marry one another. This involves that a man's maternal uncle is also his actual or potential father-in-law. The practice is now chiefly confined to the southern parts of India.

Dr. Rivers's other paper dealt with the astronomy of the islanders of the Torres Straits, who group together many stars in constellations, which often represent mythical persons. In Murray Island private property was found in stars, two stars being the property of two men who had inherited them from their ancestors.

Two physical papers were communicated by Dr. W. L. H. Duckworth. The first directed attention to a rare anomaly in human crania from Kwaiawata Island, New Guinea, the anomaly consisting in the presence of small but sharp spicular projections of bone springing from the margin of the nose due to a bony deposit formed in fibrous bands, which in all cases exist in a corresponding situation. Dr. Duckworth's other paper was a chronicle of observations made on a "eunuchoid" subject in the Anatomy School, Cambridge.

The last paper presented was a demonstration of photographs of racial types by Mr. T. E. Smurthwaite. Mr. Smurthwaite has evolved a new classification of the races of man from observations of the contours of the head and face, and he resolves all the races into six common types.

Three important reports were taken as read, namely, that of the committee to conduct anthropometric investigations among the native troops of the Egyptian Army, to which was added some observations on nasal and cephalic indices in Egypt by Dr. C. S. Myers; that of the committee to conduct anthropometric observations in the British Isles, which issued in its report a series of photographs and diagrams of the living figure with the points, between which dimensions are to be measured, marked; and that of the committee to collect anthropological photographs, which issued a first list of photographs registered.

M. LIPPMANN'S METHOD OF PHOTOGRAPHY IN COLOUR.

THE original method of photography in colour proposed by M. G. Lippmann was based on the production of interference fringes in the photographic plate, and had the disadvantages of requiring very delicate adjustments and a long exposure. In the *Comptes rendus* for July 30 M. Lippmann gives an account of a method in which long exposures are not required. Consider a photographic spectroscope consisting of a slit, a prism, a lens, and a sensitised plate. The light falling on the slit is analysed by the prism, and the rays produce a corresponding number of dark lines on the negative, each of which is a conjugate image of the slit. If a positive is taken from this negative, and the former placed in the exact position originally occupied by the latter, the system is reversible. If the plate is now illuminated by white light, the light passing through the transparent portion of the plate formed by any particular line will produce at the slit only that ray which originally imprinted the negative. On the whole spectrum, the net result will be to reconstitute at the slit the original colour. In order to apply this principle to photography in colours, the following apparatus has been arranged. The single slit of the spectroscope is replaced by a series of slits very close together, consisting of fine transparent lines ruled five to the millimetre. This grating is fixed at one end of a solidly built box, the other end carrying the photographic plate, and between these is a converging lens, in front of which is a prism of very small angle. The object to be reproduced is projected on the grating, illuminated with white light. The light passing through the prism and lens falls on the sensitive plate producing a negative in black and white, which under the lens appears lined, each line being divided into small zones, which are parts of an elementary spectrum. If the negative be now replaced in its original position and illuminated by white light, the eye being placed at the distance of distinct vision from the grating, the image of the object photographed is seen in colours, these colours being complementary to those of the object; the latter appears in its own proper colours when the negative is replaced by a positive. The spectrum of the electric light has been produced with this apparatus by the aid of a positive in its natural colours. It is necessary that the angle of the prism used should be so small that the length of each spectrum produced by it should be less than the length between each line, otherwise the spectra interfere with each other. Ordinary sensitive orthochromatic plates can be used, and the exposure required is very much less than with the interference method. The chief drawback at present is the necessity of using the identical apparatus in which the exposure is made to view the colours, but M. Lippmann suggests a method by which this difficulty may possibly be overcome.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Frank Smart studentship in botany has been awarded to Mr. D. Thoday, of Trinity College. The studentship is held at Gonville and Caius College.

ENGINEER F. R. EICHHOFF has been appointed professor of iron metallurgy in the Berlin Mining School.

A MOVEMENT is on foot for the foundation in the Glasgow Agricultural College of a bursary, to be known as "the Biggar Bursary," in memory of the late Mr. James Biggar.

THE metallurgical laboratory of the Technical High School, Charlottenburg, is to be divided into two sections, the one, especially for iron and steel, to be under Prof. Mathesius, and the other, for the metallurgy of other metals, under Prof. Doeltz. Near the technical chemistry institute of the same high school a chemical museum has been provided and placed in the charge of Prof. O. N. Witt.

PROF. EDUARD SUESS, president of the Vienna Academy of Sciences, celebrated his seventy-fifth birthday on August 20, and also the fiftieth anniversary of his appointment as extraordinary professor of palæontology in the University of Vienna. Prof. E. Ludwig, the holder of the chair of medical chemistry in the same university, has been elected an ordinary member, and Prof. J. Herzig, professor of chemistry, a corresponding member, of the Vienna Academy of Sciences.

THE issue of *Science* for August 17 gives particulars as to the degrees of Doctor of Philosophy and Doctor of Science conferred during the past year by American universities. The number of students receiving one or other of the degrees in 1906 was the same as in 1905, viz. 325, while the total number of doctorates (in philosophy or science) conferred in nine years was 2387. The names of those on whom the degrees were conferred, the subjects of their theses, and the names of the institutions conferring the degrees are given in the number.

IN connection with the meeting in Canada of the British Medical Association, the honorary degree of LL.D. has been conferred by the University of Toronto upon the following medical men:—Prof. T. Clifford Allbutt, F.R.S., Dr. A. H. Freeland Barbour, Sir Thomas Barlow, Bart., Sir James Barr, Sir William Broadbent, Bart., F.R.S., Prof. G. Cooper Franklin, Prof. W. D. Halliburton, F.R.S., Sir Victor Horsley, F.R.S., Dr. Donald MacAlister, Dr. W. Julius Mickle, Dr. Louis Lapicque, Paris, Dr. Ludwig Aachoff, Marburg, and Dr. W. J. Mayo, president of the American Medical Association. The degree was also conferred *in absentia* upon Dr. H. W. Langley Browne, chairman of the British Medical Council. The same degree is also to be conferred *in absentia* on Sir Thomas Barlow, Bart., Sir William Broadbent, Bart., F.R.S., Prof. T. Clifford Allbutt, F.R.S., and Sir Victor Horsley, F.R.S., by the McGill University, Montreal.

IN the last of six lectures on British institutions, delivered to students attending the University Extension summer meeting at Cambridge, Prof. Masterman dealt with education. He said we are just at the beginning of a systematisation of our secondary education as an attempt to complete the ladder for brilliant pupils from the elementary school to the university. There is a danger, he said, that the majority of children unable to climb such a ladder may be neglected. Prof. Masterman thinks that the next two towns to obtain a university charter will be Bristol and Newcastle. The new universities are largely dependent on the subsidies of municipal authorities. In this the lecturer sees the danger, and he does not speak without knowledge, that the universities will be hampered from the higher education point of view by the entirely inadmissible conditions of the municipal authorities. The men who provide the money may claim to control the expenditure of it and disregard the opinions of experts. That can only be averted by a large subsidy paid from the central authority. He urged that universities ought to receive greater assistance from the State.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 10.—"The Action of Anæsthetics on Living Tissues. Part II.—The Frog's Skin." By N. H. **Alcock.**

This paper is a continuation of researches made on isolated nerve (Proc. Roy. Soc., B, vol. lxxvii., p. 267), and the phenomena here described are to be considered in connection with them.

The experiments may be summarised as follows:—

(1) $CHCl_3$ vapour locally applied to the outer surface of the frog's skin abolishes the normal ingoing resting current.

(2) $CHCl_3$ to the inner surface leaves the current unaffected.

(3) $CHCl_3$ to a combination of (outer-inner) surfaces, connected with another spot on the outer surface, diminishes the current.

(4) The electrical resistance of the skin is diminished by about 24 per cent. of its value by $CHCl_3$.

Certain conclusions can be deduced from these observations:—

(*a*) The apparatus furnishing the current is located at the outer surface.

(*b*) A diagram of an electrical apparatus which would give similar results to those observed on the skin shows that the latter must consist of structures resembling galvanic cells, the positive elements of which lie towards the outer surface, and are insulated from each other, the negative elements towards the inner surface, and connected together. If it is assumed that the current in the skin is due to the movement of ions, it appears from the present experiments (and also from those in part i.) that there must be some semi-permeable apparatus in both skin and nerve, and that choloroform renders this apparatus completely permeable, so making the whole tissue iso-electric. The diminution of resistance can be accounted for by this action, which is equivalent to a diminution of viscosity.

If this interpretation of the results is correct, it furnishes an actual demonstration of the existence of some form of semi-permeable apparatus in the tissues, and suggests that a similar mechanism may play a larger part in vital phenomena than had previously been supposed.

PARIS.

Academy of Sciences, August 13.—M. Bouquet de la Grye in the chair.—Irrigation and the permeability of soils: A. **Müntz** and L. **Faure**. The authors discuss the value of the application of irrigation to parts of France, and argue that irrigation works must prove unremunerative in private hands, and should be undertaken by the State. Proper attention does not appear to have been paid in the past to the different requirements of different classes of soil for water. The nature of the soil is not a sufficient guide in this matter, apparently similar soils having been found to require very different amounts of water. A description is given of a simple instrument for making this determination.—The two specific heats of a slightly deformed elastic medium; the fundamental formulæ: P. **Duhem**.—The preparation of pure barium starting from its suboxide: M. **Guntz**. Equivalent portions of magnesium and baryta, heated in a vacuous porcelain tube containing a water-cooled steel tube, gave a deposit on the cold tube of one-half the magnesium employed, together with traces of barium. The residue in the boat possessed properties corresponding to an oxide Ba_2O. If the magnesium is replaced in this reaction by aluminium, crystallised barium deposits on the cold tube. This was found to contain 98·8 per cent. of barium, and on a second distillation in a vacuum gave pure barium. Strontium can be obtained in the same way.—The aromatic azocyanamides: P. **Pierron**.—A property of diastase: J. **Duclaux**. The application of recent studies on colloids to diastase. The author holds that the quantity of active material in diastase, by reason of which it exerts its diastatic functions, need, in a set of experiments, bear no constant and necessary relation to the quantity of crude diastase taken, and that different experiments, even simply made at different dilutions, are not comparable among themselves.—The copper-steel alloys: Pierre **Breuil**. Copper increases the tenacity and reduces the ductility of steels, but the results obtained with a given alloy depend very largely upon the treatment the metal has received.—The cultivation of micro-organisms in chemically defined media: J. **Galimard**, L. **Lacomme**, and A. **Morel**.

August 20.—M. Bouquet de la Grye in the chair.—The progress of a fruit-attacking insect, *Ceratitis capitata*, in the neighbourhood of Paris: Alfred **Giard**. Six years ago the author pointed out the presence of this destructive exotic in the neighbourhood of Paris. At that time there were only a few apricot trees attacked, and it should have been easy to prevent its acclimatisation. The author's suggestions made at that time were, however, disregarded, and at the present time damage is being done to peach trees in various localities round Paris, damage which may, given a few dry seasons, become as disastrous as at the Cape of Good Hope, unless prompt measures are taken.—The Valparaiso earthquake (August 16, 1906), registered at Paris: G. **Bigourdan**.—Observations of the Finlay comet made with the large equatorial of the Bordeaux Observatory: E. **Esclangon**.—Definitive orbit of the comet 1905*a*: M. **Giacobini**.—The boiling points of some secondary and tertiary alcohols: G. D. **Hinrichs**. Referring to a recent note by M. Louis Henry on this subject, the author points out that the relationships between the boiling points of the secondary and tertiary alcohols need not be regarded as unusual, since they can be deduced, at least qualitatively, from a consideration of the moments of inertia of the molecules.—Researches on the relations between functional groupings in distant positions. Decamethylene-imine: E. E. **Blaise** and L. **Houillon**.—The influence of some mineral compounds on the liquefaction of starch: J. **Wolff** and A. **Fernbach**.—Cultures of Protozoa and variations of living material: J. **Kunstler** and Ch. **Gineste**.

NEW SOUTH WALES.

Royal Society, July 4.—Prof. T. P. Anderson Stuart, president, in the chair.—The testing of building materials on abrasion by the sand-blast apparatus: H. **Burchartz**. The paper described a method of testing building material by means of a sand-blast apparatus. The sand-blast apparatus is used on cubes of the material, exposing an area of 4·34 square inches for two minutes, and the loss of weight, and the appearance of the area eroded by the sand, give accurate data in regard to the durability of the material. The author compared the results of testing a great variety of materials by means of the sand blast with those subjected to the grinding process proposed by Bauschwiges, and showed the superiority of the sand blast over all other tests for abrasion.

CONTENTS.

THURSDAY, SEPTEMBER 6, 1906.

NILE STUDIES.

The Physiography of the River Nile and its Basin. By Captain H. G. Lyons, Director-General, Survey Department. Pp. viii+411; with 48 plates. (Cairo: National Printing Department, 1906.)

WHEN a British army was first sent to occupy Egypt, the late Prof. Huxley called upon the Royal Society to appoint a committee to arrange for a systematic study of that most interesting country. He justly pointed out how much the French Government had accomplished in the promotion of scientific research and in the publication of its results during their short period of occupation at the beginning of last century, and he declared that it would be a national disgrace if we failed to accomplish something of the same kind with our much greater opportunities.

The publication of the work before us, and of others of a similar character, serves to show that England has not been unmindful of her responsibilities or neglectful of the opportunities which have resulted from our close association with the Egyptian Government for more than two decades. Captain Lyons, who organised the Geological Survey of Egypt—some of the admirable publications of which have been reviewed in the pages of NATURE—has now become head of the whole Survey Department of Egypt, and is administering its affairs with characteristic energy and ability.

The discovery of the Lake district of Equatorial Africa by Speke and Grant, with the surveys and observations of Gordon, Emin, Schweinfurth, Junker, and others, has afforded a safe basis for the treatises on Nile hydrography by Klöden, Lombardini, Chavanne, and de Martonne; but since the fall of Omdurman in 1898, and the consequent opening up of the Sudan, much new material has been made available. Systematic meteorological records have been collected at various stations in Uganda, Abyssinia, and the Sudan, and careful measurements have been made of the levels, at different seasons of the year, of the several lakes and of the amount of water discharged by each of the Nile tributaries. All these sources of information have been admirably utilised by Captain Lyons in his survey of the present state of our knowledge of Nile hydrography.

After a very interesting discussion of the climate and rainfall of the districts from which the waters of the Nile are supplied, Captain Lyons proceeds to describe in detail the eight regions into which the Nile basin may be conveniently divided. Recent surveys in most of these districts have given much greater precision to our knowledge of their physiography, geology, meteorology, and other natural features.

The *Lake Plateau*, which has an average elevation of about 5000 feet, is composed of various metamorphic rocks. The central part of the area is occupied by the great Lake Victoria, while in its western part is the deep rift valley with Lakes Albert Edward and Albert. The district is characterised by rapids and marshes, no regular flow of the streams having been established by erosion, but the effective supply to the Nile from the Victoria Lake varies from 500 cubic metres to 1000 cubic metres per second.

The basin of the *Bahr el Jebel, Bahr el Zaraf*, and *Bahr el Ghazal*, although having a very heavy rainfall, really absorbs, not only this, but a considerable part of the water supplied to it from the Lake Plateau. The rivers wind through level alluvial plains, and support a great marsh vegetation (the "sadd"), consisting of papyrus and various reeds with some floating plants, and evaporation and absorption by vegetation take up, not only the whole of the considerable rainfall, but diminish the amount coming from Lake Victoria by from 4 per cent. to 52 per cent.

The *Sobat Basin* is occupied by a comparatively short river with a rapid fall, and adds an appreciable but varying amount to the waters coming down the White Nile.

In the *White Nile Basin* we find that we have the most constant element in the supply of the Nile waters. The 1500 million cubic metres of water from the Sobat flood are supplied to the Nile during October, November, and December, thus modifying the fall in the water-level of the river during those months.

The Blue Nile, the Atbara, and the Khor el Gash.—These rivers drain a plateau with an elevation of from 6000 feet to 10,000 feet. Although exact information concerning the distribution of rainfall in various parts of the Abyssinian highlands is still wanting, there can be no doubt that the rainfall is very great. The regular northward movement of the rain-belt during the monsoon season leads to the flooding of the Blue Nile and Atbara, and the annual Nile flood in July, August, September, and October. The volume and continuance of this flood are clearly dependent, firstly, on the amount of rainfall in the Abyssinian highlands, and secondly, on the great length of the river courses, with their deeply-cut channels, ensuring a regulation of the water supply during torrential rains. Captain Lyons directs attention to the possible interference with this latter element in the production of the periodic Nile floods, which may result from the extensive afforestation which is said to be going on in Abyssinia.

From *Khartoum and Berber to Aswan* the united waters of the White Nile, Blue Nile, and Atbara flow in a single stream, which is eroding its bed with considerable rapidity, there being some cataracts but no flood plains. The waters of the Nile have in this part attained their maximum, and in its course northward the river is constantly losing by evaporation and the withdrawal of its waters for irrigation.

From *Aswan to Cairo* the Nile flows in a depression in which it has deposited a considerable thickness of alluvium, and the river winds through the flood plains thus formed. During the fifty centuries of which we have a record, the Nile appears to have deposited a thickness of 16 feet or 17 feet of alluvium in this part of its course, and the silting up of various water channels and the reclamation of land in consequence have resulted. It is in this way that the lake occupying the depression of the Fayum has been diminished in area.

The floods in the *Nile Delta* of which records have been kept, that are trustworthy for the past 175 years at least, have been critically studied by Captain Lyons with the view of discovering the determining causes of their variations. While no regular periodic alternations of high and low floods can be detected by the study of these records, their dependence on the rainfall and the distribution of atmospheric pressure in the highlands of Equatorial Africa is very apparent. There is reason to believe that more numerous, systematic, and complete meteorological observations in the districts outside Egypt may enable us, in the end, to predict from month to month the probable fluctuations of the annual Nile flood.

The space at our command has only permitted the notice of a few of the more salient features of this very interesting volume. In conclusion, we must congratulate Captain Lyons and the Egyptian Government upon the great amount of valuable work which has been accomplished and is still in progress. A word of praise must also be added on the excellent typography of the volume, and the admirable plates with which it is illustrated. J. W. J.

THE HISTORY OF DETERMINANTS.

The Theory of Determinants in the Historical Order of Development. Part i. Second edition. General Determinants up to 1841. Part ii. Special Determinants up to 1841. By Dr. T. Muir, C.M.G., F.R.S. Pp. xii+492. (London: Macmillan and Co., Ltd., 1906.) Price 17s. net.

A MATHEMATICAL history of the right sort is much more than a mere bibliography, and in some respects is more valuable than a treatise on the subject with which it deals. It helps us to see how mathematical ideas originate, and how, as they become familiar, the symbolism by which they are expressed becomes compact and appropriate. This is especially the case with determinants, because a determinant is essentially a comprehensive symbol, and it would perhaps be more proper to speak of the calculus than of the theory of determinants. It may seem strange, at first sight, to find a history so large as this dealing with a subject so limited; but no one can complain that the author is either diffuse or irrelevant, and his work may be praised without restriction as a model of its kind.

It is unnecessary to say much of the first part, which is mainly a reprint of the volume which appeared in 1900. Dr. Muir has written a new introduction, and added a few additional notices. Two things cannot fail to strike the reader of this part. The first is the great supremacy of Cauchy and Jacobi in everything relating to choice of notation and clearness of statement; the other is the great and long unrecognised ability of Schweins. Schweins, in a way, brought this fate upon himself; his style is heavy, and his notation cumbrous in the extreme, but his contributions to the subject are of great value and generality, although they attracted no notice for many years, and were re-discovered by others. Unfortunately, they are expressed in such a repulsive notation that no one but an enthusiast would read his works, and the student will feel very grateful to Dr. Muir for his analysis of them. Part of this analysis, in some ways the most interesting, is given on pp. 311–322; this, and the subsequent section on a paper of Sylvester's, deserve careful reading, because, as Dr. Muir points out, Schweins gives some results on alternants which even now are not familiar, and Sylvester makes some hasty statements which, as they stand, appear to be incorrect, but which, if corrected, or rightly interpreted, might lead to important formulæ.

It should be noted that on p. 323 the determinant is misprinted, a, a^2, &c., being put for a_1, a_2, &c. Moreover, it is not explained so clearly as it should be that $\zeta a^r = a_r$; while the law $a_r \,.\, a_s = a_{r+s}$ is *not* used. The right statement is $\zeta(a^r \,.\, a^s) = \zeta(a^{r+s}) = a_{r+s}$; while $\zeta(a^r)\zeta(a^s) = a_r a_s$. Readers of Sylvester's papers must be careful to distinguish this ζ from the square of the operator $\zeta^{\frac{1}{2}}$. It may be noticed, in passing, that these generalised alternants present themselves in the theory of numbers, both when the elements are roots of unity and also when they are not, so that further knowledge of their properties is desirable, and the suggestion made (p. 325) that Sylvester's results are true when the elements are periodic deserves further examination.

Considerable space is given to functional and orthogonal determinants, and here, of course, Jacobi receives most attention. The results are now so familiar that it requires some effort of imagination to realise the gain in working power which has resulted from Jacobi's investigations. In this connection attention may be directed to an odd remark on p. 297. Speaking of one of Jacobi's papers, Dr. Muir says:—"The only thing worth noticing is the curious cubic equation . . ."; this "curious" equation is nothing more nor less than the reducing cubic for two ternary quadratic forms, in the exact notation of Salmon's "Conics"! And Dr. Muir even takes the trouble to express the invariants Θ, Θ' in the forms

$$Aa' + Bb' + \ldots, \text{ \&c.}, \qquad A'a + B'b + \ldots, \text{ \&c.},$$

as if this were a quite novel idea.

Returning for a moment to alternants and their applications, attention may be directed to the work of Jacobi and Cauchy on the expansions of rational functions of several variables (pp. 331–345). This is important in the theory of functions, in that of algebraic forms, and in that of partitions. In some ways it deserves further investigation; in various applications the expansions have to be infinite series, and the question of convergency has to be faced, even when the series are used for establishing formal equivalences; this is a curious case of formal and arithmetical algebra each marching, so to speak, on the other's domain.

There is one more observation made by Dr. Muir (p. 290) which is rather puzzling. After giving some identities of Lagrange's, which are, in fact, relations between determinants, Dr. Muir says, "a reference to the original papers, already described, will make it almost perfectly certain that Lagrange did not view them in this light. The like is true of Gauss. . . ." Now Gauss, at any rate, used the term "determinant"; if this word is used in the modern sense of the *symbol*, of course Dr. Muir's remark is correct, but is then quite trivial; on the other hand, if it means the function, it is hard to see how Gauss, not to say Lagrange, could fail to see that their expressions involved determinants, especially as each was quite familiar with them in connection with the theory of numbers. This is particularly true of Gauss, who gives the name "determinant" to $(\alpha\beta\gamma)$ as well as to $(\alpha\beta)$.

It is a matter of regret that, although a bibliography of orthogonants (to 1840) has been given, Dr. Muir has not been able to include in this volume his valuable lists of writings relating to determinants. To have added them would not have increased the size of the book very much, and it would have been very convenient to have them here. But perhaps the author intends to give us the history of his favourite subject subsequent to 1841, the date at which he has now closed. G. B. M.

EUROPEAN VERTEBRATES.

Die wirbelthiere Europa's mit Berücksichtigung der Faunen von Vorderasien und Nordafrika. By Dr. O. Schmiedeknecht. Pp. vi+470. (Jena: Gustav Fischer, 1906.) Price 10 marks.

IT is always convenient to have within covers separated by a moderate distance only an account of the fauna of a definite district, especially when, as in the present instance, the fauna is one that is fairly exhaustively known. It is not likely that a manual of the scope of that which we review here will ever need substantial alteration, or even slight changes, for many years to come. The volume, in fact, is not only of permanent value, but contains the marrow of a whole library of faunistic works, and includes all that the student needs, whether the aim of his studies be purely geographical or whether he desires a handy series of definitions of families, genera, and species. Inasmuch as the volume is something less than five hundred pages in length, and seeing that the definitions of family and other characters are often from twelve to twenty lines in length, the author is compelled to deny himself any discussion of points round which opinions fluctuate, and is driven to be entirely dogmatic.

It is therefore not everyone who will follow Dr. Schmiedeknecht with complete agreement from beginning to end. He will not, for example, please all of us by placing the "reed pheasant," *Panurus biarmicus*, among the tits, though it *is* frequently called the bearded tit; nor can we agree to the use of four separate generic names for the four species of rorquals, which appears to us as a recrudescence of one of the very worst achievements of the systematists of the past. In adopting an old scheme of arrangement for birds, the author is compelled thereby to separate widely the gulls and Limicoline birds, which many anatomists have concurred in placing in very close relationship. There are plenty of similar examples to be gathered from Dr. Schmiedeknecht's pages. If the author errs at all in the number of species which he admits into his manual, it is rather on the side of economy than profusion. Of the very long series of "species" of mice admitted, or rather insisted upon, by some British naturalists, Dr. Schmiedeknecht will only consider four as established. Perhaps he carries this plan a little too far in declining to admit the "Irish weasel," *Mustela hibernica*, which is not in any way referred to. Apropos of weasels, it will certainly surprise some persons to learn that the proper name of the common weasel is not *Mustela vulgaris*, but *M. nivalis*, inasmuch as (according to Dr. Schmiedeknecht) Linnæus gave the name to an individual in winter dress.

That the weasel, like its very close ally the stoat, changes to white in winter can hardly be a fact of general knowledge, since it is not mentioned in at any, rate one well-known work upon British mammals.

In classifying the snakes, Dr. Schmiedeknecht follows a somewhat curious plan. He divides the European species into five families of equal rank, which are (in the order treated by him) Crotalidæ, Viperidæ, Colubridæ, Peropodidæ, and Typhlopidæ. To give the "pit vipers" a place in the system which divides them as far from the more typical Viperidæ as from the Peropodidæ, or Boidæ as most would prefer to call them, is quite opposed to the minute details of anatomical agreement between all vipers.

To such criticisms, however, the author might well reply that his arrangement is rather a sorting than a classification, and that, as a matter of fact, judged by external characters only (and it is these alone that are made use of), the two divisions of the vipers are very distinct, and the gulls are remote from the sandpipers, plovers, &c.

In his preface, Dr. Schmiedeknecht puts himself forward as a champion of the systematic aspect of zoology as a desirable commencement for the student of that science There is no doubt that most of us, in this country at least, were led to pursue zoological studies by reason of the fervour and enthusiasm engendered by the joys of collecting objects of natural history. The quality of knowledge possessed by the pure systematist of mature years is often but little in advance of this stage, and in remarking that "he must be as a rule a remarkable systematist who is not at the same time a biologist," the author is expressing an opinion which the annals of museums do not confirm. In fact, Dr. Schmiedeknecht's introductory remarks read a little like an apology, which is not at all needed in introducing so useful and accurate a work as that which we notice here. F. E. B.

TREATMENT OF WATER FOR STEAM BOILERS AND MANUFACTURES.

Water Softening and Treatment. By W. H. Booth. Pp. xvi+308. (London: Archibald Constable and Co., Ltd., 1906.) Price 7s. 6d. net.

THE primary object of this book is the softening of hard water for use in steam boilers and for manufacturing purposes, but, in fact, it deals largely with other matters relating to the supply of water to the boilers of steam engines. Thus it is divided into five sections, the first only of which relates to the treatment of water by softening, together with the separation of oil and filtration, and occupies about half the book; whereas the four other sections, constituting the second half of the book, consist of "Section II., Air Pumps, Condensers, and Circulating Pumps"; "Section III., Feed Heating and Stage Heating"; "Section IV., Water Cooling"; and "Section V., Feed Pumps and Injectors." Accordingly, the volume ranges over the whole subject of the treatment of water supplied to steam boilers, though dealing more expressly with the all-important point of securing, so far as practicable, the purity of the water employed for raising steam.

Comparatively few towns are able to obtain a pure water-supply by storing up the flow of rain off primitive rocks in an uninhabited mountain valley, and conveying it at considerable expense to a distance, as has been accomplished for Liverpool, Manchester, Glasgow, Birmingham, and New York. Waters derived from underground sources, such as springs, rivers fed by springs, or wells, are impregnated more or less with the soluble salts contained in the strata through which they have passed; and when steam is driven off from a boiler fed with such water, these soluble impurities are deposited as scale on the sides of the boiler. This incrustation, being a bad conductor of heat, reduces the efficiency of the boiler, and when very thick may lead to an injurious heating of the metal; whilst the necessary periodical removal of the deposit is tedious and costly, and is liable to damage the inner surface of the boiler. Accordingly, in selecting a site for a factory, the available water-supply should be carefully considered; and where a bored tube well proves the most economical, and an adequate source of supply, the geology of the district should be studied to secure the best site, and ascertain the requisite depth for the well. In such cases some softening process is generally expedient—and often even when water from a river or stream is available—to avoid incrustation of boilers, to prevent a great waste of soap in laundries, and manufactories where washing is resorted to, and to obtain the soft water which is essential in dye works, paper mills, and tanneries.

The author deals successively with the sources and impurities of water, the salts contained in it, the reagents used for softening and their reactions, water-softening apparatus of various kinds, filters, compounds added to the feed-water for preventing or removing scale from boilers, corrosion of boilers, incrustation of pipes, and the chemical and mechanical removal of oil from condensed steam. The contents of the second half of the book have been sufficiently indicated by the headings of the four sections given above; and the descriptions of apparatus are elucidated by one hundred figures in the text. Altogether, the book contains complete information with respect to the purification and supply of water to steam boilers, which will be valuable to users of steam; whilst the first portion, on water softening, will be very useful in indicating the methods by which hard water may be rendered available for various manufactures requiring pure water.

OUR BOOK SHELF.

Studies in Anatomy from the Anatomical Department of the University of Manchester. Vol. iii. Edited by Prof. Alfred H. Young. Pp. 289; 23 plates. (Manchester: University Press, 1906.) Price 10s. net.

IN the struggle to build and equip laboratories for research, the provision of means to secure the full publication of the fruits of discovery has been too often left out of sight. If the best work is to be obtained from those who devote themselves to investigation, and progress made by collective effort, the means of publication become almost as important as those of investigation. The University of Manchester has recognised this fact. The present collection of studies in anatomy the third issued since Prof. Young occupied the chair in the Owens College—appears as the first volume of the anatomical series of the publications now being issued by the University of Manchester. In this volume there are ten papers by men who work or have worked in the anatomical department under Prof. Young.

A number of the papers in this volume, such as those by Profs. Robinson and Thompson, are reprinted from the *Journal of Anatomy and Physiology*, but all of them, old and new alike, are real additions to the knowledge of the subject with which they deal. Dr. J. Cameron's observations on the development of the optic nerves in amphibians deal with a subject which has been keenly discussed during the last thirty years, viz. the manner in which nerve fibres are developed. From a study of the appearances presented by the developing fibres in the optic nerve of amphibians, Dr. Cameron concludes that the fibres begin as outgrowths from the ganglion cells of the retina, but that their further growth towards the brain is obtained by the cooperation of the cells of the optic stalk, the growing point of the nerve fibre being formed from substance derived from the optic stalk cells.

The longest paper in the collection is Dr. C. W. S. Saberton's study of the nerve plexuses of four chimpanzees, an accurate and very useful contribution to the data which must be collected before we can finally settle the problem of man's origin. Everyone who has worked at this problem is fully aware that it cannot be settled by the examination of single specimens of each species, but by dissection of large numbers; the difficulty in obtaining anthropoids, the degree of individual variation, the great labour entailed by dissection, and the expense entailed by publication, have kept us from reaching a definite conception of the exact relationship of man and the higher primates to one another. Hence Dr. Saberton's contribution to available data is very welcome. In his paper on the development and morphology of the sternum, Dr. Lickley has reverted to the older conception of that bone, viz. that it is of costal origin, but the evidence on which he bases his conclusions is not convincing. For three of the studies Prof. Young is either in part or wholly responsible, and he is to be congratulated on the vigour shown by the Manchester school of anatomists.

Refraktionstafeln. By Dr. L. de Ball, Direktor der v. Kuffnerschen Sternwarte. Pp. xiv+18. (Leipzig: W. Engelmann, 1906.) Price 2.40 marks.

THE methods of computing corrections for atmospheric refraction have always been more or less unsatisfactory. The conditions of the problem do not lend themselves to extreme accuracy on account of the uncertainty of the meteorological elements introduced. The determination of the density of the atmosphere at any precise moment, dependent as it is on the temperature, the amount of aqueous vapour present, and other conditions, is not simple, and custom and authority alike have sanctioned the employment of rough and approximate data. Bessel's tables, so long in use, were admittedly founded upon inadequate material, and probably would have long since been superseded but for the inconvenience that arises when any breach of continuity occurs in a long series of observations; but in observatories where measures of zenith distance have been made at small altitudes this inconvenience has had to be faced. At Greenwich, for example, corrections to Bessel's tables, or Airy's modifications of them, have been alternately introduced and rejected in the treatment of observations at large zenith distances.

In the tables which Dr. L. de Ball has issued the difficulty of continuing an unbroken series of corrections, available from the zenith to the horizon, has not been attempted. The tables as arranged are available up to 75° zenith distance, and within this limit represent a consistent theory, that of M. Radau. The form in which the tables are constructed gives the log. of the refraction presumably correct to four places of decimals. In the example worked out it has been necessary to take out five significant integers, and, if the second decimal place is to be correct, this may be rather a severe strain on four-figure logs.; but Dr. L. de Ball gives very good and sufficient reasons for not extending the tables beyond these limits. He reminds us that the determination of the temperature of the air is not so easy as the reading of a thermometer seems to suggest. The thermometer bulb is affected by the heat rays emitted by the objects which surround it, whilst the air absorbs only a part of those rays. On these grounds the temperature indicated by the thermometer may easily differ 0°.2 C. from that of the atmosphere, and such a difference would occasion an error of three units in the fourth decimal of the log. of the density, and a similar amount in the log. of the refraction. The tables aim at giving an accuracy which is sufficient and practical rather than making a claim to extreme and misleading rigour. A further proof that the author has considered the practical side is shown by the fact that he has included tables designed to assist the computation of differences of refraction, applicable to the reduction of heliometer and photographic observations.

The Butterflies of the British Isles. By Richard South, F.E.S. Pp. x+204. (London: Frederick Warne and Co., 1906.) Price 6s. net.

NOTWITHSTANDING the large number of books relating to British butterflies, there was still room for a pocket handbook which should do for the present generation what Coleman's "British Butterflies" did for the last, and this want Mr. South has set himself to provide. He has succeeded in giving us a portable little book, well up to date, containing full information about structure, transformation, setting, &c., besides a good account of the individual species. The plates contain coloured figures of the butterflies on one side of the page, and plain figures of caterpillars, &c., on the back, thus doubling the number of page illustrations without adding to the thickness of the book. The illustrations in the text are nearly all in the introduction. They are uncoloured, and some of them are taken from Sharp, Aurivillius, and other trustworthy authorities.

Mr. South admits sixty-eight species as British, but regards only fifty-seven of these as actual natives; but surely, though some of the remainder are extinct, and others only casual visitors, the black-veined white (once abundant, but now almost extinct in England), and the red admiral, still one of the commonest of the Vanessidæ, ought to have been included among the genuine natives. The evidence against the red admiral being a genuine British species seems to rest on the assumption of its being a migrant, though this is admittedly not proved, as it is abundantly in the case of its nearest ally, the painted lady.

The rapid disappearance of butterflies in England is doubtless largely due to the wholesale clearing away of the weeds and plants on which the caterpillars feed, by the utilisation of every scrap of waste ground. Yet this cannot be the only reason, or the black-veined white, which feeds on hawthorn as well as on fruit trees, would not be disappearing. In this case the disappearance of the butterfly seems to be due to the increase of insect-eating birds. Every fresh book on butterflies records the increasing scarcity of many species once common, and there are only a few, such as the clover-feeding clouded yellows, which are more plentiful now than in former days.

In the case of the smaller and more variable butterflies, a considerable number of varieties are figured (sometimes as many as seventeen on one plate), and we think that most entomologists who are interested in British butterflies will find Mr. South's little book a very useful supplement to any they may already happen to possess on the same subject.

W. F. K.

LETTER TO THE EDITOR.

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

The Latest Critic of Biometry.

MR. J. J. LISTER in his presidential address to Section D at the British Association felt it his duty to go somewhat out of his way in order to urge on biometricians "that the old adage should be borne in mind recommending that before beginning culinary operations it is advisable first to catch your hare, in other words, to make sure that the problem you seek to elucidate is sound from the standpoint of biology before bringing a formidable mathematical apparatus into action for its investigation" (NATURE, August 16, p. 400). The importance of the occasion no doubt prevented Mr. Lister from illustrating his criticism; he had much else to deal with, and he probably hoped that his words without detailed proof would have all the weight which attaches to presidential utterances. These are not made without careful thought and proper study. But in order that a criticism of this kind should be effective, biometricians need more information, and they recognised that Mr. Lister could hardly refuse to cite instances of the type of work which led to his advice.

Hoping that we might profit by Mr. Lister's caution, I wrote to him as soon as I read his paper in your columns asking for definite instances upon which we might consider how to amend our courses. He has kindly consented to give me an illustration, so that the reasonableness of his criticism can be tried on perfectly definite and narrow grounds.

He tells me that he cannot cite a better example than a paper by Dr. Raymond Pearl which appeared recently in the Proceedings of the Royal Society dealing with a species of Paramœcium, and of which a fuller statement was offered for publication in the Transactions. The author's position in this paper, according to Mr. Lister, is traversed by the objection that the conjugant individuals are possibly, and indeed probably, differentiated gametes. Until this objection be met, Mr. Lister holds that the elaborate series of measurements has no cogency whatever in establishing the results which the author thinks he has obtained. Mr. Lister further believes that if Dr. Pearl were more conversant with the biological aspects of the life-history of Paramœcium, or less keen on the biometric aspects of the matter, he would hardly have overlooked this view.

We have here a perfectly definite charge, not a vague insinuation, which can be discussed, and I heartily thank Mr. Lister for stating it so clearly. Now as to the actual facts :—

(1) Dr. Raymond Pearl is a brilliant young American biologist who has spent much time in studying Paramœcia in the biological laboratories of America and Germany. He has just been called to a chair of biology at an American university.

(2) Dr. Pearl *demonstrates* for the first time in the memoir to which Mr. Lister refers that conjugant Paramœcia are differentiated from the non-conjugant population, a fact which his critic only considers as possible or probable.

(3) Further, Dr. Pearl *demonstrates* that among these differentiated conjugants there is an assortative mating; in other words, he shows that conjugants with certain characteristics tend to conjugate with conjugants of like characteristics.

(4) Dr. Pearl assigns with a high degree of probability the definite physiological basis for this assortative mating. He thus shows for the first time that the "physiological selection" of Romanes plays an important part in the lower living forms, and suggests the physiological origin of differentiation of species, *i.e.* all sections of a conjugant population cannot equally readily conjugate together.

Surely such problems have a very sufficient biological reality.

Dr. Pearl's paper seemed to me, as a mere biometrician, a most brilliant piece of work. That view was shared by the then Chairman of the Zoological Committee of the Royal Society, who at once passed the abstract for publication—all that lay in his power to do. The referees of the full memoir failed, so I am told, to see "the biological significance of the constants calculated" by Dr. Pearl. This appears to be Mr. Lister's condition also. The full memoir will shortly be published in *Biometrika*, so that a judgment may be formed of the value of Mr. Lister's criticism. It would have been published there originally but for two reasons. Firstly, I held the paper to be an exceptionally brilliant one, which the Royal Society ought to be proud to publish, and, secondly, that in every other branch of science papers which are very extensive, and so costly to print, naturally go to societies largely endowed for the publication of such memoirs, and not to private journals. I see no reason why biometry should be cut off from such assistance, because biology has not yet become bionomy, a transition which it must make sooner or later, as astrology passed to astronomy.

Meanwhile Mr. Lister has chosen his own ground. He cites a paper by a biologist—who happens to have studied biometric methods—as one where the hare has been cooked before it was caught, as one which deals with problems unsound from the biological standpoint. I challenge Mr. Lister to substantiate his statements :—

(1) That Dr. Pearl has neglected the differentiation between conjugants and non-conjugants.

(2) That such differentiation, whether it exists or not, makes the least difference to Dr. Pearl's investigation of whether among conjugants like conjugates with like.

(3) That Dr. Pearl has dealt with a problem unsound from the standpoint of biology.

KARL PEARSON.

ROYAL SOCIETY ADDRESSES.[1]

THE Royal Society of London is an exclusive and retired body, known of few, understanded of still fewer. To most of those who are not men of science, the words "The Royal" mean the Royal Agricultural Society; many know the Royal Institution and perhaps still more the British Association; but the ancient learned body the home of which is now at Burlington House is something beyond the knowledge of most people. Nor is this to be wondered at; the Royal Society makes few efforts to make itself known, and, indeed, seems to some to do much to keep itself unknown. It gives, it is true, two public soirées, and it has its anniversary dinner; but it has managed to make the former chiefly reunions of its own fellows, and the latter, held in the darkening days of early winter "when nobody is in town," contrasts, by the paucity, nay, almost the absence, of public and distinguished guests, and the prominence of the fellows and their private friends, with the annual dinner of its neighbour the Royal Academy.

The late president of the society seems to have thought it would be well to try to make the general public better acquainted with some of the features and aims of the society, and has accordingly published, in an attractive and yet exceedingly cheap volume, richly illustrated with photographic reproductions and pleasing sketches, portions of his anniversary addresses, with the addition of a brief narrative of the early days of the society.

The topic on which he dwelt in his address of 1903, namely, the relation of the Royal Society to other scientific societies, illustrates indirectly the exclusiveness of the former, not only towards the general public, but even towards workers in science. This exclusiveness seems to have been at least encouraged by the change in management brought about in 1847. It was then decided, whether because the number chosen seemed sufficient for that day or through some prescience that it would result in the society attaining and keeping its present size, that not more than fifteen new fellows should be elected each year. Since that day the workers in science have largely increased and are continuing to increase rapidly, but the number elected annually remains the same. Hence the number who yearly join the society is a continually diminishing fraction of those who in 1847 would all have been looked upon as fit and desirable persons to become fellows. Hence also the admission to the fellowship, the gaining of the right to use the letters F.R.S., has become an honour of continually increasing value, and the allotment of the honour an increasingly important function of the society, possibly encroaching on some of its other duties. This relative narrowing of the society's body tends to accentuate its exclusiveness and emphasises its isolation from the younger workers in science. Nor is this tendency to exclusiveness counteracted by any very direct efforts to establish relations between those within and those without the narrow circle. Indeed, even within the circle itself the relations of the fellows to each other are not very close. The temple of science at Burlington House is, at each weekly Thursday service, brightened by the presence of many eager worshippers; and the fact that these are increasing in number shows that the society is putting forth the vigour of youth in one of its several great means of advancing natural knowledge. But between times the temple is well-nigh empty. What in other places would be called "weekday attend-

[1] "The Royal Society, or Science in the State and in the Schools." By Sir William Huggins, K.C.B., O.M., &c. Pp. xv+131. (London: Methuen and Co., n.d.) Price 4s. 6d. net.

ance" is very rare, except for this or that committee; and the neophyte of science who, led by some special guest, enters with bated breath within its doors, finds ample rooms held in a solemn silence broken only by the scratching of the pens or the guarded tread of the officials, and goes away chilled with the rarefied air of the higher realms of science. He meets with a warmer, more congenial atmosphere in his own "special society."

The presidential address of 1903 makes it clear, on the one hand, that the special societies ought to exist, to prosper, and even to multiply, and, on the other hand, that the attempt to establish formal relations between them and the Royal Society would probably fail to secure any really useful results. But might not much be done in an informal way? If the society could put on a less solemn, more genial face, if it could make its fellows feel that it belonged to them rather than that they belonged to it, if it could make it clear that it was really the central home for all the sciences, that it was anxious to advance natural knowledge by placing its great resources freely at the command, not only of the chosen few who happen to be its present fellows, but of the great many whose work is pushing science on, it would be weaving bonds binding to it the younger men and the special societies, in a way no written treaties with elaborate compromises could ever bind them.

The addresses of 1902 and 1905 deal mainly with scientific education. Many wise words are said in them, but so much has been and is still being said about scientific education that nothing need be added here except perhaps to express regret that the manifesto of the council of 1904, a sequel to the address of 1902, should have produced so little good. It seems to have served chiefly as an instrument in the hands of those upholding the old ways, a result partly, perhaps, due to the fact that the statement of a body consisting of a number of men of diverging views was naturally purged from all strong words, and took the form of a chain of mild platitudes.

The address of 1904 deals with the difficult question of the relation of the Royal Society to the State. The late president in that address gives an account of the many great unpaid services which the society has rendered, and continues to render, to the State. On the one hand, it seems most unjust that men of science, whose wrestling against poverty is in most cases as strenuous as their wrestling for truth, should give their time and labour to the State without any remuneration whatever. Had the society been rewarded for what it has done for His Majesty's Government in the way lawyers are rewarded for what they do for it, the society would by this time have been rolling in wealth. But it receives from the State absolutely nothing beyond the use of the rooms

Fig. 1.—Meeting Room of the Royal Society, Burlington House. From "The Royal Society," by Sir William Huggins, K.C.B.

in Burlington House, and that portion of the 1000*l*. grant for scientific publications which it allots to its own printed output.

On the other hand, while thus giving freely that which it cannot afford to give, it keeps untouched its own freedom; and this is very precious to it. As the late president points out in the address in question, the purpose of the society is to advance natural knowledge, and this it does mainly through stimulating, encouraging, correcting and helping research by the methods which it judges best. It is true that it also advances natural knowledge by helping and advising His Majesty's Government and in many other ways, but its main work is to promote individual research. For this it must have perfect freedom.

Undoubtedly were the society to receive aid from the State under conditions which would fetter its actions, the result would be injurious to scientific progress; it would probably be disastrous if those conditions took the form of making the society more or less a Department of State. But is it not possible for the State to buy science and pay for it, without making the seller a servant? The answer to this seems mainly to depend on whether the State is able to recognise that the value of scientific work cannot be appraised by ordinary business methods; the money worth of an inquiry carried out to-day cannot be told with certainty for many years to come, when the Government who asked that it might be done and the man who did it have both long passed away. If a Government could realise this, and be prepared to spend its money, without immediate vouchers, feeling sure that in the long run the money would be well and profitably spent, State aid to science would not be so hard a problem.

In this interesting volume the late president has not only brought before a public far wider than that which is present at the anniversary meetings and dinners of the society a knowledge of what the Royal Society is, is doing, and is striving to do, but also has directed their attention, in a striking and direct way, to questions—the importance of which cannot be exaggerated—touching the relations of science to the nation. We thank him for it.

FIG. 2.—Principal Library of the Royal Society, Burlington House. From "The Royal Society," by Sir William Huggins, K.C.B.

AN AMERICAN CONTRIBUTION TO ARCHÆOLOGY.[1]

WE welcome this publication as fresh evidence of the activity of archæological study and research in the United States at the present time. Nearly every American university now has its department of archæology, and the labours of its members are no

1 "Transactions of the Department of Archæology. Free Museum of Science and Art." Vol. i., Part iii. Pp. ix+106+36 plates. (University of Pennsylvania, 1905.)

longer confined, as they were in great part until a few years ago, to the antiquities of Central America and Mexico, but now extend into the wider fields of original research on Greek and Oriental sites. The present volume well illustrates this extension in the scope of American archæology, for while in the first article in the Transactions Mr. G. B. Gordon treats of the serpent motive in Mexican art, the five concluding papers deal with the results of the excavations in Crete and Babylonia carried on by the American Exploration Society and the Babylonian Expedition of the University of Pennsylvania.

The papers of greatest interest and importance in the volume are those dealing with the excavations at Gourniá, in Crete, and on other sites on the isthmus of Hierapetra during the year 1904, which were carried out, as in former years (see NATURE, June 1, 1905, vol. lxxii., p. 98), by Miss Harriet A. Boyd (now Mrs. Hawes) and her assistants. In the former article, above mentioned, we described Miss Boyd's discovery of the little Minoan town of Gourniá, its geographical position, and the results of the first excavations. Miss Boyd's paper on Gourniá, Miss Edith Hall's "Early painted Pottery from Gourniá," and Mr. R. B. Seager's "Excavations at Vasiliki," published in the present volume of Transactions, enable us to bring the story of the American work in Crete up to date.

The chief result has been the discovery of some entirely new styles of pottery of very early date. Those who know what a great part the classification of pottery takes in early Greek archæology will appreciate the importance of this discovery when we describe the most important of the new "Mycenæan" pottery from the isthmus of Hierapetra as a polychrome ware much anterior in date to the well-known Kamáres ware (middle Minoan period of Evans), which was contemporary with the twelfth dynasty (*circa* B.C. 2000) in Egypt. Miss Boyd describes it as "a remarkable new ware from Vasiliki, with Trojan shapes, monstrously long beaks, and decoration in black and red, mottled, with highly hand-polished surface." It is described by Mr. Seager, who discovered it in a Mycenæan settlement on the Kephala (ridge) of Vasiliki, in the Hierapetra isthmus-depression, two miles south of Gourniá. One fragment only was previously known; this was discovered at Zakro by Mr. Hogarth.

"The hard red finish is perhaps the most remarkable and characteristic feature of the ware. At first it recalls the Libyan ware of Dr. Petrie's Pre-dynastic race . . . the body-colour is usually a red shading to orange, and the patches black to bronze green, owing to the different degrees of heat to which it has been exposed. Exactly how this effect was produced has not yet been satisfactorily explained, but possibly the vases were covered with paint and then put into a bed of coals (*sic*) which were heaped over them, the black patches being the effect of a live coal lying actually against the surface of the vase. This would be only a variation of the method used in firing the Pre-dynastic Libyan ware, where the necks, which were in actual contact with the coal, have burnt to a black. Very possibly this technique may have been strongly influenced by that of Libya, but with his characteristic ingenuity the Agean (*sic*) potter, not content with the set form and colouring of the Libyan ware, experimented with the method until he produced this varied and at times gorgeous effect. The greatest charm of the prehistoric ware of the Agean is that the potters never allowed themselves to remain long tied down by a tradition of style and were constantly inventing new and original ideas of which the Egyptian workman seems never to have been capable. The Agean peoples were always ready to receive ideas from their neighbours, but they never remained content until these ideas had been changed and beautified to suit their own more artistic tastes."

We have quoted Mr. Seager's description at this length for several reasons. First and primarily because of its excellence as a description of his important discovery; this pottery is highly remarkable, and may indeed be described as "gorgeous," as the coloured plate showing specimens of it proves. The explanation of its technique is probably correct. Secondly, on account of its being a good example of the way in which Greek archæologists run down the poor Egyptians; but we will not quarrel with Mr. Seager on this score; he sins in good company, and, after all, it needs a considerable acquaintance with Egyptian archæology before one realises that the Egyptians were as capable of inventing new and original ideas as the Mycenæans. Thirdly, as an example of the way in which an archæological statement which has long been given up as incorrect by the archæologists of the branch of work to which it belongs may still be perpetuated by the archæologists of another branch: the prehistoric Egyptians, whose pottery was discovered by de Morgan and Petrie, are not known to have been Libyans, nor can their pottery be called "Libyan." We know nothing of the Libyans of 5000 B.C.; the pre-dynastic Egyptians can only be called Egyptians. We may note in passing also that it is more probable that the resemblance of early Ægean to early Egyptian pottery is due to a possible common origin of their civilisations than that Ægean technique was "strongly influenced by that of Libya" (*read* Egypt), so early. Finally, we quote this passage as a warning against misprints. "Agean" for "Ægean" three times in a few lines is not pretty, and not far off we see "Cypress" for Cyprus (p. 216). The American printer has original ideas, and often carries them out—at the author's expense.

Another unusual ware of early date was found at Gourniá; its characteristic is white paint on black, with geometric ornament. This ware is described by Miss Edith Hall. The most primitive ware of all, from the rock-shelter burials at Gourniá and Agia Photia near by, is also interesting; it is sub-Neolithic in date, and closely related to the Cycladic pottery of Thera and Amorgos, which it resembles.

The buildings at Vasiliki explored by Mr. Seager, in which the strange new pottery was found, are remarkable in plan and construction, and the description of the difficulties of excavating them is interesting. The rooms are filled with hard plaster, the presence of which is explained by Mr. Seager as follows. The ceilings were made of canes covered with heavy clay plaster, and these were supported by transverse beams. "When the beams gave way, the ceiling sank into the rooms below, making a layer of débris about fifty centimetres and sometimes more in thickness. This débris, owing to the action of fire and water, has become an almost petrified mass on which the picks of the men made but slight impression. Certain rooms had to be abandoned on this account, as little short of actual blasting would have been required to clear them. . . . As in Gourniá, and, in fact, most of the prehistoric settlements in Crete, the building seems to have been destroyed by fire. . . . It is plain that the building must have possessed several stories, as the mass of débris which fills the rooms is far too deep to have been the result of the collapse of a single floor." Mr. Seager tells us that when, "as was often the case," the clay plaster "had fallen on a deposit of pottery or pottery from the upper rooms had fallen in with it, the objects were as fresh as on the day of the catastrophe which destroyed the building, but it required the greatest skill and patience to save them unbroken, and in some cases to save an unusually fine piece it was necessary to sacrifice inferior ones surrounding it." A short time ago I visited Vasiliki myself under the guidance of Mr. Seager, and can testify to the great interest of his work there. The plaster-filled houses are remarkable. May it not be possible that this hard stuff, which makes the excavation of the houses at Vasiliki so difficult, can be explained in a manner different from that adopted by Mr. Seager? At Phaistos the older palace (*Middle Minoan* or *Kamáres* period) was partly razed, and the remains filled up and covered with a layer of hard beton or cement, as hard as that of Vasiliki, on which the *Late Minoan* palace was built. I would suggest that the plaster of Vasiliki may be in reality a cement filling-up, on which later houses were built. There are certainly two or three distinct superimposed "towns" at Vasiliki. Mr. Seager is now proceeding with the work at Vasiliki alone, as Mrs. Hawes (Miss Boyd) has not visited Crete this year.

Thus Miss Boyd's Mycenæan Pompeii still continues to be interesting, and we hope that she will be enabled to go on with her work in Crete. Miss Boyd's is the most important archæological work connected with the University of Pennsylvania, and we hope that the authorities of that institution adequately recognise this fact. H. R. HALL.

THE IMMIGRATION OF SUMMER BIRDS.[1]

THOUGH great advance in our knowledge has been made during recent years concerning the migration of birds as observed in our islands, yet much remains to be learned, and any inquiry that will add to what is already known must be hailed with satisfaction. In what direction and by what methods such advancement is to be sought are questions requiring not only careful consideration, but a full knowledge of what has already been accomplished.

In electing to investigate the immigration of summer birds, the committee appointed by the British Ornithologists' Club has selected the best known of all the phases in the phenomenon. It is true that a special feature has been added in the endeavour to trace the movements of the migrants through the country after their arrival on our shores, but it is much to be doubted whether the results will contribute anything of material importance or at all commensurate with the labour involved. On the other hand, our knowledge of the autumnal departure movements, both from their inland nesting haunts and from our shores, of these same birds is far from complete.

The new committee labours under a misapprehension in supposing that the south coast was entirely omitted from the scope of the British Association committee's inquiry, for part of both the eastern and western sections were scheduled annually. Moreover, the migratory movements on the whole of that coast, for both spring and autumn, were afterwards fully investigated for three years, and the results incorporated in the later reports submitted to the Association.

Then as to methods. It may be well, perhaps, to remind the new committee of the opinions, based on long experience, expressed by Prof. Newton and his colleagues in their final report to the Southport meeting of the British Association in 1903. They say, "the last thing your committee would wish is to discourage the prosecution of observations, but they feel bound to express the opinion that no great advance of our present knowledge of the subject seems likely to be made until new methods are applied. What they should be it is impossible to suggest, but those used at present appear to have reached their limit." In this mature opinion the present writer fully concurs.

The report under notice is not lacking in interest, but it does not add anything material to our knowledge; indeed, several years' observations will be necessary before conclusions of permanent value, though possibly not advancing what is already known, can be expected. By premature publication much harm may be done, and it is to be feared that writers will arise and tell us, on the strength of this report, that, among other things, whinchats, redstarts, whitethroats, reed warblers, cuckoos, and other species do not arrive on the western section of the south coast, when further investigations by the committee will prove that they *do*. It is certainly surprising to find the new committee instituting a comparison between the weather conditions prevailing in the English Channel and the arrival of birds on its shores (of course with abortive results), for it was hoped that it had been clearly proved by exhaustive investigations that the meteorological conditions influencing such movements must be sought in the area whence the migrants took their departure.

In conclusion, one is tempted to suggest that it would be well if the members of the committee of the British Ornithologists' Club, before proceeding further with their arduous labours, took stock of the situation, and asked themselves if their energies might not be advantageously directed to more useful and productive branches of the subject they have at heart.

[1] "Report on the Immigrations of Summer Residents in the Spring of 1905." By the Committee appointed by the British Ornithologists' Club. (London: Witherby and Co., 1906.)

NOTES.

PROF. I. P. PAVLOFF, professor of physiology in the University of St. Petersburg, will deliver the Huxley lecture at the Charing Cross Hospital Medical School on Monday, October 1.

PROF. EMIL FISCHER, professor of chemistry in the University of Berlin, has been elected a foreign member of the Royal Society of New South Wales.

AN Irish International Exhibition will be opened in Dublin in May next. It will be the first exhibition of its kind to be held in Ireland for nearly forty years.

THE Italian Electrotechnical Association will meet in Milan on September 30, when visits will be paid to various factories in the neighbourhood and the hydro-electrical installations which have been recently constructed.

THE Right Hon. Sir John Eldon Gorst has been appointed special commissioner to represent His Majesty's Government at the New Zealand International Exhibition, the opening of which is to take place on November 1 next.

WE regret to have to record the death of Prof. W. B. Dwight, who occupied the chair of natural history in Vassar College, Poughkeepsie, N.Y. Prof. Dwight was an original member of the Geological Society of America, and interested himself for many years in the Palæozoic rocks of Wappinger Valley and others in the neighbourhood of Poughkeepsie.

THE programme of the prize subjects of the Industrial Society of Mulhouse for the competition closing in 1907 has just been issued. Little change has been made in the programme of 1906, a *résumé* of which was given in Nature (vol. lxxiii., p. 164). The competition is open to all nationalities.

A Reuter telegram received at Copenhagen from Nome, Alaska, on September 3, announces that the *Gjoa*, the vessel of the Norwegian Polar Expedition, has arrived there, having completed the navigation of the North-West Passage in a westerly direction. The expedition sailed in May, 1903, in charge of Captain Amundsen, and letters recording observations made in the neighbourhood of the north magnetic pole were summarised in Nature of November 16, 1905 (vol. lxxiii., p. 59).

During the past few days the following earthquake shocks have been recorded in the daily papers:—*August* 29.—A violent earthquake was felt at Tacna and Arica, and was followed by sixteen further shocks. *August* 30.—Bodö, Norway. A violent earthquake shock was felt at midnight. *August* 31.—An earthquake shock lasting two seconds was felt at San Juan at 9.45 a.m. *September* 2. Valparaiso. Slight earthquake shocks were again felt.

Herr O. Wentzki, of Frankfurt a. M., has been awarded the 300-marks prize of the Berufsgenossenschaft der chemischen Industrie for the discovery of the best means of purifying hydrogen which contains arsenic. According to Wentzki's method, the impure gas is led up into a cylinder containing two parts of dry calcium chloride to one part of moist sand or other similarly indifferent substance, the bottom end of the cylinder being made of wire gauze of fine mesh; the capacity of the cylinder should be about one-third that of the hydrogen generator.

The opening session of the International Congress on Methods of Testing was held in the Palais des Académies, Brussels, on September 3, under the presidency of Mr. F. Berger (Vienna). Five hundred members were present from eighteen different countries. Addresses of welcome were delivered by Count de Smet de Naeyer, the Belgian Prime Minister, and by Mr. H. Raemarckers, Secretary of the Department of Railways. An address was then given by Prof. F. Schüle (Zurich) in memory of the deceased president, Ludwig von Tetmejer. A report on the work of the executive council since the last congress was presented by Mr. Berger, and interesting papers on the iron and steel industry of Belgium and on the Belgian cement industry were read by Baron E. de Laveleye and Mr. E. Camerman. The mornings of September 4, 5, and 6 were devoted to the work of the sections and the afternoons to excursions. Excursions to the works of the Cockerill Company at Seraing and to Ostend have been arranged for September 7, 8, and 9. The congress is held under the patronage of the King of the Belgians, who on September 2 received the members of council.

The agenda programme of the seventeenth annual general meeting of the Institution of Mining Engineers has just been issued. The meeting will take place at Hanley from September 12–14, and the following papers will be read or taken as read:—The Courrières explosion, by Messrs. W. N. Atkinson and A. M. Henshaw; gypsum, with special reference to the deposits of the Dove Valley, by Mr. T. Trafford Wynne. The following papers will be open for discussion: Commercial possibilities of electric winding for main shafts and auxiliary work, by Mr. W. C. Mountain; electrically driven air-compressors combined with the working of Ingersoll-Sergeant heading machines, and the subsequent working of the Busty Seam at Ouston Colliery, by Mr. A. Thompson; practical problems of machine mining, by Mr. S. Mavor; the strength of brazed joints in steel wires, by Prof. H. Louis; by-product coke and Huessener by-product coke ovens, by Dr. J. A. Roelofsen; considerations on deep mining, by Mr. George Farmer; the education of mining engineers, by Prof. J. W. Gregory; the capacity current and its effect on leakage indications on three-phase electrical power service, by Mr. S. F. Walker; petroleum occurrences in the Orange River Colony, by Mr. A. R. Sawyer; and development of placer gold mining in the Klondike district, Canada, by Mr. J. B. Tyrrell.

According to a recent report of the United States Consul at Brussels, a laboratory museum of electricity in that town will be opened to the public in October next. The museum has been built and equipped by Mr. R. Goldschmidt, of Brussels, whose object in presenting the museum is the development and extension of the use and application of electricity in Belgium by practical experimental instruction. The institution will contain all kinds of electrical models and appliances, which may be freely handled for study and experiment. Models and apparatus will be conveniently placed at the disposal of the public upon separate tables, and may be connected with the electric supply at will. The museum is divided into four large rooms, one of which will be devoted to machines serving to produce phenomena due to magnetism and to electricity and chemical reaction; another room will be given up to the demonstration of electrical laws. A circular gallery round the room is designated as the second hall; here will be found machines of all sorts, lamps, bells, agricultural and dairy implements, conveniently exhibited, which may be worked by simply adjusting the electric appliances supplied to each table. There will also be free telegraph, wireless telegraph and telephone offices. The third hall is subdivided into reading-rooms, where the latest scientific publications will be displayed. In the fourth hall will be found all kinds of large motors, dynamos, &c., with which the public are at liberty to study and experiment.

The ancient town of Nuremberg appears to be one of the most popular places for the annual meetings of many German scientific and technical societies; for example, mention may be made of the twenty-ninth Hauptversammlung des Vereins zur Wahrung der Interessen der chemischen Industrie Deutschlands, September 20–22; the third Hauptversammlung of the Verband konditionierender Apotheker für das deutsche Reich, September 1 and 2; the Verband deutscher Gewerhevereine, September 9–12; the seventeenth deutsche Mechanikertag, August 17 and 18.

Other meeting places and times fixed for this year's meetings of foreign societies, &c., include:—the international congress for cork manufacturers at Eisenach, September 1; the conference of pharmaceutical faculties (founded in 1900 for the furthering of pharmaceutical instruction in America) at Indianapolis, September 5; the eighth general meeting of the Internationaler Verein der Lederindustrie-chemiker in Frankfurt a. M., September 17–20; the International Tuberculosis Conference, Amsterdam, September 6–8; the Orzagos Iparegyesület (a national industrial society), Budapest, October 20–22 (a congress to consider questions connected with the acetylene industry); the fifth Hauptversammlung des deutschen Medizinalbeamtenvereins, Stuttgart, September 13; the Hauptversammlung des Verbandes selbständiger öffentlicher chemiker in Dessau, September 23–25; and the fourth delegates' meeting for the International Union for the Protection of Workmen's Interests, Geneva, September 26–29.

THE Mysore Government has, the *Pioneer Mail* reports, published a note on the destruction of rats in Mysore city. The system of rat destruction was given a fair trial in the city of Mysore from July, 1905, with the result that the city, which used to be infected with plague year after year, has been practically free during the year 1905–6, there being only seven cases and five deaths against 1244 and 995 respectively in the previous year. The total number of rats killed in the city since the commencement of the campaign, *i.e.* from July 4, 1905, up to July 13, 1906, was 23,741, of which about 12,000 are reported to be females. The following table shows the number of rats killed monthly in the city since January, 1906:—January, 870; February, 492; March, 708; and April, 1050.

A SPELL of exceptionally bright and hot weather occurred over England during the past week, and the thermometer attained a higher reading than had been registered for many years. At Greenwich the shade temperature exceeded 90° on four consecutive days, and the following will show the remarkable character of the weather:—

	Air max.	Sun max.	Average air max.	Absolute previous max since 1841 temp.	date
August 31	94·3	152·0	71	89	1886
Sept. 1	91·9	147·8	71	88	1886
,, 2	93·5	147·0	71	83	1880
,, 3	91·0	151·8	70	85	1880

There is no instance in the Greenwich records of the shade temperature having previously exceeded 90° on four consecutive days at any period of the summer, and the only instances of 90° on three consecutive days are August 13–15, 1876, and August 16–18, 1893. The absolutely highest temperature ever registered at Greenwich is 97°. At the reporting station of the Meteorological Office, in St. James's Park, Westminster, the highest temperature attained was 91°, and that reading occurred on each of the three days August 31 and September 1 and 2; on September 3 the reading was 88°. Equally high temperatures occurred in other parts of England. At Nottingham the sheltered thermometer registered 93° on August 31 and September 1, 94° on September 2, and 90° on September 3. The absolutely highest temperature reported to the Meteorological Office was 95° at Colly Weston, in the Midlands. A gentle southerly wind prevailed over the whole country, and the sky throughout was peculiarly free from cloud, whilst the sun shone continuously for several days. Cooler weather set in on September 4, owing to the spreading over us of a north wind, and rain occurred in many parts of the country. In London rain set in very tardily at about 10 o'clock on Tuesday night, but it afterwards fell heavily. Very hot weather also occurred in parts of France and Germany.

BIRDS and their habits constitute the whole of the contents, so far as separate articles are concerned, of the *Zoologist* for August, Mr. G. Dalgleish discussing the wild duck and grebe, Mr. E. Selous the ruff, Messrs. Clark and Rodd the avifauna of Scilly, and Mr. G. W. Kerr that of Staines. In the "Notes" Mr. Aplin's account of the breeding of the black-necked grebe in this country will be read with interest.

THE Indian fresh-water polyp, according to Dr. Nelson Annandale (Mem. Asiatic Soc. Bengal, vol. i., No. 10), is entitled to rank as a distinct species (*Hydra orientalis*). Although diœcious, sexual reproduction does not apparently play a very important part in its development; when this takes place the individuals perish, several generations being completed in a year. The memoir on the Hydra forms a part of the results of a detailed study of the fresh-water fauna of India which is now being undertaken by Dr. Annandale, who has favoured us with copies of seven papers from the Proceedings of the Asiatic Society of Bengal relating to this subject. The first part deals with a brackish-water sponge (Spongilla), while in the second the author finds himself in a position to determine definitely the systematic place of the remarkable fresh-water polyzoan discovered at Nagpur by the geologist Hislop, in whose honour it was named Hislopia by his friend Carter. Other interesting novelties are an aquatic cockroach belonging to a group hitherto known only from the Malay countries, and an aquatic weevil, which, so far at any rate as habits are concerned, is altogether unique.

IN the *Times* of August 30 is an excellent summary, by a correspondent, of the legislation and orders relating to the protection of wild birds and their eggs in the British Islands. After referring to the statutes affecting the country in general, and mentioning the fact that "sanctuaries," within which no bird may be killed at any season, have been established in five counties and two boroughs in England, the writer comments on the absence of any provision in the law for permitting birds and their eggs to be taken when required for scientific purposes. Despite many incongruities, if not absurdities—as, for instance, an enactment in Gloucestershire which practically amounts to protection for a certain species of owl during the time it is absent from the county and permission to kill it on arrival—it appears to be the opinion of the executive authorities that the statutes and orders for the protection of birds work, on the whole, satisfactorily. On the other hand, the enactments with regard to the taking of eggs are regarded as less satisfactory. In the first place, in the writer's opinion, such law "must almost of necessity work unequally, and weigh more heavily on the poor and uneducated than on well-to-do people, such as the dealers, who do most mischief." Secondly, the scheduling of the eggs of certain species (to the exclusion of others equally deserving of protection) is considered highly unsatisfactory, since it affords (on account of the difficulty of identification) a ready means of escaping conviction by those who "know the ropes," while the unsophisticated stand a great chance of being condemned, even though they may really be innocent of the particular charge. As an alternative the writer suggests the passing of a short Act making birds and their eggs the property of the owners of the soil on which they are found, waste lands being for this purpose vested in local authorities.

THE Rev. Guy Halliday writes to report that on July 30 he found *Goodyera repens* in flower near Holt, in Norfolk. This is the most southerly limit recorded for this orchid. The plant, which was identified at Kew, has not hitherto, Mr. Halliday thinks, been found south of Market Weighton, in Yorkshire.

IN continuation of previous descriptions of new or rare pyrenomycetous fungi, Mr. C. E. Fairman notes some new species from western New York in vol. iv. of the Proceedings of the Rochester Academy of Science. A new species of Sporormia was found on pods of the locust, *Robinia pseudacacia*, thus furnishing another species growing on vegetable matter, whereas most are saprophytic on dung. Among new species of Amphisphæria one receives the specific name of *aeruginosa*, but it is not evident whether the green colour is due to this fungus or to a Chlorosplenium.

ONE of the most important collections of plants in recent years was collected by Mr. E. H. Wilson, chiefly in western China, for Messrs. James Veitch and Sons. A few of the more striking new species are described in the *Kew Bulletin*, No. 5. Three species of Berberis, a new genus Hosiea under the order Icacineæ, and some roses are among the number. Sir George Watt contributes an interesting article on Burmese lacquer-ware and varnish, the basis of which is the oleo-resin, *thit-si*, of *Melanorrhea usitata*. Less generally known than the Pagan and Prome lacquer boxes and trays is the Mandalay moulded lacquer; the resin, thickened with ground rice husk, furnishes a material suitable for modelling figures and ornamentation in relief. Mr. C. H. Wright continues his diagnoses of new African plants, and Mr. J. H. Hellier identifies the Eben tree of Old Calabar as *Pachylobus edulis*.

IN a forest survey the examination and measurement of selected plots provide data for working plans. A more detailed study of certain plots in a forest reserve on the island of Luzon with the object of investigating the origin of the different types of vegetation is being undertaken by Mr. W. H. Whitford, who has published the first part of his account in the *Philippine Journal of Science*, vol. i., No. 4. Even here disturbances caused by human agency have to be taken into account. The natives clear the land for cultivation, but leave the clearings after a while, when they change to grass-land or revert to forest. Again, where the timber has been ruthlessly cut out or burnt, only brushwood mixed with trees of invading species is left. For such a type of vegetation the writer adopts the term *parang*, distinguishing the parang according to the dominant tree or trees.

A FORMULA giving the influence of frequency upon the self-inductance of coils is discussed by Mr. J. G. Coffin in the Proceedings of the American Academy of Arts and Sciences, xli., 34. The formula itself involves hyperbolic functions, but the author shows by means of curves that the results for large or small frequencies can be given with sufficient accuracy by simple approximations.

IN a short paper in the *Verhandlungen* of the German Physical Society, Prof. F. Kohlrausch suggests the use of the term "resistance capacity" as applied to the space between two electrodes to denote the resistance of that space when filled with a medium of unit electrical conductivity, and he shows how this quantity is related to the capacity of a condenser the dielectric of which occupies the space in question.

DR. JOSEPH NABL, of Vienna, contributes to the *Naturwissenschaftliche Rundschau* an article written for the purpose of explaining in simple language the meaning of the second law of thermodynamics and its connection with the theory of probability (Boltzmann's minimum theorem), as well as the notion of entropy and the properties associated with it. The account is probably as good a one as could be given in so limited a space for the instruction of non-mathematical readers.

IN the Proceedings of the American Academy of Arts and Sciences, xli., 32, Mr. Harvey N. Davis discusses the longitudinal vibrations of a rubbed string. Instead of basing the investigation on the use of Fourier's series as was done by Helmholtz in his well-known investigation of the vibrations of a violin string, Mr. Davis makes use of the graphic methods which have been commonly employed by mathematicians in discussing the impact of elastic beams. It appears both from theory and experiment that the envelope of a string which is rubbed either transversely or longitudinally at an aliquot point $1/k$ of its length is not Helmholtz's parabola, but k chords inscribed in that parabola—a result which strikes the reader as being, on the face of it, in accordance with common sense. A number of other results, such as the verification of Krigar Menzel's law, have been discussed.

VOL. iii., No. 2, of Investigations of the Departments of Psychology and Education of the University of Colorado contains several interesting papers. Under the title "Proportion as the Quotient of Two Forms of One Equation," Mr. Heman Burr Leonard suggests certain new methods of teaching problems in proportion, and if these do not look quite so simple on paper as they really are, the article certainly confirms an important point, namely, the necessity of familiarising pupils with the use of *formulae* in solving problems, instead of the more restricted methods of "rule of three." Under the title "Relation of Course of Study to Higher Wages" Prof. John B. Phillips directs attention to the large number of important inventions that have been made by men of little or no education. His suggestion that "invention" should form part of an educational curriculum is interesting, though one may perhaps ask whether *teaching* people to be *original* is not rather a contradiction of terms. Lastly, we have an account of the Colorado Mathematical Society, founded last year, from which it appears that several important points in the teaching of mathematics, such as over-elaboration of text-books, athletic and other distractions, and what has sometimes been called "spoon feeding" on the part of teachers, have been discussed.

MR. R. J. THOMPSON deals with the development of agriculture in Denmark in a paper published in the Journal of the Royal Statistical Society, lxix., 2. He attributes the prosperity of the country to three causes: land tenure, education, and cooperation. So far from rural depopulation taking place, the land is better farmed than it was forty years ago. The rate of wage is lower than in England, and thrift is a national characteristic. The bulk of the land is cultivated by the owners in small farms.

ABOUT forty years have elapsed since Gustav Theodor Fechner laid down his principle of association. The *Psychological Review* has marked the occasion in a fitting way by devoting its May number to a paper by Prof. Lilien J. Martin on an experimental study of Fechner's principles of æsthetics. It is illustrated by a portrait of Fechner and a coloured reproduction illustrating a case of chromanæsthesia.

THE isolation and identification of radio-thorium from the sediments of Bad Kreuznach is described in detail by Messrs. Elster and Geitel in the *Physikalische Zeitschrift* (No. 13). The fact that radio-thorium is associated with iron in these sediments suggested a simple method of isolating radio-thorium from ordinary thorium salts. A nearly neutral solution of thorium chloride was mixed with a solution of ferrous bicarbonate, when it was found that the ferric hydroxide precipitated in the course of a few days was highly active. After removal of the iron, several milligrams of a thorium hydroxide were obtained having an activity twelve times that of the original thorium. These results, taken in conjunction with those already recorded (NATURE, vol. lxxiv., p. 385), leave little doubt that thorium owes its activity to radio-thorium.

DESPITE the many attempts which have been made to elucidate the nature of the blue substance formed by the action of iodine on starch paste, the question still remains without a definite solution. Messrs. M. Padoa and B. Savarè in the *Gazzetta* (vol. xxxvi., p. 310) have attacked the problem in a new way by investigating the change in the electrical conductivity of a solution of iodine in potassium iodide caused by the addition of starch in known proportions. The conclusion is drawn from their experiments that the blue substance is an additive compound of iodine, starch, and potassium iodide (or hydrogen iodide) containing the two former constituents in the ratio $I : C_6H_{10}O_5 = 1 : 4$. While this result supports the opinion of Mylius, enunciated some twenty years ago, it is directly opposed to the more recent view of Küster that the blue substance is not a definite substance, but is formed as a result of adsorption by the colloid starch. Küster's contention recently received striking support by the work of Biltz in 1904, who showed that basic lanthanum acetate, which resembles starch in its colloidal nature, also produces with iodine an intensely blue substance similar in all respects to that formed from starch; in this case there seems to be no evidence to consider the substance as a definite chemical compound.

THE current issues of the *Lancet* and the *British Medical Journal* are educational numbers, and are entirely devoted to communications bearing upon preparation for the medical profession.

THE Royal Geographical Society has issued through Mr. E. Stanford a general index to the first twenty volumes of the *Geographical Journal*, 1893–1902. The work, which is divided into three parts, devoted respectively to papers, maps, and general subjects, should prove a boon to geographers.

THE third edition of Prof. R. von Wettstein's "Leitfaden der Botanik für die oberen Klassen der Mittelschulen" has just been published by Mr. F. Tempsky, Vienna. The book contains 236 pages, more than half of which (134 pages) are devoted to systematic botany, while the remaining sections deal with plant anatomy, organography, physiology and ecology, geography, and economic botany. There are three coloured plates and more than a thousand figures upon 205 blocks. Within its limits, the work makes an admirable survey of the realm of botany, being attractive in illustration, concise in description, and sound in substance.

OUR ASTRONOMICAL COLUMN.

RETURN OF HOLMES'S COMET (1906*f*).—The remarkable comet discovered by Mr. Holmes on November 2, 1892, has been re-discovered on this, its second, return by Dr. Max Wolf at the Königstuhl Observatory, Heidelberg. From the Kiel telegram announcing this fact we learn that on August 28, the date of the observation, the comet's position at 13h. 52·1m. (Königstuhl M.T.) was

R.A. = 4h. 7m. 24s., dec. = $+42° 28'$.

This position is between one-third and one-half the distance between 52 and 53 Persei, and crosses our meridian at about 5.30 a.m.

Comparing the position with that given by the ephemeris published by Dr. H. J. Zwiers in No. 4085 of the *Astronomische Nachrichten*, we find that small corrections of about +0·5m. in R.A. and $+3'\cdot5$ in declination need to be applied to the latter. A portion of this ephemeris is given hereunder:—

Ephemeris 0h. (M.T. Greenwich).

1906	α (app.) h. m.	δ (app.) ° ′	1906	α (app.) h. m.	δ (app.) ° ′
Sept. 6 ...	4 17 ...	+44 6	Sept. 14 ...	4 25 ...	+45 34
8 ...	4 19 ...	+44 29	16 ...	4 26 ...	+45 56
10 ...	4 21 ...	+44 51	18 ...	4 28 ...	+46 17
12 ...	4 23 ...	+45 12	20 ...	4 29 ...	+46 38

COMET 1906*e* (KOPFF).—Circular No. 90 from the Kiel Centralstelle gives three ephemerides for the comet recently discovered by Herr Kopff at Heidelberg. The following was computed by Herr M. Ebell:—

Ephemeris 12h. (Berlin M.T.).

1906	α h. m. s.	δ ° ′	log Δ	Brightness
Sept. 4 ...	22 39 58 ...	+9 36·0 ...	0·0490 ...	0·75
8 ...	22 37 19 ...	+9 14·9 ...	0·0639 ...	0·67
12 ...	22 34 57 ...	+8 52·0 ...	0·0797 ...	0·60
16 ...	22 32 55 ...	+8 28·1 ...	0·0961 ...	0·54

Several observations of this comet are recorded in No. 4117 of the *Astronomische Nachrichten*. Prof. Kobold, observing at Kiel on August 23, saw it as an undecided, round spot of 2′ diameter with a central condensation of magnitude 11·0. The magnitude of the whole was 10·5. From an observation, also made on August 23, Prof. Hartwig described it as having a diameter of $1'\cdot5$, a nucleus of magnitude 13·0, and a round shape, the total magnitude being 12·0.

A NEWLY-DISCOVERED PLANETARY NEBULA.—On examining one of the plates taken with the 10-inch Brashear lens of the Bruce photographic telescope, Prof. Barnard discovered the image of a fine planetary nebula which does not appear to be in the catalogues. The approximate position of the nebula, for 1855, is $\alpha = 11$h. 7m., $\delta = +15° 42'$. In the same region there appear to be quite a number of spiral nebulæ and nebulous stars (*Astronomische Nachrichten*, No. 4112).

PLEA FOR AN INTERNATIONAL SOUTHERN TELESCOPE.—In No. 182, vol. xlv., of the Proceedings of the American Philosophical Society Prof. E. C. Pickering advances a businesslike plea for the institution of a large international reflector in the southern hemisphere. He points out that, under the existing conditions, it is hard to see how any great step may be made in the advance of astronomy, but thinks that if a reflector of about 7 feet aperture and 44 feet focal length were erected in the best possible atmosphere to be found in the southern hemisphere, advances of immense importance might accrue. The cost he estimates at something less than 500,000 dollars (rather more than 100,000*l*.), and he suggests that such a scheme would be an eminently suitable one by which to commemorate the Franklin bi-centenary.

THE PROGRESS OF AGRICULTURAL SCIENCE.

THREE years ago the Royal Agricultural Society conceived the happy idea of holding, in connection with its annual shows, an agricultural education exhibition, at which the work of the various agricultural colleges might be brought prominently before the public, and especially the latest results of agricultural scientific research. The fourth annual exhibition of this kind was recently held at Derby, and the object of this note is to indicate several of the more important directions which agricultural research and rural education are now taking, and the results as illustrated at the exhibition.

Mendel's Laws of Inheritance.

Important hybridising experiments on the lines of Mendel's laws of inheritance are being carried out at the Cambridge University Agricultural Department by Mr. R. H. Biffen. Mendel's laws prove the recurrence in breeding of dominant and recessive characters in certain definite proportions, and their application renders possible the production of new fixed types in two or three generations with mathematical precision instead of as formerly after years of more or less haphazard breeding by selection. Thus in crossing smooth red with rough white wheat, the first cross was apparently of fixed type; but in the second generation only one out of sixteen bred true; in the third generation three bred true; in the fourth generation four bred true, and the type was fixed. The same principles are applicable to the inheritance of disease. Rows of wheats were shown proving the possibility of obtaining in three or four generations immunity from rust in specimens the original parents of which were of rust-susceptible and rust-resisting types. Very interesting is the application of these laws to the breeding of animals. Mr. W. Bateson, F.R.S., and Mr. R. C. Punnett, of Caius College, Cambridge, lent some preserved bodies of Andalusian and rosecomb bantam fowls. The blue Andalusian never breeds true, but always produces a definite proportion of blacks and splashed whites. From a pen of blues, one-half of the offspring will be blue, one-quarter black, and one-quarter white. When blue is mated with either blue, black, or white, one-half of the offspring will be blue. When, however, black is mated with white, all the offspring are blue. In reality, the blacks and whites are both pure breeds, and the blue is the hybrid form produced by crossing these breeds. It is therefore so constituted that it cannot breed true, and no amount of selection will ever bring about this result. White rosecomb bantams belong to the class of recessive whites, and the progeny of a white rosecomb by any pure-coloured breed are always coloured. Thus when a black and a white rosecomb are crossed, all the hybrids are black. When such hybrids are mated together, three-quarters of the chicks are black and the rest white. In Mendelian terms the black is dominant and the white recessive. There are, therefore, two kinds of blacks, those which carry whites and those which do not. When crossed with white the former give equal numbers of blacks and whites, whilst the latter give blacks only. It is, however, impossible to distinguish between the two kinds of black, except by a breeding test, the eventual result of which is the production of blacks and whites, both of which breed true to colour.

Assimilation of Nitrogen by Leguminous Plants.

The nitrogen problem has received special attention at the Midland Agricultural and Dairy College, and recently experiments have been made with the pure inoculation cultures of Dr. Hiltner, of Munich. Tares, peas, alsike, lucerne, and crimson clover (*Trifolium incarnatum*) were sown in pots of boiled, sterilised, quartz sand, and the effect of inoculating the soil in these pots with the pure cultures supplied by Dr. Hiltner was shown to have decidedly beneficial effects upon the growing plants. Mr. John Golding, by whom these experiments have been carried out, has introduced a new system of inoculation for leguminous crops, which consists in mixing dried sterilised soil with crushed healthy nodules taken from the roots of plants of the same kind as those which it is desired to inoculate. The object of sterilising the soil is to effect the destruction of harmful germs and pests such as the wireworm, &c. Buhlert has shown that the microbes of the leguminous nodules all belong to one species, but are modified so that nodules coming from a particular leguminous plant are those best adapted for inoculation of the soil in which that plant is sown. Mr. Golding's inoculating material will contain, therefore, only the microbe of value for the particular plant cultivated. If this material should prove practically efficacious on a field scale, it can be supplied at a cost of from 1*d*. to 2*d*. per lb., which at the rate of an application of 56 lb. per acre represents a cost per acre of from 4*s*. 8*d*. to 9*s*. 4*d*.

Vitality of Farm Seeds.

This question has received practical elucidation from experiments carried out during the last eleven years by Mr. William Carruthers, F.R.S., consulting botanist to the Royal Agricultural Society. The results were illustrated at Derby by a large table, which showed in respect of all the farm seeds in common use the percentage of living seeds remaining each year from the commencement of the experiments in 1885 to the present year (1906). Of the cereals, oats proved to have the greatest vitality. Black oats retained 76 per cent., and white oats 57 per cent., of living seeds in the eleventh year (1906), whilst in the ninth year (1904) the percentage was no less than 95 per cent. and 97 per cent. Wheat in the ninth year showed a germinating power of 29 per cent., but none remained alive in the tenth year. Barley retained vitality to the extent of 90 per cent. in the fifth year (1890) and 19 per cent. in the ninth year (1904), but none remained alive in the tenth year. Grasses were proved to lose their vitality very much more quickly than the cereals. Sheep's fescue, for instance, was reduced by one-half its germinating power by the third year, and all the seeds were dead by the eighth year (1903). Of Timothy, 93 per cent. remained alive in the fifth year and 12 per cent. in the eleventh year. Crested dog's tail germinated 61 per cent. in the fifth year and 11 per cent. in the eleventh year. Of the rye grasses, in the seventh year the perennial and Italian rye grasses germinated 36 per cent. and 71 per cent., and in the eleventh year 6 per cent. and 10 per cent., respectively. Of the root crops, swede turnips retained their vitality almost unimpaired for the first three years, and even up to the seventh year the germination was from 84 per cent. to 85 per cent.

Improvement of Pastures.

The increasing importance of dairying has led to the renovation of a great deal of poor pasture. No small part of the work of some of the agricultural colleges has been devoted to a study of the remedies appropriate to different conditions, whilst from 1885 to 1904 a series of experiments on the improvement of grass lands in various parts of the country was carried out by the Royal Agricultural Society. The results of these experiments were illustrated by turfs cut from the actual pastures, and they brought before the farmers who visited the show lessons of supreme practical importance. In a turf sent by the Royal Agricultural Society, and cut from a pasture in Yorkshire, the application of lime was shown to have been remarkably beneficial, and the dividing line between limed and unlimed portions was clearly indicated by the difference in the character of the herbage. This turf was from land where basic slag without lime had no appreciable effect. On the other hand, turf sent by the Cambridge University Agricultural Department from land of the Boulder-clay formation proved the necessity for the application of phosphates, and basic slag was the appropriate remedy. Lime and cake-feeding in these cases proved of no avail. Turfs sent by the Royal Agricultural College showed that the addition of kainit and superphosphate resulted in a large increase of clover, and a large reduction of moss and undecayed vegetable matter that were conspicuous in the unimproved pasture. The character of the herbage was also shown to be materially influenced by other applications, such as sulphate of ammonia and nitrate of soda, while the use of 5 cwt. per acre of guano—a natural complete manure—produced a decided improvement, the abundance of white clover and sheep's fescue providing splendid food for sheep.

British Forestry.

The exhibits consisted of seeds, cones, trees, shrubs, timbers, tools, photographs, specimens, models, diagrams, working plans, and maps. They were arranged under the supervision of members of the council of the Royal English Arboricultural Society. The Duke of Northumberland, Earl Egerton of Tatton, the Earl of Egmont, and the Earl of Yarborough sent timber specimens showing the economic uses to which British plantations may be applied, and illustrating methods of preservation, chiefly by creosoting. Lord Yarborough's woods have been scientifically managed for a long period, and a chart was displayed showing that 23,564,719 trees have been planted on the Brocklesby and Manby Estates from the year 1700 to the present time. An exhibit sent by the Duke of Northumberland consisted of young trees planted out of doors, and showing the mixture of light-demanding and shade-bearing trees according to the following plan, as adopted in Germany:—(*a*) outer row of beech providing shelter; (*b*) second row with sprinkling of sycamore as a wind-resister; (*c*) oaks, 9 feet apart, for permanent crop; (*d*) other hardwood trees for returns during rotation; (*e*) sprinkling of larch for early returns; (*f*) shade-bearers of spruce, silver fir, and beech for soil production and stimulation of main crop. Several exhibits illustrated the evils arising from incorrect pruning or from neglect of pruning. Where pruning is not effected close to the stem, the projecting stump decays, and the decay affects the trunk. Where branches are not pruned at all, or not at the right time, natural pruning caused by thick planting occurs, but the decay of the branches also affects the trunk. Too early thinning prevents the growth of clean boles with suppressed branches. All these points require careful attention in forestry, or considerable depreciation in the value of the timber ensues. The Royal Agricultural Society, the Royal Agricultural College, the Surveyors' Institution, and Mr. A. T. Gillanders (forester to the Duke of Northumberland) sent collections of mounted specimens of insects injurious to forest trees. Those of Mr. Gillanders were very complete, and were classified as beetles, saw-flies, moths, scale insects, aphidæ, and diptera.

Nature-study in Rural Schools.

This, a new feature, was by no means the least interesting department of this year's exhibition. It was organised by the County Councils Association, and was divided into groups of exhibits from public elementary schools, secondary schools, and school gardens. The counties from which exhibits were sent included Cambridge, Cumberland, Durham, Derby, Essex, Leicester, Lincoln, Nottingham, Stafford, Suffolk, Sussex, and Worcester, and the work sent was highly creditable to both teachers and scholars. It was stated that the specimens were collected and mounted by pupils of average intelligence, but the excellence of many of the water-colour drawings of common flowers was remarkable. The collections made by the scholars included mounted specimens of local flowering plants, some of them classified into hedge-row, wood, and water plants, collections of tree leaves, autumn fruits, fossils, common insects, snails, wireworms, &c. In the secondary schools the work was, of course, more advanced, and included classification into seeds, seedlings, branches, flowers, fruits, and wood in the case of common trees. The Staffordshire County Council exhibited collections of tools, seeds, and apparatus as supplied to school gardens, and a map showing that gardening classes are held in seventy-nine day schools, in thirty evening schools, and two grammar schools in that county. The introduction of nature-study into our rural schools appears to hold out great promise as a means of training and developing the intelligence of country children. It should go far to counteract that "dulness of the country" which is stated to be one of the potent causes of migration to the towns. Education of the youthful mind to the intelligent appreciation of natural phenomena may be regarded as a most important means of ensuring the future progress of agricultural science.

E. H. G.

RUSSIAN GEOGRAPHICAL WORKS.

SEVERAL papers and memoirs of scientific interest and importance are included in publications received from Russia during the past few months. The publications are printed in the Russian language, and among them are four volumes of the Proceedings of the Imperial Russian Geographical Society.

In vol. xli., part iv., of the Proceedings of this society, Mr. V. V. Markovitch contributes lengthy articles, one entitled "In Search of Eternal Ice," and the other on the ice-fields of the Caucasus, illustrated with beautiful photographs and sketches. Botanists will be interested in his notes on the flora of the mountains. Elaborate reports on the subject of ground ice, by a commission appointed to study the question, appear in the Proceedings, vol. xli., part ii. A map of European Russia is given, indicating results of investigations by many observers. In vol. xl., part iv., an important examination by Mr. A. I. Voieikoff of the question whether the Pacific Ocean will become the chief commercial route of the terrestrial globe appears, with statistics and maps.

In vol. xli., part iii., Mr. L. Berg differs from Prince P. Kropotkin's opinions on progressive desiccation of Eur-Asia, maintaining that the climatic conditions of Central Asia have been practically unchanged from the earliest recorded times, and that geological desiccation has long ceased. Mr. Berg refers to a canal called after Hammurabi (Amraphel, King of Shinar), a passage in the "Song of Songs" about the cessation of winter and stoppage of rains, a plant crowning the mummy of an Egyptian princess, Quintus Curtius's account of Bactria in the time of Alexander, down to the investigations of Heim, Hess, Bruckner, and Russian explorers. The writer adduces his experiences of the Aral region in support of his conclusions.

In 1896, 1897, and 1899 Mr. N. A. Busch was commissioned by the Imperial Russian Geographical Society to investigate the glaciers of the western Caucasus, Kuban district, and Sukhum circle. The results are recorded in his report, "Glaciers of the Western Caucasus," 1905 (134 pages), which is furnished with a helpful index and some fine views.

A work entitled "Materials for the Geography of the Urals," by Mr. P. Krotov, describes orohydrographical investigations in the southern part of the central Ural range. The preface opens with a reference to Dr. Carl Hiekisch's work "Das System des Urals" (Dorpat, 1882), to show that knowledge of the geography of these regions is meagre and superficial owing to lack of expenditure of money and exertion. It is claimed that the northern and

Ice-cave of the right glacier of the Tsherin-kol.

southern parts of the range are more familiar to scientific explorers than the more accessible central part. In 1893 it was decided to make an orohydrographical survey of portions of the Ekaterinburg and Krasnoufimsky districts, Perm government, but the area proposed was afterwards limited. Mr. Krotoff reviews previous explorations, mentioning, *inter alia*, the labours of Tatistsheff, Humboldt, and Murchison.

The six chapters contain :—historical sketch of previous explorations; cartographical materials and geological sketch; orographical description; hypsometry of the western slope of the Urals; hydrographical description; concluding notes; "absolute heights" in the southern part of the central Urals; forty-two pages of lists of heights. Orographical and geological charts are given at the end on a scale of five *versts* to the inch.

The report of the Imperial Russian Geographical Society for the year 1904 contains a vast amount of useful matter, especially in the records of scientific exploration. Following the official lists there are short biographies of deceased members, including General P. S. Vannovsky and Admiral S. O. Makaroff, medallist, constructor of the ice-breaker *Yermak*.

The society regrets that owing to unavoidable hindrances many undertakings had to be abandoned. About six pages are devoted to the exploration conducted by Mr. A. V. Zhuravsky of the Bolshezemelsky tundra, starting from the Petshora, and including the river Adzva, the Vashutkin lakes, and the Adak ridge. Samoyed natives assisted as guides. As a result, some important local points were made clear, collections of flora and water fauna, molluscs, and spiders were made, besides a herbarium, map of the lakes and rivers, photographs, meteorological report, and statistics of the native population—which is in danger of dying out—were collected. In the Proceedings of the society, vol. xli., part iii., 1905, Mr. A. Rudneff contributes a preliminary report of this expedition, with illustrations. This region has only been traversed twice previously, by Mr. William Gourdon, of Hull (1614-1615), who left a diary, and by Herr A. Schrenk (1837), author of an account of travel in north-eastern European Russia. Mr. A. V. Zhuravsky's letter to the secretary, in which he relates his activities and mentions the establishment of a zoological station at Ustzilma, appears in vol. xli., part iv.

Mr. A. A. Makarenko made an ethnographical expedition to the Yenesei government, and collected songs and information on local medicine. Other important explorations in Turkestan and the southern steppes are reported. Condensed reports of the ethnographical and other sections, financial statements, publications issued and received, and miscellaneous notes complete the volume.

The Russians have accumulated a vast amount of material with regard to the customs and literature of the Turks and Tartars, the results of researches in fields practically inaccessible to Western scholars.

"The Story of Yedigei and Toktamysh," edited by Prof. P. M. Melioransky, consists of a preface, glossary, and nearly forty pages of Kirghiz text (in Arabic characters) of an old tradition concerning some of the leading members of the famous Golden Horde, *temp.* later fourteenth and earlier fifteenth century. Khan Toktamysh, after the defeat of the Khan Mamai at Kulikovo-polie by the Grand Duke Dmitri Donskoi, in the following year attacked and burned Moscow. Yedigei was a specially distinguished emir under Toktamysh, and, according to the story, was the son of a holy man, Hodzha Amet, and a mysterious, aqueous being with a goat's feet and a transparent body, upon whom her husband does not gaze when she removes a garment for fear she should wish to leave him. Timour or Tamerlane, styled in the story *Sa*[1] *Temiru*, revered the memory of the Hodzha and protected his son. From being a follower of Toktamysh, Yedigei induces Timour to make war on him, and is credited with a similar judgment to that of Solomon in a parallel case of maternal controversy.

The tradition exists among the Nogai, Kirghiz, and Siberian Tartars in varied form. We are not in a position to criticise the text of the poem, and the learned editor hints at a vast wealth of Tartar tradition still to be collected and arranged for publication.

THE MATTEUCCI MEDAL.

THE Italian Society of Sciences known as the Society of the Forty has awarded the Matteucci medal for 1906 to Sir James Dewar in recognition of his scientific work. In presenting the report upon the award, the committee of the society, consisting of Profs. P. Blaserna, A. Righi, and A. Roiti, referred to Sir James Dewar's researches in the following terms:—

James Dewar, born in 1842 at Kincardine-on-Forth in Scotland, completed his studies and took the first steps in his professorial career in the University of Edinburgh; in 1873 he was appointed professor of natural philosophy at Cambridge, from which post he was promoted Fullerian professor in the Royal Institution in London, where he is likewise director of the laboratory founded in memory of Davy and Faraday.

We shall not pause to enumerate all the contributions which he rendered to the knowledge of aromatic compounds, nor the other important investigations in chemistry by which he initiated his scientific career. But we cannot omit to point out the work which he carried out from 1878 to 1890, for the most part in conjunction with Prof. G. D. Liveing, of Cambridge, which work undoubtedly forms part of the finest that has yet been produced in the field of spectrometry. This work is set out in about fifty short notices free from all preconceived ideas and admirable in their experimental genius, enriched with data meriting the highest attention and universally accepted, and fertile in their theoretic bearing and scope. Dewar and Liveing were the first to investigate the phenomena of inversion in many elements; afterwards they studied the influence of temperature on the spectra of the same elements, and the way in which these spectra were modified by the presence of other elements. Extremely interesting are their researches regarding the various spectra of carbon and its compounds, and in relation to the phenomena of synthesis manifested in the electric arc. They, moreover, furnished the first exact determinations of the ultra-violet spectral region, assigning with the utmost care the wave-lengths for a fair number of elements.

Various other problems made evident Dewar's extraordinary experimental ability, and his world-wide fame was secured by the problem, more than any other, of obtaining extremely low temperatures, to which he has indefatigably and courageously devoted himself for more than twenty years, with the satisfaction of seeing his labours crowned by the liquefaction and solidification of hydrogen, which allowed him to study the chemical and physical properties of gases formerly held to be irreducible, when they have changed their state of aggregation.

Having ingeniously contrived means for rendering inconsiderable the losses by evaporation of these new and highly volatile liquids, and thus for preserving them for a length of time in large quantities, he turned this to able account in order to investigate the very varied phenomena which took place at their boiling temperatures, low in themselves, and still further lowered by expansion.

Most extensive is the field covered by Dewar in his studies of this kind: variations of density and cohesion, chemical and photographic actions, phosphorescence and radio-activity, optical properties, thermoelectricity, electric conductivity and inductivity, and magnetic susceptibility. It would take too long to enumerate here the important and partly unexpected results obtained by him, and indeed it is superfluous, as they are present in the minds of all. Let us rather restrict ourselves to accompanying the Matteucci medal, which we award him, by the wish that from the 13°, which he has already reached, he may descend still further downwards towards absolute zero, and succeed in liquefying even helium.

PRACTICAL METEOROLOGY.

THE Meteorological Committee has issued its first report, for the year ended March 31, 1906. In compliance with the desire expressed by H.M. Treasury, the work of the office proceeds generally on the lines hitherto followed, and the committee record "their appreciation of the services rendered in the administration of the office by Sir R. Strachey, the chairman of the council for twenty-two years," and by other members. An important addition has been made by participation in the investigation of the upper air by means of kites. It is also proposed, if practicable, to make use of unmanned balloons, and to render the service more effective by cooperating with the representatives of other bodies concerned in the work. Among some of the useful researches initiated or completed during the past year may be mentioned (1) the study of the trajectories of air in travelling storms, embodied in an official publication entitled "The Life-history of Surface Air Currents"; (2) re-determination of the velocity equivalents of the Beaufort scale of wind force; (3) connection between the yield of wheat in eastern England and the rainfall of the previous autumn; and (4) possible relationship between exceptional strength of the south-east trade wind at St. Helena and exceptional rainfall in England. Reference to these investigations has already been made in our columns. We note that the payment hitherto made to Dr. Buchan, as inspector of stations in Scotland, is to

[1] *Sa*, it is explained, is a form of the word *Tsar* (Cæsar).

be continued for the time being in consideration of his important work in connection with the discussion of the results obtained at the Ben Nevis observatories. The complete or partial success of the weather predictions was very satisfactory during the year in question, *e.g.* harvest forecasts, 89 per cent.; forecasts appearing in morning newspapers, 88 per cent.; in both cases the best results were obtained in eastern and southern England. The number of storm-warning telegrams justified by subsequent gales or strong winds was 88·4 per cent. The committee points out that the service of storm warnings, which is extremely difficult on account of meteorological reasons, is aggravated by the frequent impossibility of getting telegrams delivered on the day of issue when dispatched in the evening or on Sundays, and it proposes to give this serious matter further consideration in the current year. The ordinary work of the marine and land branches has been much augmented by the reduction and tabulation of the observations of the National Antarctic Expedition and of auxiliary observations made in connection therewith, both at sea and on land, south of 30° S. latitude.

We have been looking rather carefully at the last published meteorological chart of the North Atlantic and Mediterranean for September, prepared by Commander Campbell Hepworth, marine superintendent of the Meteorological Office; one cannot help being struck with the almost crowded amount of information useful and interesting to seamen that it contains. Like its younger sister, the monthly chart for the Indian Ocean, the face is chiefly occupied by roses, showing for areas of 5° of latitude by 5° of longitude the frequency, direction, and average force of the winds; by waved arrows, showing the direction of ocean currents and the maximum and minimum set in twenty-four hours; and by routes recommended for steam and sailing vessels respectively. The regions where fog is most prevalent are also shown, and the icebergs most recently observed along the Transatlantic steamer routes. The most southerly berg reported up to the early part of August was roughly in 45° N. 47° W., and the most easterly in 47° N. 40½° W. On the back of the chart are given, *inter alia,* charts of tidal currents round the British Isles at the successive hours before and after high-water at Dover, and a co-tidal chart by Dr. Berghaus, with a useful explanation by Sir G. H. Darwin. As we are in the season of West India hurricanes, indications of their approach are explained and directions are given as to the most advisable steps to be taken when the centre of such a storm has been located.

The monthly meteorological chart of the North Atlantic for September, published by the Deutsche Seewarte, contains, generally speaking, similar useful information to that issued by the Meteorological Committee. The scale is somewhat larger than that of the English chart, and the wind-stars are printed in blue, the force, according to the Beaufort scale, being represented by feathers on the shafts of the arrows; altogether they form a prominent feature of the chart. The changes in the areas of high and low barometric pressure and other weather conditions shown graphically are also explained concisely in the text. On the back of the chart the true and magnetic bearings for a large number of points on the coasts when two lights or other objects are seen in line from the deck of a vessel afford an easy method of determining the deviation of the ship's compass. There are also small charts showing the mean isobars, isotherms, percentage of frequency of storms and calms for various localities in September, and the annual change in the magnetic declination. These pilot charts, brought as closely as possible up to the date of publication, are of the greatest practical value to seamen.

GEOGRAPHY AT THE BRITISH ASSOCIATION.

IN his presidential address to Section E, Sir George Goldie took the more or less obvious course of reviewing the progress of geography during the quarter of a century that had elapsed since the association last assembled in that city; but while necessarily saying something of the progress of exploration during that interval, he wisely passed rapidly over this side of the subject, and addressed himself chiefly to the wider aspects of the growth of the scientific treatment of the subject and the spread of the geographical spirit among the people at large. The address was therefore unusually valuable from the point of view of all who are interested in the present position and future of the subject, both as an item in the educational curriculum of the country and as a study of undeniable importance to the general welfare of the nation.

There was a particular fitness in laying stress on this side of the question from the fact that, twenty-five years ago, as Sir George Goldie pointed out, a true conception of the functions and scope of geography was confined to a very limited circle of specialists, so that the progress so far made may be said to belong exclusively to the period under review. The investigation undertaken by the Royal Geographical Society, which was undoubtedly the starting point of any success since achieved, was, in fact, set in motion a few years after the previous York meeting of the association. The report issued by the society as a result of Dr. Keltie's inquiries showed how entirely inadequate were the methods of geographical tuition in those days, and the little importance, with one or two praiseworthy exceptions, attached to it in educational circles. The "absurd prejudice" which, as then pointed out by one of the few more enlightened teachers, regarded the subject as unworthy of the attention of first-rate men, has happily since been to a large extent overcome.

Sir George Goldie aptly diagnosed the source of our weakness as being, not the absence of the necessary raw material, for few countries possessed a literature of travel and exploration so wide and of so high a class as ours, but the paucity of men qualified to apply scientific method to this raw material, and the want of an institution where a thorough training in geography might be obtained. He was able to point to the large measure of success which has attended the efforts of the Royal Geographical Society and its coadjutors to remedy these defects, as evidenced in the present position of geography at Oxford and Cambridge and other of our universities. As a main cause of a spread of interest in the subject among the people at large he assigned the marked re-awakening of the spirit of colonial expansion, from 1884 onwards, and held that "empire-building is an even greater factor than war in advancing and popularising geographical knowledge."

As regards the future, he pointed out that though the popularity of a subject is by no means a test of its place in the ranks of science, the democratisation of geographical ideas is a very hopeful feature, by reason of the widening of the area from which students can be drawn and men of genius evolved. In conclusion, he gave a by no means contemptible list of books and papers as samples of the work recently produced in this country under the stimulus of scientific method applied to geographical study.

Among the papers, discussions, and lectures which formed the remaining programme of the section, one by Mr. G. W. Hope, a young American professor from the Ohio State Normal College, may be first mentioned, on account of the close bearing which it had on the subject of the presidential address. In a valuable and suggestive paper Prof. Hope urged the importance of Social Geography as a subject of study which has hitherto been too much neglected. The paper well exemplified the wide field open to the student of the new geography, and the need that it should be taken up by first-rate men if it is to lead to the most valuable results. The speaker dwelt, for instance, on the wide and thorough knowledge, not merely of geography in its narrower sense, but of allied subjects such as history, technology, and economics, which is indispensable for a fruitful study of the problems of social distribution. His avowal that he had himself approached the subject largely under the inspiration of the geographical movement in this country should give much encouragement to those who have worked so strenuously in its furtherance.

A large part of two mornings was taken up with well-sustained discussions, one on coast erosion, the other on a proposal for improved geodetic measurements in Great Britain. The former was opened by a paper by Mr. Clement Reid, F.R.S., who insisted on the need of approaching the subject with an adequate knowledge of past geological events in order to gain a comprehensive grasp of all the factors. The erosion of our coast must be studied in conjunction with the deposition of the material eroded, and when this is done we find that the process has not continued regularly for an indefinite period, but began, as now manifested, only some 3000 or 4000 years ago. In Neolithic times, according to evidence supplied by buried land surfaces, the sea stood 60 feet lower relatively to the land, and on the south and east coasts of England the rising downs were separated from the coasts by a wide plain. About 4000 years ago there set in a rapid but intermittent subsidence of the land or rise of the sea, on the completion of which the coast erosion now in operation began. In course of time shingle beaches and sand dunes were formed from the eroded material, and supply the best protection against further inroads. Much valuable alluvial land has also been formed in sheltered estuaries, so that it is an important question whether the net gain from protective works (if existent at all) would justify the enormous outlay involved. In the discussion which followed (in which Prof. Percy Kendall, Mr. Whitaker, Mr. E. R. Matthews, and others took part) the need of taking a broad view of the whole question was again and again emphasised, instances being given of the detrimental results of uncoordinated protective operations. Mr. Matthews, an engineer from Bridlington, gave some instructive details as to recent changes on the Yorkshire coast.

The geodetic discussion was opened by Major E. H. Hills, who pointed out that though the fundamental triangulation of these islands was excellent work for the time at which it was done, it is now far behind the standard of modern work of its class. This is the more regrettable, inasmuch as it prevents the coordination of British with Continental work, although the necessary observations to connect the two series have actually been made, and such coordination is of high importance in connection with questions such as the determination of the figure of the earth. All that is absolutely necessary is to connect geodetically, by as good a set of triangles as possible, the extreme points of our islands, and, were this done, amplitudes of 10° and $11\frac{1}{2}$° respectively would be added to two very important geodetic lines, viz. the meridional arc through the Greenwich meridian and the longitudinal arc along 52° N., which at present extend through 18° and 57°. Major Hills's proposals were warmly supported by Colonel D. A. Johnston (who presided at the discussion), Prof. H. H. Turner, Major Close (who mentioned as a less ambitious scheme the measurement of the central meridian of England running north from Southampton), Colonel Hellard, director of the Ordnance Survey, and others, the small cost of the undertaking and the reproach to British science involved in the existing state of things being generally insisted on. At the close of the discussion Mr. E. A. Reeves described a new form of range-finder invented by him, which, though at present in an experimental stage only, gives promise of proving of great use in survey work as well as, possibly, for military purposes.

Several of the papers described the scientific results of recent expeditions. Mr. J. Stanley Gardiner, besides presenting the report on the general work of the Percy Sladen expedition in the Indian Ocean, described the Chagos Archipelago in detail, discussing the coral formations and touching also on the life conditions, especially of the vegetation. He showed that there was evidence here, as throughout the Indo-Pacific coral-reef region, of a relative rise in the land-level reaching from 5 feet to 35 feet, and probably due in great part to a withdrawal of water from the equator by the piling up of ice in the Antarctic. The atolls seem to have been formed on submerged shoals by coral and nullipore growth on the edges of the latter, and the lagoons show a progressive increase in depth and area through solution, boring and triturating organisms, and tides. Mr. R. N. Rudmose Brown described the South Orkneys and other localities in which scientific collections had been made by the Scottish Antarctic Expedition; Mr. J. Parkinson gave an outline of the physical structure of southern Nigeria—a subject on which little has been known—from observations during a mineral survey of the region under the auspices of the Imperial Institute; and Mr. James Murray sketched the general scientific results of the survey of the Scottish lochs, discussing in particular the "internal seiche" which has been brought to light, and was explained as occurring on the cessation of a gale which had maintained a temporary equilibrium between two bodies of water of different densities separated by an oblique line of separation.

Two papers dealt with the economic side of geography. That by Major Beacom, of the United States Legation, gave a most interesting account of the vast irrigation projects inaugurated within the past few years by the United States Government, enlarging in particular upon the Colorado River as the American Nile, and the changes in the Colorado desert due to irrigation. Prof. L. W. Lyde spoke of the wheat area in central Canada, showing how the climatic conditions favour the growth of that crop, especially along a line through Brandon and Battleford. He expressed a high opinion of the probable output of wheat from this area in the immediate future, but held that wheat growing was here eminently the work of the small farmer.

At the afternoon meetings illustrated lectures appealing to a more general audience than some of the above were given. Prof. W. M. Ramsay gave an instructive account of the past and present of Asiatic Turkey as influenced by physical conditions, tracing the fortunes of the region through their various vicissitudes, and forecasting a prosperous future from the advent of railway communication. Major P. M. Sykes described a tour in south-east Persia, dwelling on the many interesting historical associations and speaking of the ruined cities of the Narmáshir district. Mr. Yule Oldham interested a large audience with an account of the visit of the association to South Africa in 1905, while, lastly, Mr. Trevor-Battye showed a striking series of views illustrative of life and nature on the Zambezi above the falls, which he ascended at the close of the same visit of the association.

PHYSIOLOGY AT THE BRITISH ASSOCIATION.

SEVERAL subjects of great practical importance were discussed at the Physiological Section of the British Association; so much was this the case that the section proved to be the resort of larger audiences than formerly, and before the end of the week the building placed at the disposal of Section I was all too small for its purpose.

Of the discussions, none was more appropriate to York than that introduced by Dr. F. Gowland Hopkins on the minimum proteid value in diet. This question has two aspects, the physiological and the sociological; the former was the subject of extended researches some time back under the guidance of Prof. Atwater and Dr. Benedict, and more recently under the very able superintendence of Prof. Chittenden at Yale. It is, however, the sociological aspect of the question which gives it an especial interest in York, for in that city, as is very generally known, Mr. B. Seebohm Rowntree has made a very laborious and complete investigation of the dietetic conditions which obtain amongst the poorer classes, and has convinced himself that about one-quarter of the whole population is insufficiently fed. The value of his research depends essentially upon a correct judgment as to the minimum diet upon which a labouring man can perform an efficient day's work. The sociologist is therefore dependent upon the physiologist for his fundamental data.

The physiological requirements of the body are twofold—requirements of matter and requirements of energy; the necessary carbon and nitrogen must be provided, and they must be provided in a form which yields the number of calories equivalent to the energy dissipated by the human organism as work and heat. The subject was greatly simplified by Dr. Hopkins, for he showed that as the practical outcome of a large number of researches the energy value of the food might be almost disregarded. "It always worked out," he said, "that if the nitrogen-value of the food was looked after the calorie-value would look after itself." Very different views obtain as to the minimum nitrogen value of a daily ration, and the disparity of view has been much increased within the last five years. We used to think that 100 grams of proteid food per day, giving 15 grams of nitrogen, was a somewhat restricted diet. Prof. Atwater has raised this figure considerably, whilst Prof. Chittenden has reduced it. Facilities have

[be]en given to Prof. Chittenden and his colleagues by the American Government, and they have studied, not only themselves, but athletes in training and squads of soldiers, and have constantly found that by gradually accustoming these men to a carbohydrate diet a condition of physical efficiency and nitrogenous equilibrium can be obtained, though with some loss of weight. As the result of this gradual process the proteid might be reduced until only about 7 grams or 8 grams of nitrogen were excreted daily.

Actual figures of nitrogenous output were given by Dr. J. M. Hamill and Mr. E. P. Poulton; the former with Dr. Schryver has investigated the nitrogenous output of the workers in the physiological laboratory of University College, London; the latter has experimented upon an Oxford student, *aet.* twenty-two, while he was going through the ordinary routine of university life at Oxford. There was great disparity amongst their figures. The workers at University College varied from 8 grams to 16 grams of nitrogen daily, whilst Mr. Poulton's figure was a high one.

The low nitrogen values indicated above are of great scientific interest, but from the practical point of view they were shown to be of rather academic value by Dr. Hopkins. He made it quite clear that the observers who had obtained these values for the daily nitrogen output had done so on diets which were many times more expensive than those to which the working classes had access. He showed, in fact, that such food as a working man could buy must have a nitrogen value and a calorie value which was of the order indicated by Voit. The point at issue, then, between Dr. Hopkins and Mr. Rowntree was whether the moderate diet indicated by Voit or the more considerable one indicated by Atwater was to be taken as the basis of a proper daily allowance for the working classes. Now though there is a considerable difference between these two diets it is clear that there are lines along which a solution may be forthcoming. Three such directions were indicated by Dr. Hopkins:—

(1) More searching analyses must be made into the nature of foodstuffs (and this point was developed by Prof. Armstrong). Maize, for instance, is particularly unsuitable as a staple dietary, not because it is of insufficient nitrogen value or even of insufficient calorie value, but because a particular kind of proteid, which is necessary to growth, is conspicuously absent from maize.

(2) The relative values of the various tissues as energy transformers must be attested. This work is being carried on by a committee of the British Association, and its annual reports for the past three years have been very instructive, but only the fringe of this large subject has been touched.

(3) Conditions of age and sex have not been thoroughly investigated. It seems clear that a developing individual—say of twenty years requires a richer diet than a man of twice that age.

Dr. Hopkins readily conceded that even the trained athlete or the soldier might transform much less energy than was entailed in the daily toil of a bricklayer or a rivetter, and in view of this uncertainty we have some sympathy with Mr. Rowntree's contention that the calorie value demanded by Atwater, if acquired in the form of bad food eaten amid unappetising surroundings, was none too much for a heavy day's work.

Another discussion of great interest, entitled "The Physiological Value of Rest," was introduced by Dr. Theodore Dyke Acland and Dr. Bevan Lewis. The former dealt chiefly with the hours of rest prescribed in the large public schools of this country. His views are so well known that it is not necessary to give them at length. The discussion was useful from several points of view, which may be briefly summarised:—

(1) The necessity of obtaining scientific data concerning fatigue phenomena. This matter was dealt with by several of the pioneers in that branch of physiology, namely, psychophysics, which is rapidly springing up, and which bids fair to yield far-reaching results. Dr. Rivers, Prof. McDougall, and Dr. Myers indicated how the question might be approached on strictly scientific lines.

(2) The necessity for limiting the prevalent idea that "recreation is a change of occupation." This dictum is useful and true so long as occupation does not amount to fatigue, but its utility ends at this point. When the system becomes fatigued, and this is especially true of the brain, the toxic bodies produced affect unused as well as used cells. It is futile to throw these cells, already prejudiced, into activity. Such action simply adds to the amount of poisonous or toxic bodies in the circulation. This point was worked out with great clearness by Dr. Bevan Lewis, whose introductory address was on very different lines from that of Dr. Acland. Dr. Lewis treated the subject from a neurological, not a statistical, standpoint; he opened with a defence of the "neuron theory," now assailed from so many quarters, and on this theory worked out a conception of the neurological basis of rest and of fatigue. The practical outcome of his argument, as well as of Dr. Acland's, was that physical exercise was no substitute for sleep, but that active physical exertion added to severe mental strain demanded a double meed of slumber. In illustration of this point Dr. Acland recounted how that Mr. C. B. Fry, at once a scholar and an athlete, frequently slept till midday or even late in the afternoon during his school vacations, and in doing so gratified nothing more than the healthy demand of his frame—physical and mental—for rest.

(3) This discussion made clear the individual differences in the depth and time of slumber; thus day workers attain the maximum soundness of sleep early in the night, whilst night workers begin their slumber by sleeping somewhat lightly and sleep more soundly as morning approaches. Neurotic subjects, on the other hand, have two maxima on their sleep curve, one in the early part of the night, another in the morning; between these there is a period of shallow sleep. If any occurrence happens which causes a general reduction in depth of slumber, the period of shallow sleep in the middle of the night is replaced by a period of wakefulness.

(4) Prof. Gotch, who showed the utmost skill in weaving the separate items of this discussion into a continuum, dwelt upon the nature of dreams as an index of the soundness of sleep. If a dream was a connected series of events and was recollected as such after waking, it was clear that the mental rest was impaired. The more coherent and the more realistic the dream, and the more directly it was concerned with events in the recent past, the less restful was the sleep in which it occurred. The quality as well as the quantity of the sleep was all-important.

The sitting of Friday morning, August 3, was devoted to a paper on public health. Dr. George Reid, the medical officer of health for Staffordshire, put forward a number of telling arguments, the result of experiments which he had performed, in favour of changing the form of many sewage filters. It appears that the chemical changes which take place in a filter of fine particles are completed relatively near the surface. Dr. Reid advocates the use of one-eighth inch particles, and of filters only about 4 feet deep. Such filters would be much less expensive than those now in use. A detailed account of his investigations was recently published by the Royal Society.

Dr. Hime, of Bradford, brought forward a strong indictment of the present system of reporting and isolating infectious diseases. His data were collected from twenty-five large towns in the United Kingdom, and dealt with diphtheria, scarlatina, and typhoid, which taken together formed 95 per cent. of the cases reported. His general argument was that the epidemics of these diseases had increased in virulence and number within recent years in spite of the present system. The most telling figures which he adduced were from cases where the hospitals had been closed to one or other of these complaints and the cases sent back to their homes. On one such occasion more than ninety cases of scarlatina were sent back to the poor neighbourhoods of a town. No epidemic followed; in fact, the epidemic which was prevalent ceased at once.

The discussion which followed Dr. Hime's paper turned rather upon a matter of principle. Granted that experts were in doubt concerning the present system of reporting and isolating cases, was it wise to make the matter one of public discussion? Some medical officers held that such debate weakened the trust in the public authority, and introduced an element of personal option as to whether it should be obeyed. The view more generally taken was that, since the civic control was becoming daily more vested in the popular vote, it was desirable for the British Association to emphasise the responsibility which rested upon the public to acquaint themselves with matters connected with the public health, and to put the most trustworthy information before them in the most open way.

Amongst the more technical communications there were two excellent ones by Drs. Nasmith and Graham, of Toronto, on the hæmatology of carbon monoxide poisoning, and by Dr. Dawson Turner on the electrical resistance of the tissues. Both communications were the result of much laborious research; their interest lay along the more strictly medical line. JOSEPH BARCROFT.

LOCAL SOCIETIES AT THE BRITISH ASSOCIATION.

THIS conference was presided over by Sir Edward Brabrook, C.B., who fitly represented those societies which have recently been brought into relationship with the British Association under the title of "Associated Societies." These comprise such local bodies as exist for the encouragement of the study of science, but are not at present in a position to undertake and publish original investigations. The chairman, in opening the proceedings, dwelt on the useful work which these modest societies might accomplish, and suggested various ways in which local societies, whether belonging to the affiliated or to the associated class, might aid those sections of the British Association in which he was specially interested, namely, the sections of anthropology, economics, and educational science.

Dr. H. R. Mill delivered an address on local societies and meteorology, in which he commended the study of this science as peculiarly suitable for cultivation by the corresponding societies. Local climate can be determined only by a long, continuous record of local observations; and this continuity, so difficult to maintain by private observers, can be readily secured by a local society, which by its nature is, or should be, immortal. Sunshine and rainfall are two elements of climate which still need much further study. A vast body of meteorological observations in the past has been absolutely useless either because the instruments used were not trustworthy or the hours of observation were irregular; whilst in many cases the observations, otherwise of value, have lost their usefulness through not having been dealt with by competent authorities. In the course of a discussion, Mr. E. Kitto, the superintendent of the Falmouth Observatory, referred to the special value of the magnetic records regularly issued from his station. Dr. J. R. Ashworth, of Rochdale, pleaded for a meteorological survey of the British Islands—a work in which the local societies might obviously render material assistance.

The second meeting was presided over by Mr. J. Hepkinson, vice-chairman of the conference, who in his introductory remarks pointed out the great value of photographic surveys of counties. This subject was elaborately treated by Mr. W. Jerome Harrison, of Birmingham, in a communication on the desirability of promoting county photographic surveys. The paper gave a history of the movement, which was practically initiated by the author, and has spread from Warwickshire, where it was started, to several other counties, including Worcestershire, Essex, Surrey, and Kent. Mr. Harrison suggested that a committee should be formed to coordinate the photographic societies with the literary and scientific societies, so that all should join in the work of the surveys. The subject was warmly taken up by the delegates, and it was determined to apply, at next year's meeting, for the appointment of a county photo-survey committee. The Rev. Ashington Bullen suggested that at every meeting of the British Association there should be a photographic exhibition illustrating the archæology, ethnology, and natural history of the particular county in which the meeting was held. Prof. H. H. Turner referred to the value of pairs of photographs on the stereoscopic plan, inasmuch as they enabled the distances between various objects represented on them to be ascertained by calculation. In the course of the discussion much approval was expressed of the work of those committees of the British Association which dealt with photography as applied to geology, anthropology, and botany.

THE BOMBAY LOCUST.[1]

ANOTHER new venture among Indian memoirs has lately been issued, and if subsequent numbers are like this first instalment they will prove of great value. Mr. Maxwell-Lefroy deals in this first issue with the Bombay locust; we prefer to call it by its popular name, for its scientific one seems in doubt. Specimens were sent by Mr. Lefroy, and have been named at the British Museum by Mr. Kirby as *Acridium rubescens*, Walker, which is apparently quite correct; but we learn from this report that Mr. de Saussure assigns the Bombay locust to Linnæus's species *Acridium succinctum*. In this report the latter name is chosen as probably being most accurate, but it is extremely doubtful if Mr. Lefroy has made the right choice. It is best, therefore, as "doctors disagree," to call this pest simply the Bombay locust.

The work comprises 109 pages of letterpress and thirteen plates, the latter being an improvement on the majority we see from India. The report deals with investigations made in 1903–4, and contains an amount of useful information concerning "locust swarms."

Part i. is devoted to the subject of the formation and movements of locust swarms. In it the author shows and explains how a swarm arises, how from grasses in which they were concealed they entered the crops and "gradually formed into swarms and moved over the country-side." Then these definite bodies of locusts could be traced from village to village. Later they were shown to move in definite directions, migrating at nights, when their wings were constantly and suddenly seen glistening against the moon as they flew by, and as suddenly they vanished.

These swarms settled in the forest regions at last during November and December, and then in March and April a second or outward migration was traced. After the outward migration the swarms were shown to break up, and only scattered locusts could be found. A vast area of land thus became infested with them, but little or no damage was done, for "the locusts had apparently lost the swarming and migrating instinct." Reproduction then set in.

The summary given is as follows:—

Winged locusts emerged and entered crops ...	Oct. 1—20.
,, ,, migrated	Oct. 20—Nov. 30.
,, ,, remained in forests	Dec. 1.—March 20.
,, ,, migrated	March 20—May 20.
,, ,, scattered	May 20—June 10.
,, ,, reproduced and died	June 10—Aug. 10.

In part ii. Mr. Lefroy deals with the life-history of this locust, giving an account of the egg-laying, hatching, development, and the description of the "hoppers" after each moult.

In part iii. are related the habits of locusts and methods employed for their destruction. The first is dealt with in a clear and interesting manner, and is well worth the study of anyone engaged in locust work.

The rewards given for collecting this pest and its eggs varied, but during cold weather winged locusts were paid for at the rate of $\frac{1}{4}$ to $\frac{1}{2}$ anna per seer (2 lb.), and this pay was sufficient to give a fair wage to an active man. Later 4 annas were paid per seer, a seer containing 400 to 450 locusts. Amongst natural enemies mentioned we notice monkeys, the striped squirrel and the grey-necked crow, and several insects. No doubt these all do some good, but to rely on them to prevent locust swarms is futile. Amongst methods of destroying these noxious insects is the employment of poisoned baits. Experiments recorded here show that a weak solution of arsenate of lead proved better than a strong solution of sodium arsenate or the well-known Natal locust mixture. More than 80 per cent. of the locusts were killed when fodder baits were sprayed with 1 lb. of lead arsenate, and 5 lb. of jaggery, to 100 gallons of water, in twelve hours. For

[1] "Memoirs of the Department of Agriculture in India." Vol. i., No. 1. By H. Maxwell-Lefroy. (Calcutta, April, 1906.) Price Rs. 2.8.

some reason the locusts would not touch the other poisoned baits.

The concluding part (v.) reviews the systematic position of the Bombay locust, and gives a useful list of other species found with it. These locusts are figured in the plates.

Half this report consists of four appendices. The first deals with the action taken against locusts in the Bombay Presidency. Summing up the campaign against the locust in 1904, it is made quite evident that a very determined effort was made to cope with this pest, and that the excellent organisation that extended to every village in the Presidency was effectual in producing a very general action on the part of the people. This is all the more remarkable when we consider the natural apathy of the ryot and his strong objection to take life of any kind. Yet we are told in the report that "4152 maunds of adults, equivalent to 66,432,000 individuals, were destroyed, or two-tenths of a per cent. of the estimated number." One hundred maunds of eggs were destroyed, representing 400,000,000 individuals, and 13,252 maunds of "hoppers," which represented some 530,000,000. That is, 930 millions of young were destroyed!

In all some 1500 millions were probably accounted for, including adults, eggs, and hoppers; of these 66 millions were adults, which would have been responsible for another 3000 million "hoppers" had they lived. To accomplish this the Bombay Government spent a little more than two lakhs in rewards. Anyone knowing what "locust swarms" mean to the cultivator will acknowledge that this sum was well spent. In the same appendix are notes on the latest invasion of the Portuguese territory of Goa, where the damage in 1904 was also very great. Fears were entertained that the locusts might make their way to the seaboard and destroy the magnificent paying cocoanut trees, one of the chief sources of revenue to the country.

The second appendix is by Mr. B. P. Standen. In it are mentioned various methods used to cope with the locusts, such as the American "hopper dozer," the Russian wheeled revolving brush, bags, poison bait, bonfires, &c. But in the end of all this Mr. Standen tells us (p. 92) that "the efforts were aided in a remarkable fashion by juari birds (the Rosy Pastor), which arrived in large flocks earlier than usual and devoured the locusts greedily." . . . "It is quite possible that the preservation of the crops was due as much to these birds as to the effects of human agency." Yet a few lines further back we are told in his report that the Deputy Commissioner of Wardha considered that a third of the total number of hoppers were destroyed by the measures adopted, whilst others estimated that half at least were destroyed.

Besides the plates of various species and structural peculiarities, there is also a map showing the infested area in 1903–4.

FRED. V. THEOBALD.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The second Frank Smart studentship in botany, tenable at Gonville and Caius College, has been awarded to Mr. F. T. Brooks, late scholar of Emmanuel College, the understanding being that the student shall prosecute research in some special branch of scientific forestry.

MR. SYDNEY PENNINGTON has been appointed an instructor in veterinary science in the School of Agriculture, Ghizeh, Egypt.

MR. J. BLAKEMAN, Trinity College, Cambridge, has been appointed mathematical master at the Municipal Technical School, Leicester.

THE results of the annual examination held last July by the Oxford and Cambridge Schools Examination Board have now been issued. The total number of candidates for higher certificates was 2054, of whom 462 were girls offering letters only. Of these candidates 1084 offered Latin, 882 Greek, and 1369 French. In natural philosophy there were 143 candidates in the mechanical division, 131 in the physical division, and 132 in the chemical division. Physical geography and geology were offered by forty candidates, and biology by 183. The total number of candidates for lower certificates was 1046, and the number of candidates offering the several subjects mentioned was as follows:—Latin, 668; Greek, 393; French, 993; mechanics and physics, 74; physics and chemistry, 235; chemistry and mechanics, 23; and botany, 62. The candidates in this examination are almost entirely from public schools, and the numbers given are interesting, since they indicate the relative importance attached to linguistic and scientific studies in these schools.

AMONG calendars which have been received recently, that of the East London College, in the Mile End Road, is of special interest, showing as it does the admirable provision now made in East London for higher education. The object of the college is to provide such instruction in the various branches of a liberal education as will qualify students to take degrees at the University of London and other universities of the United Kingdom; to give such instruction in science and technology as will be serviceable to students who intend to pursue a profession or trade in which a knowledge of science in its practical applications is required; and generally to promote higher education in East London. The engineering department and other portions of the college premises have been enlarged recently at the expense of the Drapers' Company, which has made a further grant of 5000*l*. for this purpose. This company is again awarding valuable scholarships tenable at the college. The staff, too, has been strengthened, and there is every prospect of a highly successful session's work.

THE London County Council has organised for the session 1906–7 courses of instruction for teachers. These courses are open without fee to teachers in London schools, and are intended to offer to teachers in the various types of schools opportunities for developing their knowledge of different subjects and of coming into contact with those who have made a special study of the subjects in question. The Council is of opinion that few things can be of greater assistance to teachers than personal contact with some experienced teacher who has devoted special attention to a particular subject, or has made a study of the best methods of presenting the subject to others. The courses include partly lectures and demonstrations in special subjects, such as manual training, general elementary science, physics, chemistry, botany, and also courses conducted under the auspices of the County Council at the schools of the university, namely, University College, King's College, Bedford College, and the London School of Economics and Political Science. Full particulars with regard to the courses may be obtained from the executive officer, Education Offices, London County Council, Victoria Embankment, W.C.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 24.—Croonian Lecture, 1906.—"On Nerve Endings and on Special Excitable Substances in Cells." By Prof. J. N. **Langley**, F.R.S.

The author stated in his general conclusions that the paper had shown there was reason to believe that in each of the three great types of connection of the peripheral end of an efferent nerve with a cell, it is some constituent of the cell substance which is stimulated or paralysed by poison ordinarily taken as stimulating or paralysing nerve endings. Reasons, though less complete, have been given for supposing that these poisons have no special action on nerve endings, and that physiologically the nerve ending is not essentially different from the nerve fibre. In that case, not only the function of reacting to numerous chemical bodies, but probably also the special liability of both afferent and efferent nerves to fatigue must be transferred from the nerve endings to the same constituent of the cell.

This theory adds to the complexity of the cell. It necessitates the presence in it of one or more substances (receptive substances) which are capable of receiving and transmitting stimuli, and capable of isolated paralysis, and also of a substance or substances concerned with the main function of the cell (contraction or secretion, or in the case of nerve cells of discharging nerve impulses). So far as this is concerned, it does but accentuate a view which has often been put forward, and which, indeed, in some form or other is inseparable from the idea of protoplasm.

The author had spoken of different "substances" in the cell with the intent to use as vague a term as possible. The "substances," he took it, are radicles of the protoplasmic molecule; at present, however, he did not think it advisable to speculate further, either on this question or on certain other questions raised by the conclusions arrived at in the paper. There are a number of obvious experiments still to be made, and these, it may be hoped, will settle some of the problems, the solution of which is now but guesswork.

June 14.—"The Experimental Analysis of the Growth of Cancer." By E. F. **Bashford**, J. A. **Murray**, and W. H. **Bowen**.

The proliferation of Jensen's tumour when propagated in large numbers of mice is not uniformly progressive, but presents fluctuations which can be referred, with confidence, to the tumour cells themselves. The experimental conditions which introduce irregularities are shown to be (1) differences in race of the mice used, *e.g.* tame or wild; (2) differences in age of mice even of the same kind—young animals are measurably more suitable than adult animals; (3) the site of implantation of the cellular graft—the subcutaneous tissue of the back was found to be more suitable than, for example, the peritoneal cavity; (4) the size of the graft was found to be of importance, but mainly as modifying the apparent rate of growth; large grafts of more than 0·1 gram, however, were less successful than smaller ones of from 0·01 gram to 0·02 gram, as previously shown by Jensen; (5) the mode of introduction influences the success of the experiments, transplantation of small fragments of unaltered tumour giving better results than the injection of a suspension of tumour cells in physiological salt solution.

Artificial propagation was carried out on a large scale for a long period by transplantation of grafts of from 0·01 gram to 0·02 gram of unaltered tumour into the dorsal subcutaneous tissue of young tame mice from five to seven weeks old. Each tumour was transplanted into forty or more mice, and the results compared by estimating the percentage of success on the number of animals remaining alive after ten days. The method adopted results in the separation in a large number of animals of the descendants of cells previously living in one animal, so that after two or three successive transplantations the whole of the tumour in one animal represents the offspring of a very small part of a preceding tumour, and in the limit the progeny of a single cell in a tumour more or less remote. The percentage of success obtained with any tumour is used as an indication of the frequency in it of cells capable of continuing growth, and the results at different times and with a number of propagated tumours are compared by means of graphic records. The dates of transplantation are measured as abscissæ and the percentages of success as ordinates. Several such graphic records illustrate the paper, and show that the percentage of success does not vary irregularly, but that, commencing with a tumour giving a low percentage, successive transplantations may be more and more successful until a maximum is reached, it may be at 60 per cent., at 70 per cent., or at 100 per cent. The subsequent transplantations are not so successful. The percentage of success falls rapidly either at the first essay or in two or more steps until a minimum is reached, after which the process is repeated. It is concluded that the tumour cells present a cyclical activity, and suggested that the period of lower percentage of success represents a failure of the proliferative powers from which recovery occurs when the transplantations show again a progressively higher percentage of success. A graphic record of the behaviour of a large number of separate strains shows a continuously high maximum of success between 70 per cent. and 90 per cent. due to the successive development of maxima in separate strains, and it is suggested that sporadic tumours possess a similar complexity, so that growth may be proceeding rapidly at one part while dying out at another.

Spontaneous absorption of well-established tumours occurred at the same time as the rapid fall in percentage of success, failure of the cells to establish themselves in new animals coinciding with cessation of growth and extinction in animals in which they had been able to grow for a time. Without prejudice to other factors, it may be presumed that the greater frequency of spontaneous absorption in transplanted tumours may be due to their greater homogeneity resulting from the repeated intercalation of what is virtually a unicellular stage.

The extinction of certain strains of Jensen's tumour is alluded to and compared with the results of transplanting two other spontaneous mouse carcinomata, which after successful transference to normal animals gave progressively lower percentages of success until negative results were obtained.

The results indicate the necessity for caution in interpreting experiments designed to modify the growth of propagated tumours, and for accurate records of their previous history as a necessary accompaniment to therapeutical experiments.

June 21.—"On the Electric Inductive Capacities of Dry Paper and of Solid Cellulose." By Albert **Campbell**.

June 28.—"Sex-determination in Hydatina, with some Remarks on Parthenogenesis." By R. C. **Punnett**.

July 12.—"A Method for determining Velocities of Saponification." By James **Walker**.

The author takes advantage of the change in electrical conductivity for following the progress of the action of a caustic alkali on an ester. The conductivity of the original solution falls off to about one-third as the saponification proceeds, and the relation between change of conductivity and proportion transformed is very nearly linear. A device is described for simplifying the calculation of the velocity constant by appropriate selection of the resistance in the rheostat. Readings can easily be taken every minute, and the method is much less troublesome than the titration method usually employed, whilst yielding equally accurate results.

EDINBURGH.

Royal Society, July 16.—The Hon. Lord M'Laren, vice-president, in the chair.—Limnographic apparatus and measurements on Loch Earn: Prof. **Chrystal**. The paper gave a detailed account of the various modifications and simplifications which experience had suggested during the recording of seiches on the Scottish lochs. The effects of friction had been reduced to a minimum, so that it was possible to obtain records of short period motions such as wind and other meteorological causes produce. The effect of access tubes connecting the well of the limnograph with the free water of the loch had been studied with great care. By use of a proper sized access tube the shorter disturbances could be cut off and the seiche recorded in all its purity. A new and very simple method of reduction of limnograms so as to separate the various orders of seiches was described. This method of "residuation" consisted simply in superposing the seiche record upon itself displaced half the uninodal period forward. This eliminated the uninodal seiche and left the binodal and trinodal, if such were present. A second application of the same method eliminated the binodal, and in this way the principal nodalities could be separated with great ease and accuracy. It was impossible to apply harmonic analysis to seiches simply because there was no harmonic relation among the periods of the various nodalities.—Preliminary limnographic observations on Loch Earn: Mr. James **Murray**. This paper supplemented the previous paper, and described the difficulties encountered in measuring the seiches by the forms of apparatus devised by Prof. Chrystal. For eye observations the portable seismoscope had been found very serviceable. It could be installed and taken down again in a few minutes, and packed into a compass small enough to go into one's pocket.—A note on the polarimeter: J. R. **Milne**. Two appliances were described. The first, which consists of a thin plate of glass placed obliquely across half the beam of light passing through the instrument, gives the slight rotation of the plane of polarisation which is necessary to give the "half-shade" effect. It takes the place of the half wave-length plate used by Laurent and of the subsidiary Nicol used by Lippich. The principle, it was subsequently discovered, had been used by Poynting, but the particular form here described had certain advantages over its predecessor. The second appliance provides a means for increasing the brightness of the very faint field of view given by all half-shade polarimeters, and depends on the fact that when two equally bright fields of view polarised at right angles to each other are received through a double image prism, the brightness of the single field seen by the eye is twice that of each of the component fields. To obtain this effect in the polarimeter, the ordinary half-shade field is divided into two identical portions, the light of one passed through a quartz plate with a 90° rotation, and then both are superposed by a double image prism, which also takes the place of the ordinary analysing Nicol.—Spectroscopic observations of the rotation of the sun (further communication): Dr. J. **Halm.** In addition to distinct evidence of changes in the rotation of the sun as shown by the displacements of the Fraunhofer lines at the limbs, the observations made between 1901 and 1906 have also revealed the fact of a new displacement of the solar lines which affects both limbs in the same direction. During the interval 1901–6 the Fraunhofer lines have gradually shifted towards the red by an amount slightly more than 0·02 tenth-metre. The solar lines also show greater wave-lengths at the limb than near the centre when compared with the same telluric standards. The relative shift in the case of two iron lines employed by Dunér and by the author is 0·012 tenth-metre. While at least six other "low-level" lines show the same behaviour, the high-level lines appear to occupy essentially the same positions at centre and limb. This remarkable phenomenon may be explained on the assumption that the radiation from the solar gases is affected by pressure. If this explanation be correct, the gradual shift towards the red during the interval 1901–6 would indicate that the solar gases to which the Fraunhofer lines are due are under higher pressure at times of maximum than at times of minimum sun-spot frequency.—A monograph on the general morphology of the myxinoid fishes based on a study of Myxine; part ii., the anatomy of the muscles: F. J. **Cole.**

Paris.

Academy of Sciences, August 27.—M. A. Chauveau in the chair.—The earthquake at Valparaiso, August 16, 1906, registered at Paris: G. **Bigourdan.** A reproduction of the curves registered by the seismograph recently set up at the Observatory of Paris on the night of August 16–17.—The two specific heats of a slightly deformed elastic medium: some extensions of Reech's formula: P. **Duhem.**—The origin of the carbon monoxide contained in normal blood, and especially in the blood of persons suffering from anæmia: R. **Lépine** and M. **Boulud.** The injection into the veins of a dog of sodium oxalate or tartrate causes an increase in the amount of carbon monoxide present. A solution of glucose or levulose has the same result.—The laws of music: Maurice **Gandillot.**—The copper-steel alloys: Pierre **Breuil.** Alloys containing proportions of copper varying from 0·0 per cent. to 10·0 per cent. of copper were prepared, and determinations made of the strength of notched specimens submitted to shock, torsional strength, and resistance to corrosion. Micrographical examination gave results confirming those previously published by Stead.—The mechanism of the influence of acids, bases, and salts on the liquefaction of potato starch: A. **Fernbach** and J. **Wolff.**—A disease of the potato produced by *Bacillus phytophthorus*: Georges **Delacroix.**—The hæmopoietic activity of serum during the regeneration of the blood: Paul **Carnot** and Mlle. Cl. **Deflandre.**

New South Wales.

Linnean Society, June 27.—Mr. Thos. Steel, president, in the chair.—Studies in Australian entomology, part xv., revision of the Cicindelidæ of Australia: Thomas G. **Sloane.** The paper includes descriptions of two new species, synoptic lists of the tribes (2), genera (5), and species (47) of the family Cicindelidæ found in the continent of Australia; also notes on taxonomy, phytogeny, geographical distribution, &c.—Two undescribed species of Eucalyptus from eastern Australia: R. T. **Baker.** *Eucalyptus carnea*, sp.nov., and *E. thozetiana*, F.v.M., the species diagnosed in this paper, are found respectively in the coast district and dry interior of the continent. The former is a typical forest stringybark, with a pinkish or flesh-coloured, hard, durable timber. The mature fruits differ very little in shape and size from those of *E. acmenioides*, Schau., but otherwise these two species can be differentiated by their leaves, timber, and oil. This latter constituent is of some chemical and industrial importance, as it contains, besides a dextrorotatory pinene and eucalyptol, an acetic acid ester. Only a small quantity of free acetic acid was found in the crude oil, but the ester split off acid on distilling the oil under atmospheric pressure. Systematically the species should be placed with the stringybarks, and in sequence with *E. nigra*, R. T. B., and *E. acmenioides*, Sch. *E. thozetiana*, F.v.M., ined., has only been known previously to systematists from imperfect material, and both Baron von Mueller and J. H. Maiden refer to it in their writings on the genus. The material upon which the complete description is now based was obtained by Mr. N. C. Champion from his station of Tandawanna, Gooniwindi, Queensland. It attains a height of about 60 feet, has a tesselated bark at the base, and is smooth above to the ultimate branches. The wood is very hard and very heavy, dark coloured, close grained, and interlocked and very durable. It is the hardest yet recorded from any Eucalyptus tree, and very much resembles the South American "lignum vitæ," *Guaiacum officinale*, Linn., and is specially suitable for cog-wheel teeth, mallets, girders, bridge-work, &c. Systematically it might be placed with *E. tesselaris*, F.v.M. As both the species described in this paper yield excellent timber, they are recommended for forest cultivation.—The formation of slime or gum by *Rhizobium leguminosarum*: Dr. R. **Greig-Smith.**—The structure of *Rhizobium leguminosarum*: Dr. R. **Greig-Smith.**

CONTENTS.

THURSDAY, SEPTEMBER 13, 1906.

THE PHENOMENON OF "DEAD-WATER."

The Norwegian North Polar Expedition, 1893–6. Scientific Results. Vol. v. On Dead Water. By V. Walfrid Ekman. (London: Longmans, Green and Co., 1906.) Price 20s. net.

On August 29, 1893, the *Fram* was steaming in smooth and open water between the isle of Taimur and Almquist Islands; towards evening she approached thick ice in order to make fast to it. A very slight current was observed as she neared the ice, but the vessel made extremely slow progress, and the speed was reduced to 1 or $1\frac{1}{2}$ knots, although the engines were working at full power, which would have given a speed of $4\frac{1}{2}$ to 5 knots in ordinary circumstances. Nansen's journal attributed this singular behaviour to the *Fram* having "got into *dead-water*" a condition which has been frequently met with by ships navigating the Norwegian fiords, and occasionally encountered elsewhere. Nansen consulted Prof. Bjerknes (in 1898) on the subject, and that gentleman suggested the explanation that "in the case of a layer of fresh water resting on the top of salt water, a ship will not only produce the ordinary waves at the boundary between the air and the water, but will also generate invisible waves in the boundary between salt water and fresh water; . . . the great resistance experienced by the ship being due to the work done in generating these invisible waves." After some discussion between Nansen and Bjerknes it was decided to make a rigorous experimental investigation; the work was entrusted to Dr. Ekman (assistant in the Central Laboratory for the International Study of the Sea at Christiania). Its history and results are recorded in the remarkable memoir under review, which occupies the greater part of the volume in which it appears, and forms an important item in the scientific results of the North Polar Expedition.

Dr. Ekman's memoir must be closely studied before its full merits can be appreciated. It contains an excellent summary of the present state of knowledge in regard to the resistance offered by water to the motions of ships, and deals in great detail with the wave-phenomena attending these motions through homogeneous fluids and through layers of different densities. The mathematical and experimental works of Scott Russell, W. Froude, Stokes, and Lamb are laid under contribution, and it is demonstrated that Prof. Bjerknes's suggestion furnishes a reasonable explanation of the phenomena of "dead-water." A great body of testimony regarding these phenomena is brought together from logs, journals, and letters of experienced seamen, who confirm the observation made by Nansen in the *Fram*, viz. that ships encountering a layer of fresh water or brackish water superposed on sea water of greater density do experience greatly increased resistance, lose in speed, and not infrequently become unhandy, not answering their helm. These results obtain when vessels are moving at very low speeds before they "get into dead-water"; they are much more frequently seen in sailing vessels than in steamers, and occur in the estuaries of rivers, straits, fiords, or other situations where fresh water accumulates. Sometimes ships get into dead-water when considerable currents are seen on the surface; at other times there is little or no current. In some cases the depth of fresh or brackish water has been less than the draught of the ship, and in others greater. Ships get into dead-water suddenly, and may become free again as suddenly. Any change of condition in the surrounding water, such as the passage of another vessel near the ship "in dead-water," or a sudden alteration in the speed of a ship, tends to destroy the "drag" of dead-water and to set the vessel free. Steamships possessing capacity for high speed may get into dead-water when moving very slowly, but have no difficulty in freeing themselves by using the engine-power in reserve. Sailing ships, or auxiliary steamships like the *Fram*, have not the same command of speed. It will be seen, therefore, that the elucidation of the problem has scientific rather than practical interest, but from the scientific side the experiments of Dr. Ekman deserve and will receive close study by all interested in ship propulsion and hydrodynamics. The experiments were necessarily made on a small scale, the larger model ships used being only one-hundredth of the full size (1 : 100). Dr. Ekman acknowledges the drawbacks unavoidable with such small models, and there is no need to dwell further upon the point; but great interest would attach to the performance of experiments of a similar character on a larger scale in experimental tanks now existing in this country and abroad, wherein the methods introduced by William Froude are followed and developed.

One cannot speak too highly of the extreme ingenuity and care bestowed by Dr. Ekman on these experiments, their numerical and photographic records, and the detailed analysis of results. The illustrative diagrams appended to the memoir are valuable and suggestive, and the broad conclusions reached command acceptance. A singularly close agreement is reached between the experimental results obtained with models and the observations made by Nansen in the *Fram*. The enormously increased resistance and loss of speed are shown to be fully accounted for by the energy expended in forming an invisible wave series at the boundary of fresh and sea water. This would hardly appear probable at a first glance. Supposing the speed of the *Fram* to have been diminished from $4\frac{1}{2}$ to $1\frac{1}{2}$ knots, the resistance at the lower speed in dead-water must have been about nine times as great as that when the *Fram* moved at the same speed in sea water of considerable depth. In the latter circumstances it is well known that nearly the whole resistance would be accounted for by friction of water against the bottom, and a very small part by wave making, as there would be little surface disturbance at so low a speed. These considerations make the results obtained by Dr. Ekman the more remarkable, and it is worth notice that even when a ship is "in dead-water" the disturbance of the upper surface may be very small, although that at the boundary between fresh and sea water may produce a large proportionate increase in resistance.

There are many other matters of interest that cannot be mentioned in the space available. The parallel drawn between resistance in shallow water and in layers of different densities is most suggestive. The determination of the critical speeds at which the influence of dead-water rapidly diminishes or disappears and the accompanying changes in the wave-phenomena are of great interest. On the whole Dr. Ekman is to be congratulated on his work on an obscure problem that has puzzled many persons; Prof. Bjerknes on his prescience in suggesting the solution and his selection of so capable an investigator; and Dr. Nansen on having decided to get to the bottom of the phenomena of "dead-water." It may be hoped that the subject will not be overlooked by other investigators possessing facilities for experiments on a larger scale. W. H. WHITE.

SEGREGATION AS A FACTOR IN EVOLUTION.

Evolution, Racial and Habitudinal. By Rev. John T. Gulick. Pp. xii+269; three plates. (Washington: Carnegie Institution, 1905.)

MORE than fifty years ago Mr. Gulick collected snails on the island of Oahu, and was impressed and puzzled by the fact that each valley seemed to be inhabited by peculiar forms. "Valleys only a mile apart were occupied by distinct varieties, and often by distinct species." The more facts he accumulated the more puzzling did they appear, and a perusal of the "Origin of Species" left his riddle unread. In many cases of divergence diversity of sexual selection cannot be the cause; in the case of snails this hardly requires proof. In many of the same cases diversity of natural selection cannot be the cause, because in many cases the divergence is not in proportion to the degree of environmental difference, because the divergence is sometimes non-utilitarian, and for other reasons.

Gradually Mr. Gulick was led to the position, with which his name is honourably and familiarly associated, that isolation itself, by preventing all chance of crossing with the original stock, may open the way for new habits, for new forms of selection, and, in short, for new species. He believes that no process of natural selection, or of sexual selection, or of any other form of selection, can transform one species into two or more species without the prevention of free crossing between the branches that are thus transformed. "Isolation is an essential factor in the production and maintenance of divergent types." Segregation in particular, *i.e.*, the intergeneration of like with like, with the prevention of crossing between unlike groups, is one of the fundamental factors in the formation, continuance, and control of divergent types. To substantiate and develop this thesis is the aim of the present bulky volume, the full title of which should read, he tells us, "Habitudinal and Racial Segregation; or the origin and intensification of organic types, guided by innovation and tradition acting under segregate association, and established by variation and heredity acting under segregate intergeneration"!

Mr. Gulick distinguishes *racial* (or *aptitudinal*) segregation, produced by the intergeneration of individuals with like *innate* characters, from *social* (or *habitudinal*) segregation produced by the association of individuals with like *acquired* characters, but these two "spheres of evolution" interact. Hereditarily similar forms draw together, and we have "racial segregation"; modificationally similar forms draw together and we have "habitudinal segregation." Each of these is "controlled by two principles." The former is controlled by racial demarcation through *isolation*, and racial intensification through *survival* (in its two forms, selection and indiscriminate elimination). The latter is controlled by habitudinal demarcation through *partition*, and habitudinal intensification through *success* (in its two forms, *election* and indiscriminate failure). "We have, therefore, four main principles cooperating in the production of segregate types, namely, partition, success, isolation, and survival." All this sounds very "wordy," but it need hardly be said that the author illustrates his new distinctions by concrete instances. And, after all, the terms are of less importance than the analysis of the modes of segregation which they express.

Partition (P), acting on acquired characters, produces habitudinal demarcation with initial habitudinal segregation; election (E), acting on acquired characters, produces intensified habitudinal segregation; isolation (I), acting on inherited characters, produces racial demarcation with initial racial segregation; selection (S), acting on inherited characters, produces intensified racial segregation; but we must refer the reader to the book to see what is produced when P and E, I and S, P and I, E and S, respectively work together. The interaction of the principles of segregation is illustrated, *inter alia*, by the Tarpon Island cats, quoted from the New Orleans *Times-Democrat*, which wade freely off the beach, and even swim out to the oyster boats.

Moreover, as to P, E, I, and S, each has its *reflexive* mode, produced by the action of the members of the species upon each other, and its *environal* mode, determined by the relations between the environment and the species; also its *regressive* aspects, caused by the cessation or reversal of the influence that has been ruling; and its *indiscriminate* aspects. There may be *conjunctional* P, E, I, and S; *sexual* forms of S, E, and I; *social* forms of P, E, I, and S. Moreover, under the environal mode of each principle, the relations between the group and its environment may be determined by conditions within the group (*endonomic* P, E, I, or S), or they may be determined chiefly by conditions lying outside of the group (*heteronomic* P, E, I, or S), Eleven forms of P, eleven forms of E, fifteen forms of I, and twenty forms of S are duly distinguished and defined, and we begin to feel that the grammar of evolution is not easy. Altogether twenty-one forms of segregation are found in natural species, and to these must be added institutional segregation and eight forms of intensive segregation found to occur in man.

Is it possible to state the gist of the contribution which the almost too analytic author has to make? Like draws to like; animals with similar acquired characters tend to come together and keep together in habitudinal segregation; "isolation" and "selection" in their varied forms work on inborn variations, and the habitudinal segregation is replaced by a stabler racial segregation. Segregate breeding, fortified by physiological and psychological incompatibilities, results in divergent evolution. "The whole process of bionomic evolution, whether progressive or retrogressive, whether increasingly ramified and divergent, or increasingly convergent through amalgamation, is a process by which the limitations of segregate breeding are either set up and established or cast down and obliterated." It is of value that all the various possibilities and actualities of segregation should be analysed out and illustrated as Mr. Gulick has so painstakingly and ingeniously done; and another great merit of the book is the insistence on the fact that, even in the case of invertebrate animals, members of the same species, exposed to the same environment in isolated groups, will often arrive at divergent methods of dealing with the environment, and so subject themselves to divergent forms of selection. Just as the social group may learn to determine its own social evolution, so, Mr. Gulick maintains, justly, we think, that the animal is in some measure master of its fate, and that changes in the organism are not controlled in all their details by changes in the environment. We are too much given to ranking the environment always first and the organism second; Mr. Gulick thinks this is putting the cart before the horse; and in this insistence on *active* or *endonomic selection,* he does not stand alone. For, as he says, there has been during the past ten or fifteen years an increasing recognition of the fact that not only sexual selection but other autonomic factors are more or less effective in controlling the forms of selection, and, therefore, in controlling the transformations of organisms. Do we not thus reach one explanation of the continuous advance—the determinate evolution—of certain large classes of animals? The recognition of autonomic factors in the process of evolution is giving new insight into the self-developing endowments of the organic world. In conclusion, we must direct special attention to the fact that Mr. Gulick's contribution to our understanding of the intricate factors of evolution is all the more valuable that he rises from biology to sociology—from the Hawaiian snails to Man himself.

J. A. T.

ENTOMOLOGICAL STUDIES.

The Hope Reports. Vol. v., 1903–6. Edited by Prof. E. B. Poulton, F.R.S. (Oxford: Printed for Private Circulation by Horace Hart, 1906.)

THIS is a substantial volume, some hundreds of pages being occupied by prints of papers contained in the Transactions of the Entomological Society of London or by prints of that society's proceedings, one, however, being of a paper in French contributed by Prof. Poulton to the "Annales de la Société Entomologique de France." These prints comprise a useful *résumé* of recent papers and discussions at the meetings of the English Entomological Society during the last three years on bionomic subjects, as well as the two presidential addresses of Prof. Poulton to that society on the questions, "What is a Species?" and "Are Acquired Characters Hereditary?" and in this and in other ways they deal with many matters of extreme interest to naturalists generally. These prints are followed by the reports proper, belonging to the great Hope collection, one for each of the years 1903, 1904, and 1905, occupying together nearly 160 pages. They tell a story of expansion, classification, and orderly rearrangement, all on an extensive scale. It is satisfactory to learn that the very considerable work which this entails is making great progress, and that, with the voluntary assistance so liberally given by competent persons in the different departments, the task of overtaking arrears is being rapidly pursued. The time seems not far distant when, notwithstanding the labour involved in disposing of the immense numbers of new specimens flowing in from various sources, there will be little wanting and much to approve in the Hope Museum as a reference and self-explanatory collection. Very valuable service has already been rendered by it and its officers and staff as a consulting and educative authority for effective observation by entomologists proceeding abroad.

Incidentally, many interesting observations find a place in the reports bearing on matters which have recently engaged much attention; among these reference may be made to illustrations of the extent to which insects are attacked by vertebrate animals, as well as by those predaceous two-winged flies, the Asilids, which successfully attack the stinging Hymenoptera, as well as less formidable victims often much larger than themselves.

A large part of the report for 1903 is devoted to an account of the work done upon the immense Burchell collection presented in 1866 to the Hope Museum by the sister of the illustrious naturalist, including the preparation of a complete and efficient catalogue. In connection with this the interesting story is told of the discovery, as the result of a lecture given by Prof. Poulton at Cape Town, of a portion of Burchell's original journal written in his ox waggon.

South Africa has been in so many ways disappointing that it is pleasant to find evidence in the "Hope Reports" of its extraordinary value to zoological science. Prof. Ray Lankester, in his recent address as president of the British Association at York, has told us that the study of insects, especially of butterflies, is one of the most prolific fields in which new facts can be gathered in support of Darwin and new views tested. It is not, therefore, surprising that many pages of the reports are devoted to butterflies, and to the numerous examples they furnish as to the magnitude and extraordinary character of the different kinds of variation they present, especially those from South Africa, differences in size, form, colour, and habits between parents and offspring and between offspring *inter se*, and the association of some of these differences with differing seasons and climates. Many large additions exhibiting striking variations of these kinds are recorded in the descriptions given of collections of butterflies received from South Africa, so wonderfully rich in these varied forms, as well as from New Zealand, the islands of the Indian Ocean, and elsewhere.

Special arrangements made at the museum for the study and illustration of mimicry in various orders of insects are described. All the orders receive attention and study there, and with such an affluence of contributors from all parts of the world, with the aid of the numerous willing and capable helpers to whom Prof. Poulton heartily acknowledges the obligations that science owes them, and with the enthusiastic and intelligent interest in the subjects that manifestly prevails in every department of the institution, the Hope Museum is plainly pursuing a career that is rendering it of great and increasing scientific value. F. M.

OUR BOOK SHELF.

Insect Pests of the Farm and Garden. By F. Martin-Duncan. Pp. vii+143; illustrated. (London: Swan Sonnenschein and Co., Ltd.) Price 2s. 6d. net.

THIS little book appears in the Naturalists' Library Series. It deals with a number of common insects that are destructive in the field and garden, and at least one *rare* one. The printing and illustrations are good on the whole, and it is clearly and interestingly written. There are, of course, printer's errors, such as Brachus for Bruchus, Centorhynchus for Ceutorhynchus, ov*ae* for ova, &c. A few illustrations are scarcely recognisable, such as that of the codling moth (Fig. 38), the currant gall mite, and the gooseberry red spider (the currant mite, evidently copied from the Board of Agriculture leaflet, being particularly poor, and quite unlike the actual acarus).

When one reads the part dealing with treatment the impression is at once formed that the author is not only not practically acquainted with the subject, but is not *au fait* with any up-to-date work. No mention is made of the most important insecticides, &c., such as arsenate of lead, which is superseding Paris green, caustic alkali wash, bisulphide of carbon, &c., whilst many of the receipts given are quite out of date.

Such advice as picking up maggotty apples, the cleaning of hop poles, and burning the bine, &c., will scarcely meet with the approval of farmers, and is certainly not necessary. One does not now see many hop-poles about to clean. Nothing up to date is given concerning wireworm, whilst, on the other hand, people are cautioned against having animals and fowls in orchards sprayed with Paris green; the author evidently knows nothing of the experiments carried out which show that we can safely keep stock of all kinds in the orchards even when they are actually being sprayed.

Some of the scientific names used are wrong; that of the celery fly is not *Tephritis onopordinis*; the names of the diamond-back moth and the red spider of hops are also wrong.

The work has evidently not been compiled from sufficiently up-to-date material to recommend it to the notice of practical men, and there is nothing new in it of scientific value.

Elementary Electrical Engineering in Theory and Practice. By J. H. Alexander. Pp. xii+208. (London: Crosby Lockwood and Son, 1906.)

IT is difficult to find much in this book to recommend. It is evidently not intended for the higher classes of students or engineers, but this fact is scarcely sufficient to warrant an entire absence of logical sequence or method in the arrangement of the material. The scope of the book is far too wide, taking in as it does fundamental principles, measuring instruments, electrical machinery, batteries, cables, transmission, and generating stations.

Such a wide range compressed into two hundred pages must inevitably lead to a superficial grasp of the subject. For instance, what can be the utility of such a paragraph as the following?

"Storage cells are always fixed up in a separate room. Brickwork or stone, laid in cement and concrete, are used for the foundations for the machinery. The coal bunkers should allow of a store of coal supply for three or four weeks."

The author would be well advised to concentrate his attention on one of the sections mentioned above instead of attempting to include in a single volume so much that cannot adequately be treated in so small a space.

Immanuel Kants Grundlegung zur Metaphysik der Sitten. Dritte Auflage. Edited by Karl Vorländer. Pp. xxx+102. (Leipzig: Verlag der Dürr'schen Buchhandlung, 1906.) Price 1.40 marks.

THIS is the third edition of one of Kant's best-known works in the excellent series of the Philosophische Bibliothek. The introduction contains a well-informed account of Kant's occupation with ethical subjects between the years 1764 and 1785, and of the interest excited by the publication of the "Grundlegung." The text is based on the best authorities, and variant readings are added in the footnotes. A full index of names and subjects completes the volume.

LETTERS TO THE EDITOR.

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

The Mixed Transformation of Lagrange's Equations.

RETURNING to Padua after a month's absence, I read in NATURE of August 2 (p. 317) a letter by Mr. A. B. Basset on "The Mixed Transformation of Lagrange's Equations."

The letter begins:—"I should fancy from the review by 'G. H. B.' in NATURE of July 19 (p. 265) that the papers of Prof. Levi-Civita relate largely to the *mixed* transformation of Lagrange's equations, the complete theory (Proc. Camb. Phil. Soc., vol. vi., p. 117; 'Hydrodynamics,' vol. i., p. 171) of which was first given by myself so far back as 1887"; it is then shown that the *mixed* form of Lagrange's equations may be obtained in the most simple way through an elegant artifice of elimination.

The words here quoted give the impression that my papers deal principally with the announced theory, and that they may be little more than the reproduction of some previous papers by Mr. Basset. I wish, however, the readers of NATURE to know—and Mr. Basset will be the first to recognise the fact—that the case is quite different. The papers in question (as it appears from the general title, "Sur la Recherche de Solutions particulières des Systèmes différentiels et sur les Mouvements stationnaires," and as it seems to me to result also from the review by

"G. H. B.") are essentially dedicated to the *effective research* of particular solutions of dynamical equations. Not a word is said of transformations, *mixed* forms, &c., and ignoration of coordinates is mentioned only in the preface, because this was Routh's point of view in defining and studying the stationary motions.

T. LEVI-CIVITA.

University of Padua, August 29.

I do not recollect by whom the phrases "ignoration of coordinates" and "ignored coordinates" were originally introduced, but on consideration I am of opinion that they are singularly inappropriate ones, and I much prefer the phrase "kinosthenic coordinates."

The advantages of the mixed transformation are that, whenever a generalised momentum is known to be constant, the motion can be determined without knowing anything about the coordinate or the velocity corresponding to this momentum. The first trace I can find of this idea is contained in a paper published by Lord Kelvin about 1872 (see "Hydrodynamics," vol. i., p. 177).

The discovery of the mixed transformation was the result of certain hydrodynamical investigations relating to cyclic irrotational motion, but the circumstance that I originally published it in a hydrodynamical form may have obscured the character of the result as a general theorem of dynamics.

A. B. BASSET.

September 4.

The alleged Triassic Foraminifera of Chellaston, near Derby.

IN NATURE for July 26, in a notice of Mr. Fox-Strangway's memoir on the Loughborough district, reference is made to certain Foraminifera of Liassic type, at one time believed to come from the local Trias. Prof. Rupert Jones, F.R.S., has kindly directed my attention to his explanation of the matter in the "Foraminifera of the Crag," part ii., p. 161, published by the Palæontographical Society in 1895. He there gives a history of the observations, including personal inquiries, and believes that the Foraminifera in question came from Liassic clay in Leicestershire, which was "inadvertently thrown in with the 'red clay' on its journey to Cubitt's works in London." Mr. Fox-Strangways gives a reference to this passage, but does not quote it, and suggests on his own part that the Foraminifera may have come from Liassic material in the drift.

GRENVILLE A. J. COLE.

White- and Brown-shelled Eggs.

BIRDS which lay their eggs in comparatively unprotected places and in a hollow in the ground, as is the case with the pheasant, partridge, jungle fowl, &c., always lay coloured eggs closely resembling in tint the colouring of their surroundings. White-shelled eggs are laid only by birds which make a good nest—those which make it in a secluded spot, or which take the precaution of covering their eggs with leaves, &c., when they are off the nest. It is a strange fact, therefore, that the non-sitting breeds of our domestic fowls lay white-shelled eggs, whereas in the eggs of the sitting or Asiatic breeds the protective colouring is retained in the shell of the egg. This loss of colour cannot be merely the result of centuries of domestication, or all breeds of domestic fowls would lay white-shelled eggs. The systematic repression of the maternal instincts of the hen carried on by man for a number of years has certainly produced the white-shelled egg. It would almost appear to be the case that the hen, knowing she will have nothing to do with the hatching and rearing of the chicken in the egg, loses all interest in the egg, and leaves it, as it were, to its fate. For this reason she neglects in some mysterious way to impart to the shell the protective colouring which is so necessary, in a state of nature, for the preservation of her race. If this be really the case there is an insurmountable obstacle in the way of obtaining brown eggs from the non-sitting breeds of domestic hens, and poultry keepers are only wasting time in trying to accomplish the impossible.

L. M. F.

FLASHLIGHT PHOTOGRAPHS OF WILD ANIMALS.

FROM the popularity of his well-known work "Mit Blitzlicht und Büchse" (or its English translation, "With Flashlight and Rifle"), there is, we believe, a very general impression that Mr. C. G. Schillings was the pioneer in the practice of photographing big game animals by night in their native haunts by combining the use of the flashlight with the camera. It appears, however, from a most interesting and profusely illustrated article in the July number of the *National Geographic Magazine* that the true claimant to this position is an American

FIG. 1.—A White-tailed Deer watching a light on bushes in the distance. From the *National Geographic Magazine*.

sportsman, the Hon. George Shiras. With regard to his position in the matter of flashlight-photography, Mr. Shiras writes as follows:—

"While a number of the present illustrations were taken in the daytime, this method of photography is now so well known that I will not attempt to describe such pictures in detail; but in view of the fact that I was the first to attempt flashlight pictures of wild game, and for the first fifteen years was the sole occupant of this attractive field of photography, it may be of interest to the readers of this article to learn something about this rather odd way of picturing wild animals."

One of the author's most successful plans in the forests of North America was to mount his apparatus in the bow of a boat manned by a selected crew, and then to set forth in search of his quarry. Describing the photographing of a deer the presence of which has been made known by the light reflected by his eyes, the author writes that "The flashlight-apparatus has been raised well above any obstructions in the front of the boat, the powder lies in the pan ready to ignite at the pull of a trigger; everything is in readiness for immediate action. Closer comes the boat, and still the blue translucent eyes watch it. . . . Suddenly there is a click, and a white wave of light breaks out from the bow of the boat—deer, hills, trees, everything stands out for a moment in the white glare of noonday. A dull report, and then a veil of inky darkness descends. Just a twenty-fifth of a second has elapsed, but it has been long enough to trace the picture of the deer on the plates of the cameras, and long enough to blind for the moment the eyes of both deer and men. Some place out in the darkness the deer makes a mighty leap; . . . and soon he is heard running, as only a frightened deer can."

A variation of the plan is to let the creature take its own portrait, and here again we may quote the author's own phraseology :—

"A string is passed across a runway or other point where the deer are likely to pass, which, when touched, sets off the trigger and ignites the magnesium powder. The same method can be used for daylight pictures, except that here a slender black thread is laid across the path, one end of which is attached to the shutter of the camera. The shutter revolves as soon as there is any pressure upon the thread, and a picture of any passing object is taken instantaneously. Not the least interesting part of this species of photography is that the operator does not know until he develops his plates what manner of beast, bird, or reptile has caused the shutter to open."

FIG. 2.—A Raccoon taking his own portrait. From the *National Geographic Magazine.*

Although many of the portraits thus obtained are not in every detail satisfactory to the naturalist, yet they frequently reveal the animal in characteristic and unsuspected attitudes, or display peculiar alarm-features, such as the expansion of the hairs of the light rump-patch of the wapiti revealed in one of the author's pictures. Such pictures are indeed especially valuable in the case of many of the smaller mammals, the nocturnal habits of which make it so difficult to become acquainted with their mode of life.

Whether photography—flashlight or otherwise—will, as the author and Sir Harry Johnston (in the introduction to the English edition of Mr. Schillings's book) hope, ever induce sportsmen to be satisfied with pictures instead of the lives of their quarry remains to be seen. R. L.

A SEARCH FOR A BURIED METEORITE.

THE mode of origin of a remarkable terrestrial feature, known as Coon Butte or Coon Mountain, has been the subject of much speculation and study, of which an account was given in the year 1895 to the Geological Society of Washington by Mr. Grove Karl Gilbert, of the United States Geological Survey, in a presidential address entitled "The Origin of Hypotheses."

This so-called mountain, situated in Central Arizona, rises only 130 to 160 feet above the surrounding plain. When climbed, it is found to contain a crater 530 to 560 feet deep, the dry bottom being thus 400 feet below the level of the land surrounding the rim. The crater is almost exactly circular, and is nearly three-quarters of a mile across, two diameters at right-angles with each other measuring 3654 and 3808 feet respectively. From the crest of the rim to a distance of about three and a half miles outwards the surface of the country is strewn with fragments of sandstone of various colours; for the first half-mile the fragments are large blocks, some of them of enormous size, 60 or even 100 feet in diameter; for the next half-mile the fragments are smaller and less plentiful; beyond this distance they are isolated from each other, and become smaller and less frequent as the distance from the crater increases.

In 1886 some shepherds encamped on the slopes of Coon Mountain found among the rock-fragments on the rim some lumps of iron, which they mistook, as is not infrequently the case, for native silver. The general distribution of the fragments and the nature of their material suggested to the shepherds that all the scattered masses, both stony and metallic, had been shot from the crater of the mountain. A few years later some of the metal fell into the hands of the late Dr. A. E. Foote, of Philadelphia, for whom it was analysed by Prof. G. A. Koenig, of that city. In structure and chemical composition the metal proved to be identical with ordinary meteoric iron, but of exceptional interest as enclosing microscopic diamonds. Since that time the celestial origin of the iron masses found about Coon Mountain has been recognised as beyond doubt, and the meteorite has become well known under the name of Cañon Diablo, small masses having been found in the cañon of that name distant about two and a half miles from the mountain. During the oral discussion which followed the reading of the paper of Dr. Foote on August 20, 1891, before the American Association for the Advancement of Science, Mr. Gilbert, who chanced to be present, suggested that the fall of the iron masses might have been connected with the formation of the crater, and that the large hole might have been caused by the penetration of the earth by an enormous iron meteorite, perhaps 1500 feet in diameter, large enough to be termed an asteroid. In such case the asteroid is buried in or near the hole and probably at no great depth.

Not being at that time at liberty to visit Coon Mountain himself, Mr. Gilbert asked his colleague, Mr. Willard D. Johnson, to examine the district and try to discover what had been the mode of origin of the crater. On his return Mr. Johnson reported that the crater had probably been produced by a tremendous steam explosion, the fragmental material around being the original contents of the hole. Within a radius of fifty miles there are hundreds of vents, from which lava has issued during the later geological periods, and thus there existed at one time a neighbouring mass of molten material sufficient to account for the production of the required amount of steam. In such case the fall of the masses of iron had been independent of the formation of the crater.

The rocks in the region containing the crater, however, are stratified and of sedimental origin, and the strata, except at the hole itself, are still quite horizontal. They are of late Carboniferous age, and consist, to a considerable depth, of coloured sandstones, one kind being so calcareous as to have claims to be regarded as a limestone. But all round the hole itself the strata have been bent, and are now directed upwards, approximately towards the same point.

This explanation and report being of an extraordinary character, Mr. Gilbert's interest in the problem became even greater than before, and he soon seized an opportunity of making an examination himself. This was done with such minuteness that he was able to draw contour lines of the crater and district for every ten feet of difference of level, and could form an approximate estimate as to the positions of the contour lines at the time the crater had been formed; hence he was able to calculate the respective volumes of the crater and the fragmental material. He came to the conclusion that the two volumes were virtually equal (eighty-two millions of cubic yards), and thus that no asteroid could have buried itself there. Further, he made a delicate magnetic survey of the district; no magnetic disturbance being discoverable, he concluded that no mass of iron large enough to have produced the crater could be lying within some miles of the earth's surface, whereupon he renounced the asteroidal hypothesis, and accepted the explanation which had been given by his colleague.

Some years later the crater and the speculations as to its origin became known to Mr. D. M. Barringer and Mr. B. C. Tilghman. They formed the opinion that the asteroidal hypothesis had been renounced by Mr. Gilbert on insufficient grounds. In the first place, according to their calculations, there is a great difference between the volume of the crater and that of the fragmental material; in the second place, the absence of magnetic disturbance may be due to the asteroid having been broken up into smaller masses, each of them polarised, and each having its magnetic axis in an accidental direction. So convinced were they that in 1903 they "located" the mountain under the United States Mineral Land Laws, and at great expense proceeded to sink shafts and make bore-holes with the hope of finding the buried asteroid. The results of this work, so far as it has yet gone, were recently recorded in two papers published in the Proceedings of the Academy of Natural Sciences of Philadelphia (December, 1905). One of them has been written from the point of view of the geologist (Mr. Barringer), the other from those of the physicist, chemist, and mathematician (Mr. Tilghman). The former says:—"They do not leave in my mind a scintilla of doubt that this mountain and its crater were produced by the impact of a huge meteorite or small asteroid"; the latter feels that "he is justified, under due reserve as to subsequently developed facts, in announcing that the formation at this locality is due to the impact of a meteor of enormous and unprecedented size."

It may be mentioned that a few years ago a successful search was made by Finnish geologists for a large meteorite which was believed by them to have buried itself within a certain area. But in that case the presumptive evidence was very strong. A meteor had lighted up a large extent of the country, and the next morning a newly made hole, with cracks radiating from it in various directions, had been found in the ice covering the Baltic Sea, near Bjurböle, in Finland. After a patient search the mass was at last located at a considerable depth below the sea-bottom, and eventually extracted. What are the prospects of a similar success at Coon Mountain?

For many miles round the crater the order of succession of the rocks, beginning at the surface, is as follows:—

(1) Red sandstone, 20 to 40 feet thick.
(2) Yellowish (calcareous) sandstone, 200 to 350 feet.
(3) Whitish sandstone, probably 400 to 500 feet.
(4) Yellow sandstone, thin layer.
(5) Reddish-brown sandstone, more than 1000 feet.

The uppermost stratum has been largely eroded, and remains only as widely separated flat-topped buttes scattered about the plain.

This upper stratum of red sandstone still existed at the place at the time when the crater was formed, for it is the material of the upper part of the rim. It has been raised 140–180 feet above its original position. The upper part of the interior of the crater consists of sandstone cliffs, the lower part of talus. The lower portion of the latter is covered with horizontally stratified sediments having a total thickness of 60–100 feet and a nearly level upper surface of circular outline and 1800 feet in diameter. The material must have settled in a shallow fresh-water lake once occupying the crater.

The fragmental material of the rim consists of the débris of the strata in which the crater has been formed, the blocks being piled one upon another in the utmost confusion. Further, there are many millions of tons of pulverised sand-grains, much of the material being an impalpable powder. It constitutes a great part, not only of the rim, which is three miles in length round the base, but also of the bottom of the crater, for it has been found by means of bore-holes to extend to a depth of more than 850 feet.

The masses of meteoric iron, being of pecuniary value as specimens, have been much sought for, and masses small and large, amounting altogether to about fifteen tons, have been found among the upper blocks on the rim, and on or near the surface of the surrounding plain in all directions from the crater; none have been found within the latter. Several masses weigh from 600 lb. to more than 1000 lb. Mr. Gilbert states that some of the iron has been found outside the range of the rock débris, one large mass being as much as eight miles distant from the crater. There have also been found lumps of oxide of iron, in great quantity and having a similar distribution to that of the metal. Mr. Gilbert (and also Dr. Foote) regarded them as also being of meteoric origin, and as perhaps having resulted from the weathering of a particular constituent of the meteorite, namely, the protosulphide of iron; but Mr. Barringer and Mr. Tilghman have found that they contain much nickel, and that many of them consist internally of magnetic oxide of iron, sometimes itself containing a nucleus of meteoric iron. Mr. Barringer, like Dr. Foote, suggests that the magnetic oxide resulted from the combustion of the iron when the meteorite was travelling through the air, but in the opinion of the present writer all the oxide, magnetic or not, is a result of weathering. There has been plenty of time for this action, for cedars now 700 years old are growing on the rim of the mountain. Further, the masses of iron found on the surface of the plain must have penetrated the earth to some depth at the time of the fall, and have been since exposed by denudation of the penetrated material. The authors roughly estimate the fall to have taken place not more than 5000 years ago, perhaps much less.

Though all the masses of iron found in the rim have been got from the surface, lumps of the meteoric oxide have been met with to a depth of 27 feet, and this is of interest because some of them were lying beneath big blocks of sandstone, through which, whether as metal or as oxide, they could not have passed. They must have taken up their present positions at the same time as the blocks themselves. To the present writer it seems probable that they had been buried, possibly a long time, in the upper layers of sandstone, and were ejected with the rock-fragments when the crater was formed, but Mr. Barringer explains them as fragments which had been broken from the asteroid during its passage through the air, had diverged from the path of the meteor, and had while still burning become entangled, and afterwards smothered, among the blocks of sandstone and minute débris projected into the air through the penetration of the earth by the main mass.

As for the enormous amount of pulverised silica, the authors hold that it cannot have been produced otherwise than by the action of an enormous projectile penetrating the sandstone. But it is difficult to see why the crushing of the grains could not have been produced by an enormous pressure of steam, such as must have preceded, according to Mr. Johnson, the formation of the crater. The following remark made by the late M. Daubrée was published by him in 1879, before Coon Mountain had been heard of, and is also suggestive ("Géologie Expérimentale," part ii., p. 645):—"In the deep and hot portions of the globe, for instance in volcanic reservoirs, water is present under enormous pressure. The pressure of that which forces lava up to the summit of Mt. Etna must certainly exceed 1000 atmospheres. It is therefore quite comparable with the tension developed in the chamber in which these experiments have been made. When water escapes to the surface by narrow fissures in such circumstances, it must bring different substances into a state of pulverisation simulating that of volatilisation."

Two other observations are relied on by the authors in their support of the asteroidal hypothesis. According to the first observation, obstacles at a great depth and probably of small size were found to interfere with the boring. They were inferred, chiefly from their hardness and from the difficulty of removal of a magnet let down to the bottom of the bore-hole, to be probably metallic iron, and to be parts of the broken asteroid. But the presence of some small masses of iron beneath the crater is to be expected if all the masses were lying embedded in the sandstone before the crater was formed. Those which were projected nearly vertically upwards must have fallen back into the large hole and be deep down among the débris. According to the second observation, a stratum at a considerable depth contains small particles of oxide of iron thought to be of meteoric origin. The same kind of material is said to occur on the surface of the surrounding country for several miles. The material in which these small particles of oxide are distributed in the crater must either be *in situ* or have fallen back into the hole: in the former case they cannot be of meteoric origin, for small particles would not have had the requisite penetrative power; in the latter case, it is probable that they were lying near the surface before the steam-explosion, and fell back with the fragmental material into the hole.

It is found as a matter of experience that meteorites on striking the ground have a comparatively small velocity—only a few hundreds of feet a second. Is it possible that an asteroid after passing through the earth's atmosphere could retain a velocity large enough for the production of such a crater? Applying a method devised by Schiaparelli and numerical data obtained from artillery experiments, the present writer has made some calculations as to the velocity of a meteoritic ball on reaching the ground, the ball being supposed to have a specific gravity seven times that of water, to have entered the earth's atmosphere at a speed of fifty miles a second, and to have travelled vertically. Neglecting the small additional velocity due to the action of gravity for the few seconds of flight, and the diminution of size of the ball during the flight, the numbers are as follows:—

Radius of ball in metres	Final velocity in metres
0·1	21
1·0	694
10·0	2590
100·0	8261
1000·0	25,461

According to Mr. Gilbert, it has been found in artillery experiments that a spherical projectile striking solid limestone with a velocity of 1800 feet a second will penetrate to a depth of something less than two diameters. It would appear, then, that a meteorite of large size would not be prevented by the earth's atmosphere from having a penetrative effect sufficient for the production of such a crater.

L. FLETCHER.

PROF. H. MARSHALL WARD, F.R.S.

It is long since the cause of British botany has sustained so severe a loss as that from which it is now suffering by the deaths, within a few days of each other, of Charles Baron Clarke and of Harry Marshall Ward. Though differing widely in most respects, in age, in pursuits, in circumstances, yet this they had in common, high distinction in their respective lines of work and a long record of devoted and unremitting toil. It is not for me to attempt an appreciation of Clarke—that will be done by more competent hands—but I cannot forbear this slight tribute of esteem and regard. Nor is it possible for me, within the limits of space and time at my disposal, to give an at all adequate account of Ward's life and work. I can only aim at recalling some of the memories of a personal association at one time most intimate, at no time entirely severed, and at merely indicating the scope and the value of his achievements.

My acquaintance with Ward dates from the year 1875. In the spring of that year I was assisting Sir William Thiselton-Dyer at the Royal College of Science, South Kensington, in the conduct of a course of instruction in botany, one of the earliest courses of practical study, in the modern sense, ever given in this country. We were both struck by the singular intelligence and enthusiasm of one of our pupils, who, we felt, ought to be secured for the service of botany. That pupil was Ward. At our suggestion he became a candidate, in the spring of 1876, for an open scholarship in natural science at Christ's College, Cambridge, where I was a lecturer, and, having obtained the scholarship, he came into residence in October of that year. His undergraduate career was marked by a further development of those characteristics that had so impressed Sir William Thiselton-Dyer and myself at South Kensington. Under considerable difficulties, the practical teaching of botany was being established in the University; but whatever the shortcomings of the instruction, they were amply compensated by the earnestness of the students, who, besides Ward, included Prof. Bower, F.R.S., of Glasgow; Dr. Hill, Master of Downing College; Prof. Hillhouse, of Birmingham; Dr. Walter Gardiner, F.R.S., and others. However, Ward did not confine himself to the study of botany, but availed himself to the full of the excellent opportunities for acquiring a sound knowledge of physiology under Sir Michael Foster, and of comparative anatomy under the late Prof. F. M. Balfour. A first-class in the natural sciences tripos of 1879 was a fitting close to his undergraduate days at Cambridge.

After taking his degree Ward went abroad for purposes of study, and worked for some time under the late Prof. Sachs at Würzburg; but the respite from botanical duty was not long. In 1880 he was called upon, as cryptogamic botanist to the Government of Ceylon, to go out and investigate the coffee-leaf disease then ravaging the island, a difficult task that he accomplished with considerable success. On his return, in 1882, he was elected Berkeley fellow at Owens College, Manchester, and became assistant to the late Prof. Williamson, F.R.S. Here he laboured for three years, and did much to promote the growth of the botanical school, leaving Manchester in 1885 to become professor of botany in the forestry department of the Royal Indian Engineering College, Coopers Hill. In the meantime (1883) he had been elected a fellow of his old college at Cambridge. For ten years he remained at Coopers Hill, throwing himself with his habitual energy into the life of the place, until in 1895 he succeeded the late Prof. C. C. Babington, F.R.S., as professor of botany in the University of Cambridge, becoming at the same time professorial fellow of Sidney Sussex College. In this larger and most congenial sphere he found full scope for the play of his activities in every direction. Supported by a highly competent staff, and with such colleagues as Mr. F. Darwin, F.R.S., reader in botany, Dr. Gardiner, F.R.S., and Mr. Seward, F.R.S., university lecturers, Ward soon succeeded, by his infectious enthusiasm, in giving a fresh impulse to the progress of his science at Cambridge. He himself always took charge of the large elementary class, and won therefrom many recruits for the ranks of botany by the attractiveness of his lectures; he gave besides one or more courses on advanced subjects during the year, generally, as might be expected, on some groups of fungi. His weak point as a teacher is eminently characteristic—it was that he generally attempted to cover a great deal more ground, to convey a great deal more information in his lectures, than was possible either physically or mentally. He educated many who have since done excellent botanical work, for he not only taught his pupils what was known, but also inspired them to attack the unknown. Under him the botanical school attained such importance that the University allotted a large portion of the benefaction fund to the erection of a new botanical institute, one of the best in the country, which, together with other university buildings, was formally opened by His Majesty the King in March, 1904.

So far I have spoken of Ward only as student and as teacher; I have yet to speak of him as investigator, his most important *rôle*. The bent towards original research was strong within him from the very first. His earliest papers date back to 1879 (Journ. Linn. Soc., vol. xvii.; Quart. Journ. Micr. Sci., vol. xx.), and relate to the embryo-sac, a subject that, owing to the brilliant discoveries of Prof. Strasburger and others, was at the time especially engaging the attention of botanists; but it was not until his visit to Ceylon that he entered upon what was to be his life-work, the investigation of the fungi and bacteria. The first fruits of his work there was a series of three elaborate reports on the coffee-leaf disease to the Colonial Secretary (1880–1), and a scientific paper on the fungus producing it (*Hemeleia vastatrix*), read before the Linnean Society on June 1, 1882 (Journ., vol. xix.); moreover, his experience in this case led him to form views on the physiology of parasitism that influenced all his subsequent work. However, when in Ceylon his attention was not so wholly absorbed by the coffee disease as to prevent him from making other observations, the results of which are embodied in a paper on the perithecium of Meliola, published in the Phil. Trans. of the Royal Society, 1883, and in another on a curious epiphyllous Lichen, *Strigula complanata*, that appeared in the Trans. Linn. Soc., vol. ii., 1884. After these, and two other papers on the Saprolegniæ and on Pythium in the Quart. Journ. Micr. Sci., vol. xxiii., 1883, there was for a time, owing to his transfer to Coopers Hill, a lull in the activity of publication, broken by the appearance in 1887 of two papers in the Phil. Trans., the one on *Entyloma Ranunculi*, the other on the tubercular swellings on the roots of *Vicia Faba*, of which the latter is of special interest. At this time the causation of these swellings and their relation to the nitrogenous nutrition of the plants bearing them was one of the leading problems of plant physiology. To the solution of this problem Ward's paper contributed the important facts that (1) the tubercles are undoubtedly of parasitic origin, and (2) that the parasite gains admission by the root-hairs, though he thought the parasite was a myceloid fungus, whereas it has since been proved to be a bacterium. The whole subject was admirably resumed by him in an article contained in vol. i. of the *Annals of Botany* (1887–8), of which periodical he was one of the founders. The same volume opens with a paper by him and Mr. T. Dunlop on the histology and physiology of the fruits and seeds of Rhamnus, perhaps one of the best of his researches, in which it is shown that the yellow pigment (rhamnin), obtained from the fruits for dyeing purposes, is formed by the decomposition of the glucoside (xanthorhamnin) contained in the pericarp by a ferment existing principally in the testa of the seed. In the second volume of the *Annals* (1888–9) there is an elaborate paper, "A Lily-disease," the chief point of interest being the discovery that the fungus (Botrytis) penetrates the cell-walls of the host by means of a ferment (since termed *cytase*) secreted at the tips of the hyphæ. Ward's views on parasitism were further developed in his paper "On some Relations between Host and Parasite in certain Epidemic Diseases of Plants" (Proc. Roy. Soc., vol. xlvii., 1890), which gained the honour of selection as the Croonian Lecture for that year. Passing over with mere mention the papers on Craterostigma (Trans. Linn. Soc., 1890) and on the Ginger-beer Plant (Phil. Trans., 1892), I come to his most laborious achievement, a series of reports on the bacteriology of the Thames, presented, in conjunction with Prof. Percy Frankland, F.R.S., to the Water Research Committee of the Royal Society in the years 1893–6. It is difficult to form any adequate conception of the unfailing assiduity necessary to the working out, as Ward did, of the life-histories of the no less than eighty different bacterial organisms that he found in the river, nor is it possible here to give an account of these voluminous documents, a *résumé* of which, so far as his share of the work is concerned, was given by him in the fifth report (Proc. Roy. Soc., vol. lxi., 1897). He had proved his fitness for this difficult task by his paper "On the Characters or Marks employed for Classifying the Schizomycetes" in the *Annals of Botany*, vol. vi., 1892, and the accomplishing of it gave rise to such interesting *parerga* as the papers "On the Action of Light on Bacteria" (Phil. Trans., 1895), "A Violet Bacillus from the Thames," and "Some Thames Bacteria" (*Ann. Bot.*, xii., 1898). The first of these papers is of considerable importance in that the bactericidal effect of light, whether of the sun or of the electric arc, is conclusively demonstrated, and is shown to be confined to the more highly refrangible rays of the spectrum.

Ward was a regular attendant at the meetings of the British Association for the Advancement of Science, and was president of the botanical section at the meeting in Toronto in 1897. His address on that occasion dealt with a subject that was always in his mind, the economic significance of the fungi, of which he gave a characteristically exhaustive account. In fact, all his subsequent work was the expression of this idea. Thus in 1898 (Phil. Trans.) he published an investigation of *Stereum hirsutum*, the fungus that attacks the wood of the oak, having succeeded, by means of pure cultures, in tracing its life-history from the spore to the fructification, and he did the same for *Onygena equina*, the horn-destroying fungus (Phil. Trans., 1899). He then entered upon what was destined to be his last line of research, the investigation of the Uredines or Rusts, with an energy that was remarkable even for him; but it was not until 1902 that the publication of the results began, so long and so numerous were the experiments from which they were drawn. The first paper on the subject was read before the Cambridge Philosophical Society in January, 1902 (Proc., vol. xi.), treating of the physiological races of these fungi, with special reference to the Brown Rust of the Brome-grasses. Having shown that certain species of Bromes can only be attacked successfully by certain forms or breeds of the Rust, he arrived at the striking conclusion that "the capacity for infection, or for resistance to infection, is independent of the anatomical structure of the leaf (of the Grass), and must depend upon some other internal factor or factors in the plant." Two papers published later on in the year (Proc. Roy. Soc., vols. lxix. and lxxi.) discuss the question, with an answer in the negative, as to whether or not susceptibility to infection depends upon the nutritive conditions offered by the host to the parasite, the foregoing conclusion being re-asserted thus:—"All the evidence points to the existence, in the cells of the fungus, of enzymes or toxins, or both, and in the cells of the host-plant of anti-toxins or similar substances, as the decisive factors in infection or immunity, although I have as yet failed to isolate any such bodies." In the meantime yet another paper had appeared in the *Annals of Botany* (vol. xvi., June, 1902) confirming his previously expressed conviction that differences in details of anatomical structure do not afford any explanation of the relations between the Bromes and their Rusts. His last paper on this subject is that dealing with the adaptive parasitism of the Brown Rust (*Annales Mycologici*, vol. i., 1903), in which he developed the interesting idea of the existence of what he termed "bridging species." The idea is briefly this, that although it is generally true that the adapted races of the parasitic fungus are restricted to groups of closely allied host-species, there do occur host-species which serve as intermediaries in the passage of the parasite from members of one section of the host-genus to those of another section.

Incidentally, a controversy arose between Ward and Prof. Eriksson, of Stockholm, with reference to the "mycoplasm-theory" of the latter. In order to account for the occurrence of sudden and widespread epidemics of Rust, Eriksson had assumed the persistence in a dormant state, within the tissues of the host-plants, of a combination of the protoplasm of the fungal hyphæ with that of the host, which he had described and figured and had called "mycoplasm." As stated in his paper on the question (Histology of *Uredo dispersa*, &c., Phil. Trans., Ser. B, vol. cxcvi., 1903), Ward was unable to confirm Eriksson's observations, and regarded his assumption as unnecessary. One of the most interesting discussions in Section K during the Cambridge meeting of the British Association, 1904, was that in which the *pros* and *cons* of this theory were urged by the two protagonists. Their views were subsequently published, side by side, in the *Annals of Botany* (vol. xix., January, 1905).

At this point the record of his work as an investigator abruptly ends, when great things might still have been anticipated, and it might well be deemed sufficient to have occupied all the time and energy at his disposal. However, this is far from being the case. Besides writing all these papers, many of them illustrated by elaborate drawings—for Ward was an excellent draughtsman—as well as others necessarily omitted here, he produced several books:—a translation of Sachs's "Physiology of Plants," 1884; "Timber and some of its Diseases," 1889; "The Oak," 1892; an edition of Laslett's "Timber and Timber-trees," 1894; "Diseases of Plants," 1889; "Grasses," 1901; "Disease in Plants," 1901; "Trees," a considerable work, of which several parts have appeared, and I understand that some MSS. remain to be published.

It is pleasant to reflect that so much good work was not allowed to pass unrecognised. In addition to the distinctions already mentioned, many others were conferred upon him. Ward became a Fellow of the Linnean Society in 1886, and was elected a Fellow of the Royal Society in 1888, receiving a Royal medal in 1893; he served on the council of the Linnean Society, 1887–9, and on that of the Royal Society, 1895–6. He was elected an honorary fellow of Christ's College, Cambridge, in 1897, and in 1902 received the degree of D.Sc. *honoris causa* from his first *Alma Mater*, the Victoria University, having previously taken the same degree at Cambridge. He was president of the British Mycological Society, 1900–2, and had received the honorary fellowship of the Manchester Literary and Philosophical Society and of other societies.

Beginning in 1854 at Hereford, his life is a story of unremitting and successful effort until its close at Torquay on Sunday, August 26, 1906. I remember Ward as a genial companion, a man of varied interests, delighting especially in music; but the dominant impression is that of his whole-hearted devotion to his science; all else counted with him as nothing in comparison with that. No doubt this led him to impose too severe a strain upon a constitution never very robust: but such as he was, it could not have been otherwise. He was laid to rest in the Huntingdon Road Cemetery, Cambridge, on September 3, attended by many friends and colleagues, amid tokens of regret from near and far.

S. H. VINES.

CHARLES BARON CLARKE, F.R.S.

THE death of Mr. Charles Baron Clarke on August 25, in his seventy-fourth year, deprives the botanical world of an able worker, and takes from a wider circle still a friend endeared for his breadth of sympathy and charm of manner.

Born at Andover in 1832, Clarke was educated at King's College School, London, and at Trinity and Queens' Colleges, Cambridge. He graduated in 1856, being bracketed third wrangler. Elected a fellow of Queens' in 1857, he was in 1858 called to the Bar at Lincoln's Inn, and appointed mathematical lecturer of his college. This position he held until 1865, when he joined the Bengal Educational Department.

While at Cambridge Clarke was one of a brilliant group holding advanced economic views, which included Henry Fawcett, Leslie Stephen, and John Rigby. His interest in political economy continued throughout his life, and found expression in occasional pamphlets on economic subjects, which he treated in a manner pleasing for its lucidity and freedom from political bias.

Before he left England, Clarke, as a recreation, was interested in field botany. On reaching India he printed at Calcutta, in 1866, a list of the plants of Andover, his birthplace. Clarke began his Indian career as a teacher in the Presidency College, Calcutta, but soon became an inspector of schools. His work as inspector involved touring within the circle allotted to him, and gave him facilities for botanical field work. Of these he made the utmost use, and supplemented them by vacation visits to districts outside his circle and provinces beyond Bengal. He made extensive collections, and at the same time found material for contributions to ethnology and geography. From 1869 until 1871 Clarke was in charge of the Royal Botanic Garden at Calcutta, with the use of a well-equipped herbarium at his command. The administrative work of these two years left little time for publication of results, but, on reverting to his own department, Clarke, while as ardent a collector as ever, found time to commence the issue of his valuable contributions to Eastern botany. His monographs of the Indian Cyrtandraceæ and Commelynaceæ were issued in 1874; that of the Indian Compositæ appeared in 1876. In the former year also, Clarke, at his own risk and cost, issued a new and cheap edition of Roxburgh's "Flora Indica," which had become almost unprocurable.

The extent and value of the field work done by Clarke during the first ten years of his Indian service may be best measured by the character of the collection presented by him to Kew in 1877. This included 25,000 numbers, representing some 5000 species. The fulness of the notes, often accompanied by useful analyses; the precise indication of localities and altitudes; the excellence of the specimens themselves, combine to render this contribution one of the most munificent additions ever made to the Indian material at Kew. It represents journeys in the Bengal plain, on the Chutia Nagpur plateau, in Chittagong, in the Khasia Hills, in Sikkim from the Terai to the snows, in the Punjab Himalaya, in Kashmir and thence to the Karakoram, in the Nilgiri Hills. No botanist since Griffith had seen more of India; none since Hooker had more fully examined the areas visited.

Early in 1879 Clarke was placed on special duty in England, and for four years was engaged at Kew assisting Sir Joseph Hooker in the preparation of the "Flora of British India"; for the second, third, and fourth volumes of this work he prepared the accounts of many important natural families. While in England Clarke also published, in 1880, a review of the "Ferns of Northern India." He returned to India early in 1883, and towards the close of 1884 he was appointed to act as Director of Public Instruction, Bengal. In 1885 his services were transferred from Bengal to Assam, a change of province which admitted of his further exploration of the Surma and Brahmaputra valleys and of the Khasia and Jaintia Hills, and enabled him to make a botanical journey in the Naga Hills and Manipur, new ground even for him, the results of which were published in the Journal of the Linnean Society.

In 1887 Clarke retired from the Indian Service and settled at Kew, so as to be near the herbarium there, in which he worked for nineteen years as a volunteer. Early in his Indian career he appears to have been particularly attracted to the study of the Cyperaceæ, and one of the objects of his life was the completion of a general monograph of this difficult family, with regard to which Clarke became the recognised authority to whom botanists in every country sent their collections for identification and description. His devotion to this group, accounts of which he prepared for the "Flora of British India," the "Flora Capensis," and the "Flora of Tropical Africa," was not, however, exclusive, for he elaborated several important families for both the African "Floras" and for the "Flora of the Malay Peninsula," and communicated numerous botanical papers to the Linnean and Royal Societies.

Clarke joined the Linnean Society in 1867, when his active botanical work in India first began. In the society's fortunes he took the keenest interest, being, while on special duty in England and again since his retirement, one of the most trusted councillors of the society, over which he presided from 1894 until 1896. He was elected a Fellow of the Royal Society in 1882, and served on the council in 1888–9. He was also a Fellow of the Geological and of the Geographical Societies.

NOTES.

THE jubilee of the coal-tar industry will be celebrated in America next month, and Sir William Perkin, F.R.S., the discoverer of "mauve," will leave England on September 22 for New York to receive a public tribute from Americans for the services he has rendered to chemical industry and science. At a public meeting held last May, the committee submitted the following programme:—(1) To invite Sir (then Dr.) W. H. Perkin to be present at the American celebration as the guest of the Americans, the date of the event to be October 6 (subject to the approval of Sir William Perkin), and to consist of a banquet and symposium on the coal-tar industry; (2) the presentation to Sir William Perkin of a personal token; (3) the foundation of a Perkin medal, to be awarded annually to an American chemist for distinguished work in applied chemistry; (4) the establishment of a nucleus of a fund at the Chemists' Club in New York City for a reference and circulating library covering the entire field of theoretical and applied chemistry, which is to be in charge of a salaried librarian, and to contain duplicate sets, one of them to be used for circulation among American chemists. A sum of at least 50,000 dollars was estimated as necessary to place the library on a permanent basis. It is also expected that a substantial contribution will be made to the international fund in London. The American committee includes the names of about 150 of the leading scientific and public men in the United States.

WE notice with deep regret the announcement that Prof. Ludwig Boltzmann, professor of theoretical physics in the University of Vienna, died by his own hand at Duino a few days ago.

ON October 1 Sir George Watt, C.I.E., reporter on economic products to the Indian Government, will deliver the opening address of the session at the School of Pharmacy of the Pharmaceutical Society of Great Britain, and the president of the society will present the Pereira medal.

A REUTER message from Tiflis reports that the township of Kwareli, covering an area of five kilometres in the district of Telaff (Caucasus), has been almost entirely destroyed by an avalanche of mud, sand, and stones from the neighbouring mountain-side. Disasters of this nature are of frequent occurrence in the Caucasian valleys.

A MEETING of the German Astronomical Society opened yesterday morning at Jena, and will continue in session until Saturday. In addition to scientific business, visits will be paid to the optical works of Zeiss and to Schott's glassworks. The meeting of the German Association of Naturalists and Physicians will open at Stuttgart on September 16, so that members of the Astronomical Society who propose to attend it will be able to leave Jena in time to do so.

THE Government of Cape Colony has placed a sum upon the Supplementary Estimates toward the expenses incurred in carrying out investigations upon defects in ostrich feathers, under the direction of Prof. J. E. Duerden, of Rhodes University College, Grahamstown. A letter upon the subject appeared in NATURE of May 17 (p. 55).

THE famous engineering firm of Friedrich Krupp, Ltd., of Essen, is contemplating the erection of a technico-physical laboratory at a probable cost of 2,500,000 marks.

PROF. MAX TOEPLER, the inventor of the mercury pump bearing his name, and professor of physics at the Technical High School, Dresden, celebrated his seventieth birthday on September 7.

THE Berlin municipal laboratories for the analysis of foodstuffs will be ready shortly. On the first floor will be the chemical and microscopical sections, in a hall on the ground floor there will be a collection room for tests and samples, while above the chemical and microscopical sections there will be rooms for bacteriology, electrolytic work, the hydrology bureau, and the library, with reading room. A special outbuilding will be used for animal examinations.

PROF. WILHELM HITTORF will shortly celebrate his golden "Universitäts-Jubiläum" in Münster. In 1848 he was a privatdocent at the then Münster Akademie; from 1852–6, extraordinary professor of physics and chemistry; and from 1856–1875, ordinary professor of both subjects, but since the latter date he has only retained the professorship of physics. His professorial colleagues are presenting him with a marble bust of himself, by Herr Rüller, of Münster. Prof. Hittorf has presented 25,000 marks to the science faculty for the purpose of furthering scientific work.

AN international congress for the study of the Polar regions was opened on September 7 at the Palais des Académies, Brussels, under the presidency of M. Beernaert, Ministre d'État. The *Times* correspondent states that among those present were Dr. Nordenskjöld, M. Arctowski, M. de Gerlache, Captain Scott, and Prince Buonaparte. Baron de Favereau, the Belgian Minister for Foreign Affairs, welcomed the delegates. A draft scheme for the formation of an international Polar commission was adopted on Tuesday. The primary aims of the commission are to bring about closer relations among Polar explorers, to coordinate scientific observations, and to assist Polar enterprise, without, however, organising expeditions on its own account. It was resolved to submit this scheme to the approval of the respective Governments. At the final meeting M. Charcot announced his intention of organising a fresh expedition to the South Pole, and Dr. Nordenskjöld expressed a hope that Belgians would cooperate with the French in this undertaking.

THE committee of the Quekett Microscopical Club has arranged for a series of demonstrations at 20 Hanover Square, W., on "The Practical Use of the Microscope and its Accessories," to be given from 7 p.m. to 8 p.m. on the third Friday in each month during the ensuing session. The first will be on November 16, when Mr. H. F. Angus will deal with axial substage illumination, including the use of the plane and concave mirrors, substage condensers, and methods of centring the illuminant and of obtaining critical illumination. At other demonstrations, the order of which is not yet finally settled, the following subjects, among others, will be considered:—substage non-axial illumination, including oblique and dark ground illumination; the use of the micropolariscope; various methods of illuminating opaque objects; the testing and comparison of objectives; and the employment of micrometers and finders. These demonstrations will be in addition to the "Gossip" meetings of the club, which are held on the first Friday, and to the ordinary meetings, held also on the third Friday of the month at 8 p.m. Further particulars may be obtained from the hon. sec., Mr. A. Earland, 31 Denmark Street, Watford, Herts.

IT is well known that during the last few years the study of protozoa has made remarkable advances. It has been shown that numerous protozoa play an important *rôle* in human and animal diseases, and the unravelling of their life-histories has been attempted by many workers with enthusiasm and success. Among these workers no one has done more than Fritz Schaudinn, whose premature death this summer has been lamented by the whole world of biologists. He not only made many discoveries of importance, he opened up new lines of investigation which are full of promise. His work has made it safe to prophesy that protozoology will surely develop into a department not less important than bacteriology. Doubtless influenced by his master, F. E. Schulze, Fritz Schaudinn began about ten years ago to study protozoa, and he soon attained the rank of a discoverer. His researches on multiple nuclear division, the central corpuscle of heliozoa, and the dimorphism of foraminifera (at the same time elucidated by Mr. J. J. Lister) were of much interest, but it was his working out (along with Siedlecki) of the life-history of Coccidia (1897) that first indicated his characteristic ability. During the last few years he published memoir after memoir on the life-histories of parasitic protozoa, such as Trypanosoma and Spirochæte, and made excursions into the field of bacteriology, *e.g.* in the discovery of the spirillum of syphilis. He founded the *Archiv für Protistenkunde*, now in its seventh volume, and he had time to indulge in some purely zoological work, *e.g.* the study of Tardigrada. He was cut off in June last in the midst of his labours, at the early age of thirty-five—an irreparable loss to science. Nor does the sadness end here, for Schaudinn has left a widow and young family very inadequately provided for. As he has left the world his debtor, it is to be hoped that success will attend a proposed international memorial, in which many prominent biologists and physicians in this country have already interested themselves. Subscriptions should be sent to the treasurer, Mr. Adam Sedgwick, F.R.S., New Museums, Cambridge.

The May issue of the Proceedings of the Academy of Natural Sciences of Philadelphia contains a paper by Mr. J. A. G. Rehn on non-saltatorial orthopterous insects (inclusive of Mantidæ and Phasmidæ) from British Guiana, in which several new species are named and described, and a second, by the same author, on five new species of Orthoptera from Tonkin.

The whole of the second part of vol. lxxxiv. of the *Zeitschrift für wissenschaftliche Zoologie* is taken up by a paper of 155 pages on the terminal nerve apparatus in the mouth-parts of birds, and the general mode of nerve termination in vertebrates as a whole. The author, Dr. E. Botezat, concludes that the terminations of peripheral nerves conform to a common fundamental plan, and have a definite structure of their own, which is unlike that of the nerve terminations of the higher sensory organs.

The habits and reactions of the American pond-snail *Lymnaeus elodes* (probably only a local phase of the European *L. palustris*) form the subject of No. 6 of Cold Spring Harbour Monographs, the author in this instance being Mr. H. E. Walter. Although the creature ordinarily breathes by coming at intervals to the surface and filling its lung-chamber with air, in exceptional circumstances it is able to breathe without rising to the surface at all, the lung-chamber being then filled with water. This secondary adaptation is, however, at once relinquished when the inducing circumstances disappear.

Science Bulletin No. 8 (vol. i.) of the Brooklyn Institute of Arts and Sciences contains notes on birds from Trinidad, by Mr. G. K. Cherrie; descriptions of various North American moths and their larvæ, by Mr. H. G. Dyar; and a list of geometrid moths from Utah, Texas, and Arizona, with descriptions of new species, by Mr. R. T. Pearsall. A number of star-fishes from the Pacific coast of North America are described as new by Mr. W. K. Fisher in vol. viii., pp. 111–139, of the Proceedings of the Washington Academy of Sciences. A detailed monograph, with illustrations, is promised later.

The contents of the September number of the *Entomologists' Monthly Magazine* include a continuation of the nomenclature of the Microlepidoptera by Lord Walsingham and Mr. J. H. Durrant, a further instalment of Dr. J. H. Wood's synopsis of the British flies of the genus Phora, and a paper by Mr. N. H. Joy on beetles infesting the nests of birds and mammals. Having taken the beetle *Cholera colonoides*, as well as other supposed rare species, in birds' nests last year, the author of the paper just mentioned came to the conclusion that if such "stations" were carefully searched the rarity of the beetles in question would prove a myth. Put to the test of experiment, the theory has turned out to be true, while the nests of the smaller mammals have proved an even more productive source of interesting Coleoptera.

The fourth part of vol. xxxv. of Gegenbaur's *Morphologisches Jahrbuch* opens with a eulogy of the founder delivered by Prof. C. Seffner at the unveiling at Heidelberg on May 12 of a bust of the great anatomist. A photograph of the bust accompanies this brief *résumé* of Carl Gegenbaur's life and work. A large part of the rest of the issue is occupied by a long and elaborate description and discussion, by Mr. H. Braus, of Heidelberg, on the fore-limb and operculum of the larva of the frog Bombinator. Attention is directed to a certain correlation between the fore-limb and the operculum, more especially with regard to the perforation in the latter. Dr. Charlotte Müller discusses the development of the human thoracic cavity, while Messrs. G. Kolossoff and E. Paukul formulate a mathematical theory to explain the papillary ridges and grooves on the palm and sole of the human hand and foot.

During last year's visit of the British Association to South Africa, Mr. C. F. Rousselet occupied himself, so far as circumstances would permit, with collecting the rotiferous animalcules of the country. Despite very unfavourable conditions for collecting, the result of his labours has been enormously to increase the South African list, especially if Natal (where more work on the group had been done than elsewhere) be excluded. Mr. Rousselet's paper on this fauna is published, with illustrations, in the August number of the Journal of the Royal Microscopical Society. At the conclusion of his paper the author comments on the extraordinarily wide geographical distribution of many of these minute organisms. "The best explanation is that the Rotifera, in addition to thin-shelled summer eggs which hatch at once, produce resting eggs with thick tough shells capable of withstanding any amount of desiccation, and which may be wafted up with the dust of dried-up pools, and carried very long distances by the wind and air-currents, and thus scattered over the whole surface of the earth, and then come to life and produce their kind."

An account in *Naturwissenschaftliche Wochenschrift* (July 8) of the Sigillarieæ, by Dr. W. Koehne, indicates how the impressions or casts, known as *incrustations*, of these fossil Lycopods are produced, and contrasts them with petrifactions in which cell structure is preserved.

For several years the application of electricity to agriculture has been increasing in Germany, where the owners of large farms have been brought to see the advantages of this system. Some of the large electrical manufacturing firms have entered actively into the development and supply of machinery in this new field, and some striking illustrations are given by Mr. Franz Koester in the *Engineering Magazine* (vol. xxxi., No. 5) showing views taken on farms where electricity is used exclusively for motive power.

In the *Revue de Métallurgie* (vol. iii., No. 2), issued as a supplement to the *Bulletin de la Société d'Encouragement*, Mr. Guillery describes a new method of determining the elastic limit of metals by recording the variations in the electric resistance of the test-piece as the load in the testing machine is increased. The method is not yet fully developed, but the results of a number of tests made by the author at Denain, and the simplicity of the apparatus used, render it worthy of careful consideration.

In the case of an engine using saturated steam, the PV diagram can be converted into the $\theta\phi$ equivalent either by a somewhat tedious calculative method or by Boulvin's graphic method. The latter necessitates the preliminary re-plotting of the diagrams to the pressure and volume scales before the graphic transference can be carried out. A modification of this method has been devised by Mr. W. J. Goudie, and is described in the *Engineering Review* (vol. xv., No. 2). A direct transference from the actual indicator diagrams is effected, and the saving in time and labour should render the method useful to engineers who make frequent use of the temperature-entropy chart.

The September issue of the new bi-monthly journal *Concrete* contains admirably illustrated articles on the micro-structure of Portland cement by Dr. C. H. Desch, and on reinforced concrete at the Milan Exhibition by Mr. F. R. Farrow. This new addition to technical periodical literature should prove a valuable source of information to all workers in concrete and cement. The details of the new uses to which concrete and reinforced concrete are put are very remarkable. The use of reinforced concrete as a substitute for timber in exposed positions is rapidly increasing. Railway sleepers, telegraph posts, and fence posts are being tried, and efforts are being made to prove that reinforced concrete is an excellent substitute for brickwork where structures of great height are required.

We have received from the Geological Survey of Canada three reports of special economic interest. The report (No. 923) on the Chibougamau mining region in the northern part of the province of Quebec, by Mr. A. P. Low, records the discovery of an area of serpentine rocks containing asbestos of excellent quality, together with the finding of a large vein of gold-bearing quartz and numerous indications of copper ores. Mr. R. W. Brock submits a preliminary report (No. 939) on the Rossland mining district, British Columbia. A more complete report is in preparation. Mr. C. W. Willimott's monograph on the mineral pigments of Canada (No. 913) contains the results of an elaborate series of experiments with the various pigments that can be derived from minerals, ochres, and clays either in their crude state or by burning. They show that in almost every colour a paint of good body and permanent tone may be produced from Canadian material.

An account of Sinhalese earthenware is given by Mr. A. K. Coomaraswamy in vol. iv., part xiii., of *Spolia Zeylanica*. Elaborate types are not found, and no glaze is used; the sides of the pots are made on the wheel, which is turned by a boy; some hours or days later, putting a smooth stone inside, the potter fashions the lower part of the sides so as to form the bottom—a most unusual procedure. In addition to domestic and ritual pottery, the author deals with roof-tiles, some of which, for use on the eaves, are decorated. Earthen vessels are also decorated with incised, stamped, or slip-painted designs, and the most effective of these styles is stamping, though some of the incised designs produce a very Greek-like effect. The paper is illustrated by three collotypes and numerous blocks in the text.

The summary of the weather for the week ended September 8, issued by the Meteorological Office, shows that the highest shade temperature in the recent hot spell was 96°, at Bawtry, in the Midland counties, registered on September 2. The rains which occurred with the change to cooler weather were very heavy in places, although by no means general. In parts of London the fall on the night of September 4–5 amounted to an inch, and to 1·68 inches at Ventnor; while at Glencarron the measurement on September 5 was 1·98 inches, and at Fort William 1·87 inches. In most parts of England the weather has been exceptionally dry for nearly three weeks. At Spurn Head and Bath no rain has fallen since August 24, and at Shields none has fallen since August 26, while at many places, widely separated, the measurement since about August 25 amounts only to a few hundredths of an inch. The general type of weather which has characterised the summer is still continuing. Bright sunshine is unusually prevalent, with very dry conditions, but the temperature has fallen, although the days at present are still mostly warm. At Greenwich, the exposed thermometer on the grass registered 28° on the morning of September 11, and the ground in the suburbs of London was coated with hoar-frost.

We have received from the meteorological reporter to the Government of India a memorandum on the weather conditions during June and July, with an estimate of the monsoon rainfall during August and September, 1906. It is stated that the total rainfall of June and July was distributed with about the usual uniformity over the greater part of India; the only areas of large defect were Sind (52 per cent.), the Punjab (27 per cent.), and Bengal (21 per cent.). In both these months there was, on the average of the whole country, a defect of 3 per cent. in the rainfall. In forming a forecast for August and September, the conditions in various parts of the world are stated; of these, the most powerful factor is thought to be the pressure in the southern Indian Ocean. An illustration of this is given by a table containing all years since 1875 in which pressure at Mauritius in July differed from the normal by more than 0·024 inch, together with the rainfall of Bombay and bay currents in the ensuing August and September; it shows that there is a marked tendency for high pressure to be followed by deficient rainfall, and *vice versâ*. At Mauritius, pressure this year was below the normal in June by 0·045 inch, and in July by 0·020 inch, a fact which is, therefore, decidedly favourable; but so many factors come into play, *e.g.* temperature, the distribution of snowfall in the mountain regions north and west of India, and probably pressure over South America, that Dr. Walker is unable to say more than that there appears, on the whole, to be no reason for anticipating either a large excess or a large defect in the rainfall of August or September.

The Royal Society of Canada, which was founded by the Duke of Argyll in 1881, celebrated its semi-jubilee this summer. The president, Prof. Alexander Johnson, in his address at the annual meeting, described the conditions which led to the society's inception and the development of its activities. A large portion of the address was appropriately devoted to considering the different conceptions which have been held with regard to matter, culminating in the theory of atomic disintegration, which had its birth in Montreal in 1902.

AT the end of an interesting and instructive paper in a recent number of the *Chemiker Zeitung* (No. 61, p. 742) on the chemical composition of the eruptive products of volcanic actions, and more especially that of Vesuvius in April of this year, Prof. Julius Stoklasa, of Prague, directs attention to the meagre primitive equipment of the Royal Seismological Observatory situated in the immediate neighbourhood of Vesuvius, where on April 3 Prof. Matteucci observed the first subterranean signs of this year's eruption, and which Prof. Stoklasa visited in May last. In this article Prof. Stoklasa throws out the suggestion that the observatory should be re-modelled and made an international experimental station with geophysical and chemical laboratories, similar, in fact, to the International Biological Station at Naples, which is being provided with extensions to its physiological and chemical laboratories for the purpose of more thoroughly investigating marine fauna and flora.

IN 1903, from the occurrence of a number of lines common to the spectra of krypton and xenon, Dr. Baly inferred the existence of a new element present as an impurity in those gases. From a study of the spectra of different fractions of the most easily condensable portion of the inert gases of the atmosphere, Dr. Rudolf Schmidt now concludes in the *Verhandlungen* of the German Physical Society (vol. viii., No. 14) that xenon is not a true element, but a mixture, possibly of several gases. The ultra-violet spectrum between $\lambda=3450$ and $\lambda=2800$ of one fraction of the gas was found to contain only about forty lines, the greater part corresponding with those ascribed to xenon; several, however, were new. Within the same range Baly measured about 500 lines, and the difference in the two numbers might at first sight appear to be due to insufficient illumination in the one case. This view is contradicted, however, by the fact that some of the lines which appeared feeblest in Baly's spectra showed the greatest intensity in the case of this particular fraction, whilst all the brightest lines of "xenon" were missing. The only explanation appears to be that the gas hitherto called xenon is a more or less complex mixture.

THE Country Press, 19 Ball Street, Kensington, W., has added to its series of nature-study picture postcards twelve cards, which may be obtained for one shilling, depicting twenty-three species of British grasses. The popular and botanical names are given in each case, together with the time of flowering and a magnified representation of the fructification.

THE Nagari-pracharina Sabha, of Benares, has published a "Hindi Scientific Glossary," containing the terms employed in most of the sciences, except biology and geology. The glossary has been edited by Mr. Syam Sundar Das, honorary secretary of the Nagari-pracharina Sabha, with the cooperation and assistance of an editorial committee. The glossary is divided into seven parts, dealing respectively with terms of geography, astronomy, political economy, chemistry, mathematics, physics, and philosophy. Preference has been given to common and current Hindi terms. In the absence of appropriate Hindi equivalents, certain appropriate terms existing in some of the prevalent vernaculars have been used. When these have failed, the existing Sanskrit terms have been taken or the English terms employed.

OUR ASTRONOMICAL COLUMN.

HOLMES'S COMET (1906*f*).—According to Prof. Wolf's telegram announcing its re-discovery, as published in No. 4118 of the *Astronomische Nachrichten*, the photographic magnitude of Holmes's comet on August 28 was 15·5. As the comet passed through perihelion on about March 14 it is not likely to become a brilliant object during the present apparition. The corrections to Dr. Zwiers's ephemeris are −6s. and −2′.

FINLAY'S COMET (1906*d*).—A continuation from M. L. Schulhof's ephemeris for Finlay's comet is given below:

1906	α (app.) h. m.	δ (app.) ° ′	1906	α (app.) h. m.	δ (app.)
Sept. 15	6 40	+19 19	Sept. 23	7 7	+20 3
17	6 47	+19 33	25	7 13	+20 11
19	6 54	+19 44	27	7 19	+20 17
21	7 1	+19 54	29	7 24	+20 22

The comet will pass about 1° south of ζ Geminorum on September 20, and about 2° south of δ Geminorum on September 25.

COMET 1906*e* (KOPFF).—A further extract from Herr M. Ebell's ephemeris for Kopff's comet (1906*e*) is given below:—

Ephemeris (12*h. M.T. Berlin*).

1906	α (true) h. m.	δ (true) ° ′	Brightness
Sept. 16	22 33	+8 28	0·54
18	22 32	+8 16	
20	22 31	+8 4	0·48
22	22 31	+7 52	
24	22 30	+7 40	0·43
26	22 29	+7 28	
28	22 29	+7 16	0·38

Herr Ebell calculated two sets of elements, obtaining October 16, 1905, and May 14, 1906, as the respective times of perihelion passage, but, as seen from the residuals (observed-calculated), there is considerable uncertainty attaching to the calculated path.

Two other sets of elements, communicated by Prof. E. C. Pickering, give April 12, 1907, and December 7, 1906, respectively, as the time of perihelion, and the resultant ephemerides show the comet's brightness to be increasing at the present time. Observing at Hamburg on August 23, Dr. Graff found that the comet had a coma of 0′·5 diameter, with a nucleus of magnitude 12·5, the magnitude of the whole being 11·5 (*Astronomische Nachrichten*, No. 4118).

THE PLANET MERCURY.—Continuing his articles in the *Observatory* (No. 374) on planets and planetary observations, Mr. Denning this month discusses the best times and methods of observing Mercury. Dealing with the legendary lament of Copernicus that he had never seen this planet, Mr. Denning expresses his doubts as to its authenticity. The late Rev. S. J. Johnson saw Mercury as an evening star about 150 times during the years 1858–1905, whilst Mr. Denning has seen it some 130 times since February, 1868, and suggests that, if looked for regularly, this elusive object may probably be seen on about fifteen occasions per annum in the English climate. In the spring, Mercury should be looked for some days *before* the maximum elongation, but in the autumn apparitions some days *after* the elongation. After discussing the observing conditions, Mr. Denning proceeds to describe the surface markings as seen—with great difficulty—on the telescopic image of Mercury since the time of Schröter.

OBSERVATIONS OF SATELLITES.—Prof. Barnard observed the sixth satellite of Jupiter nine times, on February 27 and March 20, during last winter, and found it quite an easy object, under fair weather conditions, with the 40-inch refractor of the Yerkes Observatory.

On February 27 the magnitude was 14·0, and on March 20, when Jupiter was lower down at the time of observation, it was estimated as 14·5. The positions determined from these observations are recorded in No. 4112 of the *Astronomische Nachrichten*.

In No. 4116 of the same journal the same observer gives the results of his observations of Phœbe, the ninth satellite of Saturn, made with the 40-inch on July 24 and 29. The satellite was about 1m. in R.A. and 6′ in declination from the planet, and had a magnitude of 16·5; at times it appeared hazy. The observations give the following corrections, taken (observed-calculated), to Dr. Ross's ephemeris:—

	m. s.	′ ″
July 24	−0 0·93	+0 3·5
29	0 0·87	+0 2·9

ENGINEERING AT THE BRITISH ASSOCIATION.

In his presidential address to the section, Dr. Ewing dealt with certain aspects of the inner structure of metals and the manner in which they yield under strain, and he made a notable departure from the usual custom of such addresses by illustrating his speculations by experiments and by models in order to demonstrate his ideas as to the processes of crystal building.

After the presidential address a paper was read by Major W. E. Edwards, R.A., on modern armour and its attack. The author first gave a very complete and useful history of the application of armour to ships and forts, and then explained in detail the elaborate and costly processes through which the material passes, from the casting of the steel ingot to the completion of the plate. The second part of the paper dealt with the attack of armour and the various ways in which a plate may yield, and the influence of the cap in reducing the resisting power of hard-faced plates. In the discussion Sir William White expressed the opinion that British armour-plate makers had introduced many of the more important improvements in the resisting power of armour-plates, and that eventually the 6-inch gun would be chiefly used for defence against torpedo craft.

The first paper on Friday, August 3, was on the removal of dust and smoke from chimney gases, by Messrs. S. H. Davies and F. G. Fryer. The paper dealt with an ingenious plant the authors have designed and fitted up at the cocoa works of Messrs. Rowntree and Co. for thoroughly washing the smoke, and for removing from it the whole of the grit and dust and practically all the sulphur acids. Members of the section had an opportunity later on of seeing this plant in operation; it certainly thoroughly effects the purposes for which it was installed, and it might certainly be adopted with advantage in many factories where a cheap and plentiful supply of water is available.

In the next paper, on standardisation in British engineering practice, Sir John Wolfe-Barry gave an account of the admirable work which has been carried out by the Engineering Standards Committee since its first institution in 1901 at the instance of Sir John Wolfe-Barry himself. There are now thirty-six subcommittees with 260 members dealing with some thirty different branches of the work. The work of the committee has been invaluable both to manufacturers and to engineers, and the publications of the committee are indispensable to all engineers.

Dr. Ewing has during recent years done much valuable research work on the crystalline structure of metals, both in a strained and in an unstrained state, and it was only natural that there should be several papers on this important branch of the subject of the strength of materials. Mr. W. Rosenhain dealt with the deformation and fracture of iron and steel, and his paper was illustrated by a number of beautiful lantern slides. The author of this paper has done such admirable work in the microscopic study of the crystalline structure of metals that everything he has to say on this subject is sure to be of value. In his latest researches he has by a most ingenious method been able to study the crystalline structure of the actual fracture itself in broken test-pieces. The second paper on this subject of the crystalline structure of metals was by Mr. J. E. Stead, and dealt with segregation in steel ingots and its effect in modifying the mechanical properties of steel. To all those concerned either with the manufacture or with the employment of steel in industrial operations this paper was most valuable, for the author had brought together a large amount of information previously scattered in the pages of various publications. The microscopic study of the crystalline structure of different portions of steel ingots is rapidly changing the views of engineers in regard to many important problems in connection with the life of steel rails, and there is no question that the microscope now plays as important a part in the laboratory of the metallurgist as in that of the biologist.

Dr. H. C. H. Carpenter next read his paper on structural changes in nickel wire at high temperatures; this research, carried out at the National Physical Laboratory, was intended to throw light on the fact that fundamental changes occur in the mechanical properties of nickel wire used as the heating coil of an electrically-heated porcelain tube-furnace. Here again the microscope was the chief instrument in the research, and the study of the crystalline structure of the wires showed, the author suggested, that wire intended for electrical heating should be as free from gases as possible. A paper by Mr. W. Taylor describing a magnetic indicator of temperature for hardening steel concluded the day's proceedings.

On Saturday, August 4, the section paid a visit of inspection to the Roundhills Reservoir of the Harrogate Corporation. The dam, a masonry one, will, when completed, be 125 feet in height above the river bed, and members of the section were fortunate enough to see the work when the more difficult operations of such an undertaking were just in their most interesting condition.

On Monday, August 6, the first paper read was by Prof. Hudson Beare, on the new engineering laboratories of the University of Edinburgh and their equipment; the author pointed out that he had made special provision in these new laboratories for experimental work of an advanced character on the strength of materials and on hydraulics. At the conclusion of the discussion of this paper Sir W. H. Preece read a communication on glow lamps up to date, and the grading of voltages, in which he strongly advocated that steps should be taken to secure uniformity of practice in regard to regulation of voltage in connection with the distribution of electrical energy, and also in regard to the grading of carbon filament glow lamps; in the latter part of the paper data were given to show how poor in quality were many of the lamps on the English market. In the discussion on this paper Colonel Crompton directed attention to the fact that only a comparatively small proportion of lamps was used in private houses in America, while in this country the proportion was large; he also pointed out that the demand for electric current for power and for heating was now becoming a very important factor in the working of central stations.

In a paper on the advent of single-phase electric traction, Mr. C. F. Jenkin directed attention to the rapid advance of electric traction on railways, and pointed out its advantages. He pointed out that the real advantage of electrification was that it would make the line pay better. Mr. Jenkin then dealt with the two alternative systems—alternating current transmission, continuous current distribution with low-tension third rail, and alternating current transmission with high-tension trolley wire; he was of opinion that the latter method had very great advantages, and he advocated also single-phase instead of three-phase currents.

The business of the section for this day concluded with a paper by Mr. A. J. Martin on a general supply of gas for light, heat, and power production. Mr. Martin pointed out that the main obstacle to the general use of gas for purposes other than lighting was its cost, and that the chief causes of this high cost were the standards of illuminating value to which gas has to conform and the high prices paid for coal. At the present day both natural gas and coal gas have been piped in America to great distances (in the case of natural gas to 200 miles) with success, and Mr. Martin was of opinion that it would be perfectly feasible to generate gas cheaply at large works in the centre of our coalfields, and then to convey it under pressure to all our large cities for manufacturing and heating purposes.

In the course of the afternoon many members of the section took part in an excursion to Middlesbrough to visit the works of the Cargo Fleet Iron Co., Ltd. The whole of the plant at these works has been recently remodelled and fitted with the latest labour-saving devices and plant for recovery of by-products; the Talbot continuous steel process, which was introduced to the notice of English metallurgists only in 1900, has been adopted, and at the Cargo Fleet Works each of the three furnaces holds about 175 tons of molten steel.

On Tuesday, August 7, the section began its proceedings with a paper by Prof. W. E. Dalby on experiments illustrating the balancing of engines. The beautiful working models which Prof. Dalby has designed to illustrate the principles which underlie the problem of balancing various types of engines were shown in operation, and, as the president remarked during the discussion, it was a pity that the London County Council had not made use of the author's services in this field of engineering research before it began the design of a large generating station not half a mile away from Greenwich Observatory.

Mr. G. Stoney then read a paper on recent advances in steam turbines, land and marine. The figures given by the author showed how wonderful had been the advance since Mr. C. A. Parsons built his first turbo-dynamo of about 10 h.p. in 1884; at the present time 6000 kw. generators are in course of construction, while turbines of 10,000 kw. are proposed for the great power scheme to supply electric energy in bulk for London. The use of large turbine blowing engines in metallurgical work has also rapidly developed during the past three or four years, while for marine purposes the total horse-power of turbines, either completed or on order, now approaches 1,000,000. Mr. Stoney also described the "vacuum augmenter," a device for increasing the vacuum in the condenser without increasing unduly the volume of the circulating water by the use of a steam jet placed in a contracted pipe between the condenser and the air pump, which compresses the air and vapour from the condenser and delivers it to the air pump through a small auxiliary condenser.

The next paper was by Mr. J. Smith, on an application of stream-line apparatus to the determination of the direction and approximate magnitude of the principal stresses in certain portions of the structure of ships; this valuable paper was, the president stated, one of the first fruits of the laboratory of the Royal Naval College at Greenwich. The author showed that a strain diagram of the deck of a ship very closely approximated to the stream-line shown by Prof. Hele-Shaw's well-known apparatus, in which a very thin film of water is compelled to flow between two sheets of glass.

In the afternoon the section had a joint meeting with the physical and educational sections, and a discussion on the teaching of mechanics was opened by a paper by Mr. C. E. Ashford, headmaster of the Royal Naval College, Dartmouth. In his paper Mr. Ashford pointed out that there was a serious danger that school science might become as academic as classics, and he directed attention to the absolute necessity of employing for laboratory experimental work, not toys, but apparatus such as screw-jacks, Weston's blocks, &c., and also to the great need of experiments for showing the phenomena of kinetics; several new pieces of apparatus designed for this purpose by the staff at the college were described and illustrated.

Wednesday, August 8, the last day of the meeting, was an unusually busy one for the section; no fewer than six papers were dealt with. Prof. Ashcroft described, and showed in operation, the Central Technical College lecture table testing machine, an exceedingly ingenious and beautiful piece of apparatus; Prof. Ashcroft has adopted, with, however, considerable simplifications, the plan first devised by Prof. Kennedy, of using a "spring bar" to measure the loads upon the specimen under test, and to give one of the two necessary motions to the recording apparatus, thus overcoming the difficulties unavoidable when an attempt is made to keep the steelyard of the testing machine floating during the final drawing-down stage prior to fracture.

The next paper was one by Prof. J. B. Henderson, on recent advances in our knowledge of radiation phenomena and their bearing on the optical measurement of temperature. After discussing the four laws of radiation from an ideal black body, the author dealt with pyrometers based on these laws, such as Féry's, and the optical thermometer of Holborn and Kurlbaum.

Mr. S. Cowper Coles read a paper on electropositive coatings for the protection of iron and steel from corrosion, and showed a number of beautiful examples of electro-deposition. In the discussion Colonel Crompton stated that the processes invented by the author had solved a very difficult problem in connection with the piston rods of steam engines using very high-pressure steam, for it was now possible to give these rods a very hard, incorrodible surface without any sacrifice of strength.

In a paper on suction-gas plants, Prof. Dalby dealt with the principles underlying the design of such plants, and then described a number of plants which were entered for the recent trials in connection with the Royal Agricultural Society's show at Derby, and the methods of starting such plants. In reply to the discussion, Prof. Dalby stated that a 15 h.p. engine would use about 0·7 lb. anthracite coal per B.H.P. during running, or, if allowance is made for lighting up and standing by, about 1·0 lb. per B.H.P. hour.

Mr. W. A. Scoble, in a paper on the strength and behaviour of ductile materials under combined stress, described the results of a series of tests of steel bars with a distribution similar to that which occurs most frequently in practice, as obtained under combined bending and twisting; the experiments showed conclusively that the maximum principal stress and the maximum shear both varied through a wide range, the point used as a criterion of strength being the yield point.

The section concluded its business with the reading of a paper by Mr. D. Mackenzie, on waterproof roads as a solution of the dust problem. The various processes at present in use were described and their deficiencies pointed out. Tar alone was most unsatisfactory; at the end of twelve months it had entirely disappeared; the best material, he considered, was "tarmac," made from blast-furnace slag broken when hot and immediately immersed in hot tar; only forge pig slag should be used for this purpose.

It was a great pleasure to see the section so well attended, especially when it is remembered that the early days of the meeting clashed with the summer meeting of the Institution of Mechanical Engineers. No doubt much of the increased interest shown in the work of the section was due to the personal popularity of its distinguished president.

T. H. B.

EDUCATION AT THE BRITISH ASSOCIATION.

AMONG the "growing points" mentioned by Prof. M. E. Sadler in his address were the keenness of intelligent workmen to make the elementary schools better, the demand by adult workers for an education touched by imagination, humanity, and civic idealism, the encouragement of education by employers of labour, educational experiments carefully planned and systematically watched (*e.g.* in practical courses of study and corporal training in higher elementary schools for ages twelve to fifteen, and in the actual results of postponing the beginning of Latin until twelve years of age), and the need for continuation schools to check the drift into the physical and intellectual disorder of the unemployed. A full report of Prof. Sadler's address appears in the *School World* for September.

The list of schools and other institutions to which visits had been arranged included the Yorkshire School for the Blind, the classes in domestic economy for employees at Messrs. Rowntree's Cocoa Works, the British Botanical Association, with its extensive arrangements for the supply of botanical material, and two hospitals for the insane, the latter typifying the help which the schools may expect to receive from all contributions to mental science.

Health at School and *Physical Education* are topics which seem amenable to scientific treatment, and as such were very properly placed in the forefront of the programme. Sir Edward Brabrook presented the report on the conditions of health essential to the carrying on of the work of instruction in schools. This report deals with hearing, teeth, playtime, and leisure. Some standard method of testing the hearing of children is desirable. Reports from other countries show that 12 per cent. to 20 per cent. of school children may be defective in their hearing. An examination of the teeth of 10,500 English and Scotch boys and girls of an average age of twelve years in poor law schools, workhouses, and reformatories showed only 14 per cent. of these children with teeth free from decay. The children in our public elementary schools are in a much more neglected state than the poor-law children. The committee thinks that daily cleansing of teeth should be enforced by parents and teachers, and that dentists employed by school authorities should make systematic examination of teeth.

Sir Lauder Brunton spoke on physical education, and showed that mind development was brain development. The teaching of hygiene might begin with the washing and dressing of dolls. He urged the medical inspection of schools, and brought to the notice of the section the National League of Physical Education and Improvement. His lecture was supported by a most welcome and generous distribution of pamphlets sent by that league, and his display of lantern-slides in the adjacent room when the botanists adjourned for lunch allowed of the presentation of evidence to a section which does not always find it easy to get at the facts which underlie opinions.

Dr. Ethel Williams gave careful estimates of the time, cost, and usefulness of medical inspection. In Newcastle, with 45,000 children on the books, three officers could inspect each child thrice in its school life at a cost of about 2000*l.* per annum, equivalent to a farthing rate. For the whole country 200,000*l.* would give similar inspection of children, with supervision of epidemics and of school buildings. Prof. Sadler pointed to the crux of the difficulty in getting parents to act on medical officers' reports, and Mr. Ernest Gray spoke of the attitude of suspicion in the working classes. Major Salmon spoke of the Swedish system of gymnastics as developed in Denmark. To keep the air clean for breathing exercises a damp felt or sacking is passed over the floors before every lesson.

Mr. A. Burrell said that freedom to move in one's clothes and a sense of cleanliness were the bases of true hygiene. The rightly dressed, clean child, and the well-ventilated class-room were the best lessons. Organised games had been approved, but playing centres had not yet been provided. A medico-ethical training was necessary for the teacher who was to stand hour by hour before weak sight, incipient deafness, and malnutrition. There should be a standard of health in training colleges analogous to that demanded by the Army and Navy.

Mrs. J. R. Macdonald showed how all schemes for the education of wage-earners of school age were bound up with social and economic questions. She urged a better enforcement of the Employment of Children Act, 1903. Mr. Hugh O. Meredith described the Workers' Educational Association—an effort to organise the higher education of working men by means of collegiate life in local guilds associated with the University Extension movement. Mr. Arnold S. Rowntree explained how similar ends were achieved by the adult schools meeting on Sunday mornings.

The discussion in Section I on the physiological value of rest might almost have been called a joint meeting, considering its interest for those attending Section L. Dr. Acland found that sleep was necessary for the growth of the brain and nervous system, and that many schools had not secured sufficient sleep either for younger boys or for those older boys who needed it. Mental and bodily health cannot be severed, and muscular exertion is not a remedy for brain fatigue. Dr. Bevan Lewis correlated brain-fag with muscular fatigue. The minimum of sleep for growing children was not defined, but no one advocated less than nine hours. Laboratory investigation into the general laws of fatigue is needed in the opinion of Dr. W. H. R. Rivers. Dr. Macdougall suggested that early morning sunlight should be shut out of a child's room.

Sir Philip Magnus presented the report upon the course of *Experimental, Observational, and Practical Studies most Suitable for Elementary Schools.* The committee asks that active and constructive work on the part of children should be largely substituted for ordinary class-teaching. To make this possible, smaller classes, trained teachers, and sympathetic inspectors are necessary. Supplementary reports of subcommittees were presented by Prof. R. A. Gregory on arithmetic and mensuration, by Mr. R. H. Adie on nature-study, and by Mr. George Fletcher on domestic work. There was an eager and universal request for copies of the full text of these reports, and the printed supply proved very unequal to the demand. The committee of the section proposed to arrange for further reprints. Prof. Green said that primary teachers needed training to use the freedom now given them, and needed also the opportunity of a higher professional course at the universities for those desirous of promotion. Mr. Cyril Jackson admitted the difficulties of large classes, Mr. T. P. Sykes emphasised the need for freedom to experiment, and Dr. Traill the importance of training teachers before trying to rush reforms through the schools.

In the discussion on *School Training for the Home Duties of Women*, Prof. A. Smithells said that at present home training reveals the methods of superstition, ignorance, prejudice, and folly. Nor does a formal course on the oxides of nitrogen and chlorides of phosphorus always produce a scientific attitude of mind in a household where ovens will not heat and meat will not keep. A school-mistress with a scientific degree may fail to understand the hot-water system, the gas meter, or the filter. There is a more excellent way, and it is possible to develop a science of the household free from pedantry and free from empiricism in that vast undeveloped intellectual region connected with the domestic work of women. The discussion was continued by Prof. Armstrong, Prof. Millicent Mackenzie, and others.

The morning of Monday, August 6, was reserved for those public- and secondary-school questions relating to the *Balance of Subjects in the Curriculum*, the perennial interest in which has lately been revived by "Kappa" and by the "Upton Letters." Papers contributed by the Hon. and Rev. E. Lyttelton and by Mr. A. C. Benson were read in the absence of the authors. The possible omission of Latin in the preparatory school seems to have come within the range of discussion; at any rate, precedence for French seems agreed upon. Mr. T. E. Page proposed a committee to draw up a scheme of general study, to indicate the method and purpose of teaching the various subjects, and to show at what stage specialisation should be allowed. Mr. G. Gidley Robinson spoke of the preparatory-school master as not a free agent, scholarships being the root of the mischief. Mr. Arthur Rowntree assumed that training for power of work and service should be the prime object of education, and asked for an unburdening of the curriculum to allow of individuality in leisure hours.

Scientific Method in the Study of School Teaching was described by Prof. J. J. Findlay. Progress has been hindered by those earlier advocates of training who treated education merely as applied logic and ethics, but progress may be expected from experimental psychology and genetic psychology or child study. The popular interest in education leads to the ready adoption of opinions rather than the encouragement of prolonged investigations; but results in methods of school teaching can only be secured by observation of children. Educational experiments require the cooperation of several teachers for several years without external interference. Reforms have recently been introduced by external pressure, and only very inadequately tested by scientific experiments within the schools. Teachers should work in their schools as in a laboratory; but scientific habits are not easily acquired, and men trained in one branch of science do not readily transfer their scientific habits to the regions of prejudice and tradition. The demonstration schools at Manchester propose to investigate a few special topics, such as the elementary teaching of modern languages, practical mathematics, the association of parents with school life, and a school camp. Prof. Findlay applied his experimental methods for more than five years in Cardiff to discover the *Processes involved in the Acquirement of a Foreign Language.* The process is fundamentally one of acquiring habits of automatic reaction in the association of foreign symbols with ideas.

The native speech centre is a special hindrance, and the translation habit, although the path of least discomfort, is really a bar to progress. The rate of progress depends upon the intensity of the learner's absorption during the early stage. Inquiry into cases of aphasia among bilingual people may be expected to throw some light upon the nature of brain centres for foreign speech. The attempt to establish two foreign languages at the same time should not be made; each tends to inhibit the other. Latin, however, taken on a translation method does not appreciably interfere. Progress is hindered by the incapacity of some scholars to perceive new sounds.

The discussion on the *Examination and Inspection of Schools* was started by Prof. Armstrong, who asserted the need for freedom to develop individuality. The ideal system would be for the schools to examine themselves with the aid occasionally of competent assessors. Mr. W. M. Heller spoke on the constructive work of an inspector of schools. The transition from payment by results to inspection was accompanied for some years by a diminution in the proficiency of pupils. An inspector should possess successful teaching experience in both primary and secondary schools, if possible with the wider outlook of a headmaster. It takes time to know a large number of schools and teachers, and first impressions are sometimes wrong; hence an inspector should be left for several years in the same district. An inspector has a magnificent field for scientific research; he can watch, foster, and institute educational experiments of all kinds. The Rev. E. C. Owen doubted whether the inferior teacher well inspected was an improvement on the good teacher uninspected. Training would never eliminate mediocrity. If practical experience in teaching were made a *sine qua non* for administrative posts, this would attract good men to educational work.

A joint meeting was held with Sections A and G to discuss the *Teaching of Mechanics by Experiment*. Mr. C. E. Ashford spoke of the results obtained at Dartmouth by the cooperation of schoolmaster and engineer, and the use of real machinery instead of scientific toys. The science master who plays with laboratory toys is apt to be too academic, and the technical schools are too rule-of-thumb, lacking the rigorous mathematician and trained educationist; but the finest of laboratory toys were the delightful trolleys and vibrating springs shown by the lecturer and used by his pupils for measuring velocity, acceleration, and momentum.

Those who attended Section L greatly enjoyed Prof. Sadler's chairmanship, "serious and sunny." His summing up at the close of each day's discussion pointed through primitive chaos to the spirit of search, the growing desire for educational unity, and the fading away of narrow aims.

HUGH RICHARDSON.

INTERNATIONAL TESTING CONGRESS.

IN NATURE of September 6 (p. 471) brief reference was made to the opening of the International Testing Congress at Brussels on September 3. The work of the sections began on September 4, and was continued on September 5 and 6. The amount of work to be dealt with was so considerable that three sections were formed, A dealing with metals, B with building stone and cement, and C with other materials. Altogether there were twenty-seven reports of committees and forty-five original papers, the greater portion of which were submitted to the section on metals. Mr. J. Magery (Namur) presided over this section, and he was supported by honorary presidents representing the various nationalities present, and including Messrs. Wedding (Berlin), Brough (London), Saladin (France), Hackstroh (Holland), Chernoff (Russia), Brinell (Sweden), Popper (Austria), and Tonello (Spain). The following are brief notes on the various reports presented:—

Mr. A. Rieppel (Nuremberg) reported on the introduction of standard specifications in various countries; Mr. W. Ast (Vienna) reported on methods for inspecting and testing in order to ensure uniformity in iron and steel; Mr. R. Krohn (Danzig) reported that it was not feasible to establish standard welding tests. Prof. E. Heyn (Berlin), reporting on the value of etching malleable iron for the investigation of structure, showed that examination by the unaided eye gave valuable information as to the character of quenched high-carbon steel. Prof. N. Belelubsky (St. Petersburg) reported on the unification of methods of testing, and submitted a series of proposals. Prof. H. M. Howe and Mr. A. Sauveur submitted proposals for the uniform nomenclature of iron and steel. Dr. R. Moldenke (New York) reported on the establishment of standard methods of testing cast-iron and finished castings. He noted that the American and German specifications differ but slightly, and could easily be made identical.

Mr. E. Sauvage (Paris) submitted a report on impact tests on notched bars, and there was an animated discussion as to the value of this method of testing, opinions being equally divided as to the desirability or not of recommending it in specifications. The Brinell hardness test, which was reported on by Mr. J. A. Brinell and Mr. G. Dillner (Stockholm), was also keenly discussed, the general opinion being that, with the view of placing information on record, tensile tests of metals should, when possible, be supplemented by tests by the Brinell method. Mr. W. Ast (Vienna) submitted a report on international researches in the macroscopic examination of iron. The etching test is recommended for preliminary examination. Lastly, Mr. F. Osmond and Mr. G. Cartaud (Paris) submitted an interesting report on the progress of metallography since the Budapest congress of 1901.

The second section, dealing with cements, was under the presidency of Mr. Levie (Charleroi). The subjects discussed included the determination of the adhesive force of hydraulic cement, the determination of the weight of a litre of cement, and the behaviour of cement in sea-water. It was decided to appoint a committee to inquire into reinforced concrete.

The third section, under the presidency of Mr. E. Roussel (Malines), devoted attention to tests of paints, linseed oil, wood, bitumen, asphalt, and india-rubber. The congress concluded with a lecture by Prof. H. Le Chatelier (Paris) on the practical applications of metallography. An interesting feature of the congress was a small laboratory installed to illustrate modern methods of testing, under the direction of Prof. Le Chatelier, Mr. Guillet (Paris), and Prince Gagarine (St. Petersburg). It was decided that the next congress should be held in 1909 in Copenhagen under the presidency of Mr. A. Foss, president of the Society of Danish Engineers.

THE ANTI-TUBERCULOSIS CAMPAIGN.

THE Hague, preparing to receive the great Peace Congress of 1907, which is to discuss questions of peace and disarmament, recently entertained delegates from the chief European and American States to the fifth International Conference on Tuberculosis. At this conference questions of *increased* armaments were discussed, with the view of waging a more effective war against this great evil. The great interest taken all over the world in the proceedings of the conference testifies to the awakening of mankind to the necessity of making further and greater efforts in order to reduce the ravages of tubercular infection to a minimum.

At the present time the campaign against tuberculosis is being carried on with greater energy than at any previous period in medical history. Since Koch's discovery of the tubercle bacillus in 1882, and the publication of his exhaustive researches arising therefrom, it has been known to medical men that tuberculosis is as much a preventable disease as plague or cholera. Nevertheless, the public in England have remained until very recently apathetic and apparently indifferent to the fact that untold misery and sixty thousand actual deaths occur annually from a disease which can and ought to be eradicated. At last we are waking from our lethargy. This change has been gradually induced by the insistent pressure of medical opinion, aided largely by the King's active sympathy and interest. More lately Prof. Wright's great work on "opsonins" has given fresh hope and energy to many who were becoming jaded in an apparently hopeless conflict.

Since 1851 statistics show a steady decline in the mortality of tuberculosis, and for this the principles of general sanitation have been chiefly responsible. We may expect in the future that this improvement will be maintained by the continued prevention of overcrowding, the enforcement of good ventilation, improvement of insanitary areas, more effective drainage, better cleansing of streets, and the more stringent supervision of meat, cowsheds, dairies, &c.; but more rapid progress may be made and eventual extinction of the disease attained if more direct measures are employed in an intelligent and comprehensive manner.

Of more direct measures, hospitals for consumption have no doubt played a part in the decline of phthisis, but anyone acquainted with the conditions of life obtaining in our great centres of population must admit that their sphere of usefulness is but limited. The reasons for this are not far to seek:—firstly, hospital treatment is practically useless for cases of advanced tuberculosis, and most hospitals refuse admission to patients suffering from a widespread infection; secondly, patients well fed and passing a restful existence in hospital under the best hygienic conditions rapidly break down on again returning to their homes, where such favourable conditions are impossible. The recognition of this latter fact has led to the erection of sanatoria in various parts of the country, where patients may continue for a time to build up their powers of resistance after leaving hospital, and where they may by graduated exercise under proper medical supervision steadily fit themselves for the more arduous work of ordinary life.

At the present time the number of sanatoria is limited, and hopelessly inadequate for the work. Efforts are, however, being made all over the country to increase their number, but the cost of building and the cost of maintaining an efficient sanatorium is a practical difficulty with which we are faced at the outset. The King's Sanatorium at Midhurst, perhaps the most perfect of its kind in the world, cost approximately 1000*l.* per bed. Having regard to the number of beds required all over the country, a cost anything approaching these figures is prohibitive. The Open-air League, however, has directed its attention to this point, and has as one of its principal objects the erection of sanatoria at a cost estimated at not more than 100*l.* per bed, including complete equipment and the freehold of the ground. At Woodilee and Gartloch Asylums (Scotland) wood and iron sanatoria have been erected at a cost of 90*l.* per bed. If satisfactory headway is to be made we must have more sanatoria, and from the nature of the case they must be erected as cheaply as possible.

Another philanthropic body, under the presidency of H.R.H. Princess Christian, called The National Committee for the Establishment of Sanatoria for Workers Suffering from Tuberculosis, having similar objects in view, recently purchased 250 acres of land in Kent, and is about to build a sanatorium for poor patients; the committee expects that the institution will be self-supporting, without endowment from local rates or private charitable subscriptions. These organisations are working along the right line and doing splendid work, but so great is the number of tuberculous patients (80,000 in London alone) that they are only able to touch the fringe of this tremendous problem.

Hitherto sanatorium treatment has mainly consisted of fresh air, rest in bed, full diet, and graduated exercise under constant medical supervision. Such a life is not a very healthy moral existence; it produces the "sanatorium habit," which renders one who has acquired it morally unfit, as he is already physically, for the more strenuous life to which he must sooner or later return. In order to counteract the emasculating influence of sanatorium life as hitherto pursued, to reduce the cost of maintenance, and in order to provide work for patients who would otherwise lead an indolent and purposeless life, various schemes have been proposed.

The Open-air League intends to found farm colonies in connection with its sanatoria where patients cured, but as yet unfit to return home, may occupy themselves in farming, in the cultivation of vegetables, and other similar light occupations. An intermediate stage is thus created during which the patient is braced up physically and morally, and his tendency to relapse reduced to a minimum. Hospitals and sanatoria, however, under their rules exclude cases of advanced tuberculosis. Such cases under hospital treatment remain stationary or get worse, and merely occupy beds which may be more usefully employed in the treatment and cure of patients less extensively infected. Advanced cases, then, added to the many who for various reasons prefer to remain at home, are under no control, and constitute a constant and very real menace to the health of the general public. How to reach these patients and bring them under proper medical supervision is in most localities a great difficulty, yet until it is dealt with all hope of eradicating tuberculosis may be abandoned. In London there appears to be no organisation as yet which will undertake this necessary work. The difficulty has been met in Scotland by the founding of "dispensaries for tuberculosis," and this example has been followed in France and Belgium. In Germany, too, similar institutions (Wohlfahrtstellen für Lungenkranke) have been founded. The functions of a dispensary are briefly these:—

(1) Medical examination of patients.

(2) Inquiry by a medical man or nurse into the history of the illness, the home conditions, the economic condition of the family, the suitability of the accommodation for home treatment.

(3) Arrangements for providing medical treatment and nursing of patients that could be treated at home without risk of infection.

(4) Dispensing of medicines and disinfectants.

(5) Selection of cases suitable for hospital treatment.

The type of dispensary which might well be copied by other cities is the Royal Victoria Dispensary, founded eighteen years ago by Dr. R. W. Philip in Edinburgh. The excellent work done by this pioneer institution has been of incalculable benefit to the community.

By these means the campaign is carried into the very homes of the patients, and an attempt is made to limit at its source the constant stream of more or less advanced cases of tuberculosis which appear daily in the out-patient departments of our hospitals.

The cost of such dispensaries is not great; Dr. Philip estimates it at 500*l.* to 1000*l.* per annum for a city of 300,000 inhabitants. It might be paid out of the rates, and the dispensaries, for administrative purposes, should be under the control of the medical officer of health.

Pulmonary tuberculosis has been recognised in Scotland by the Local Government Board as an infectious disease within the meaning of the Public Health Act (Scotland), 1897; consequently the obligations of the local authority with regard to infectious disease are extended to phthisis, and much more efficient control is established.

Under the Infectious Diseases Act (1889) the Local Government Board can invest local authorities with similar powers. In Sheffield these powers have been obtained in a modified form, and in Manchester and some other localities notification of tuberculosis has been tried with success.

Surely the time has now arrived when the powers possible under the Infectious Diseases Act should be more generally employed. A system of voluntary notification has been inaugurated in Manchester; this was at first limited to public institutions, but in 1900 medical men were invited to notify the cases occurring in their private practice. The system has worked well, and has been of immense benefit in affording opportunities for visiting the homes of the patients and instructing them in the principles of disinfection, ventilation, and the proper disposal of sputa, &c. It cannot be doubted that some system of notification (voluntary or compulsory) is imperative if efficient control is to be obtained. It is not contended that notification by itself has any administrative value, but if efficiently followed up by adequate preventive measures it would alter the whole aspect of affairs; on the other hand, application of the provisions of the Public Health Act to tuberculosis is impossible unless some system of notification is employed.

Many new cases of infection arise from ignorance of the infectivity of tuberculosis, and from an absence of any knowledge as to how best to live without spreading infection. To combat this local authorities have distributed leaflets conveying simple instructions for the everyday life of tuberculous persons, and various philanthropic bodies (*e.g.* the Open-air League) have this education of the public as one of their chief objects.

Brighton, however, under the able leadership of Dr

Newsholme, has struck out a new line. The vacant wards of the hospital are utilised for the education of consumptives. Patients living at home are admitted to the hospital for short periods (four to six weeks), during which time they are instructed as to how they should live and in all the precautions and preventive measures they should practise on returning to their homes. In this way a constant stream of enlightened information is continually disseminated among the most ignorant. Some other towns are following this excellent example.

Although it has been shown that much time, money, and energy are being expended by various public and private bodies in the effort to throw a net over the whole tuberculous population, yet it must be confessed there remain many gaps which must be filled up if success is to be attained in our war against consumption. Proper organisation and coordination of effort are needed. A well-thought-out scheme must be put in action throughout the country and controlled by some central authority. This duty falls naturally to the Local Government Board, and is it too much to expect that a "tuberculosis committee" of that board may be appointed the chief duty of which should be the control and direction of the isolated efforts now being made in various parts of the country? By this means greater efficiency and better results would accrue at a proportionately smaller cost.

R. FIELDING-OULD.

ATMOSPHERIC ELECTRICITY IN ALGERIA.

IN the *Revue générale des Sciences* of May 30, M. Ch. Nordmann gives an account of the phenomena of atmospheric electricity, and of one or two of the latest theories on the subject, and also describes some recent observations made by himself in Algeria. Atmospheric electricity is now so large a subject that the essay naturally covers only a part of the ground, and does not go into many details. It shows, however, the clearness and lightness of touch one expects from our neighbours across the Channel. In a few points perhaps its conclusions are a little precipitate, but it contains some shrewd criticisms of other people's theories. The paper contains copies of some interesting electrograms, mostly obtained by the author in August and September, 1905, at Philippeville, on the southern coast of the Mediterranean.

M. Nordmann first points out that the normal potential gradient in the atmosphere may arise from a negative charge on the earth, or a positive charge in the air, or from the two combined. He regards the presence of an excess of positive electrification in the air as proved by the fall in the potential gradient with increasing height observed in balloon ascents. He refers to Elster and Geitel as having discovered that any charged body, however well insulated, loses its charge in ordinary atmospheric air. Historically this is hardly complete, as Elster and Geitel merely confirmed what Linss had discovered many years before. Elster and Geitel have, of course, added enormously to our knowledge of the subject, and they gave it much greater precision, besides bringing it into line with recent laboratory research.

Passing to the diurnal variation in the potential gradient, p. 445, M. Nordmann refers to the double period with maxima about 8 a.m. and 8 p.m. as having been regarded until recently as universal. He next refers to observations on mountains, especially those on the Sonnblick, as showing that at high levels the afternoon minimum disappears, the diurnal variation becoming simple, and mentions Chauveau as having established the existence of the same phenomenon on the Eiffel Tower. In both cases the observations show rather a reduced prominence in the afternoon minimum than its total absence, and on p. 447 Nordmann somewhat qualifies his earlier remarks. His own observations at Philippeville supply a very interesting example of a simple period. Observing on an eminence 160 metres high, immediately adjacent to the sea, he obtained as the mean from the quietest days of his stay (the number of which is not stated) a diurnal variation with a minimum from 4 a.m. to 5 a.m., and a maximum about 5 p.m. The value was above the mean from 11 a.m. to 10 p.m., and below from 11 p.m. to 10 a.m. During the day the wind blew straight from the sea, and during the night from the land. The results are so unusual, and if confirmed so suggestive, that an extension of the observations over a much longer period is desirable. Until that is done, one cannot feel sure that the results are fairly representative, even of the particular season of the year when they were observed. Among the electrograms reproduced is one showing the effects of a sirocco from the desert. The large and sudden changes of potential, the curves going off the sheet both in the positive and negative directions, are similar to those met with in England during thunder or heavy rain. Other curves of interest are those showing the changes of the potential and of the positive ionisation of the air at Philippeville during the total eclipse of the sun on August 30, 1905. Between the times of the first and last contacts the potential was *slightly* above its mean for the time of the day, and the ionisation fell decidedly as totality approached. The maximum in the one curve and the minimum in the other occurred forty-five minutes after totality.

In his criticisms of theories by Elster and Geitel and Ebert the author points out that at Philippeville the potential was below, not above, its mean when the wind blew off the land, and that the barometric pressure showed the ordinary double period. In discussing some theoretical views of his own, he refers to a difficulty in that "en passant de l'été à l'hiver la diminution du rayonnement solaire s'accompagne d'un abaissement du champ, en passant du jour à la nuit elle coincide, au contraire, avec une augmentation." This is rather puzzling in view of the author's perfectly correct statement, p. 446, that the potential is highest in winter.

C. CHREE.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE University of Greifswald has received a legacy of 60,000 marks under the will of the late Dr. Milschewsky, who died recently in Loburg.

PROF. MORRIS TRAVERS, F.R.S., professor of chemistry at the University College, Bristol, has been appointed director of the Indian Institute of Science which is to be established in Bangalore.

ACCORDING to the *Chemiker Zeitung*, the authorities of the Zürich University have decided to increase considerably the University lecture and laboratory fees chargeable to foreigners, with the idea of lessening to some extent the present high percentage of foreigners who attend.

IN the columns of the *Chemiker Zeitung* for last week we read that the Grecian Government recently received from St. Petersburg a legacy of about eight million roubles, or $1\frac{1}{4}$ millions sterling, which was left in the beginning of the last century by a rich Grecian merchant, of the name of Dombolis, with the condition that after the lapse of a definite time a second Grecian university should be built in Corfu out of the capital and interest, and be called the Kapodistrias University.

THE fees for the examinations of the German technical high schools have been fixed on the following scale:—for the preliminary diploma examination, 60 marks for naturalised Germans, 120 marks for foreigners; for the diploma examination, 120 marks for Germans and 240 marks for foreigners; for the doctor of engineering examination, 240 marks, of which the first half is to be paid when the examination thesis is handed in, and the remainder before the oral examination is taken.

THE university buildings of Groningen were almost completely destroyed by fire on August 30. The fire is supposed to have been caused by careless use of benzine or methylated spirits on the part of workmen. The natural history museum and the chemical and pharmaceutical laboratories were entirely destroyed, while the hygienic and physiological laboratories were saved. The university buildings, which, strangely enough, were not insured, were erected in 1846–1852. An emergency committee has made arrangements for the lectures and classes of the coming session to be begun as usual. The University has approximately five hundred students.

THE prospectus of the Borough Polytechnic Institute for the session 1906–7 contains abundant proof that the educational needs of the young men and women of South London are well provided for. The object of the classes is to provide sound instruction and to promote industrial skill and general knowledge. It is interesting to note that the trade classes are intended especially and only for those who are engaged in the several trades. Among such classes may be mentioned as typical those for motor drivers and repairers, motor engineers and designers, sanitary inspectors, men engaged in electrical and building industries, and bakers and confectioners. Special attention is paid also to the technical education of women, for whom a variety of trade classes has been arranged. Women are trained for home duties in a special department, and prominence is given to the scientific principles upon which successful domestic practices depend. The arrangements made for the coming winter are of a very complete character.

In the opening pages of the new calendar of the University College Hospital Medical School is an explanatory statement of the new arrangements for medical education consequent upon the formation by the University of London of university centres for instruction. Under these arrangements a student will enter one of the university centres for the preliminary and intermediate medical studies, and will then complete his career at the Hospital Medical School, the whole of the energies and resources of which will be devoted to a development of the medical studies proper. The calendar contains an engraving of the new buildings of University College Hospital, provided by the generosity of the late Sir Blundell Maple, which will be opened formally by H.R.H. the Duke of Connaught on November 6. Another engraving shows an elevation of the new medical school buildings erected through the munificence of Sir Donald Currie. These buildings are being specially constructed with laboratories and research rooms for medicine, surgery, pathology, and other departments.

A COMPREHENSIVE resolution referring to education was adopted last week at the Trade Union Congress at Liverpool. Among the points accepted by the congress as essential to a sound educational system are the following:—(1) scientific physical education with medical inspection and records of the physical development of all children attending State schools, and skilled medical attendance for any child requiring same; (2) a national system of education under full popular control, free and secular, from the primary school to the university; (3) secondary and technical education to be an essential part of every child's education, and to be secured by such an extension of the scholarship system as will place a maintenance scholarship within the reach of every child, and thus make it possible for all children to be full-time day pupils up to the age of sixteen; (4) the best intellectual and technical training to be provided for the teachers of the children; (5) the cost of education to be met by grants from the Imperial Exchequer, and by the restoration of misappropriated educational endowments.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 28.—"Researches on Explosives." Part iv. By Sir A. **Noble**, Bart., K.C.B., F.R.S.

In part iii. of his "Researches on Explosives" the author gave the results of a very extensive series of experiments on certain explosives, which were, first, the cordite of the Service, known as Mark I.; second, the modified cordite, known as M.D.; and third, the nitrocellulose, known as Rottweil R.R. The experiments made extended, for all the above explosives, from densities of 0·05 to 0·45 or 0·50, and pressures of from 2·75 tons per square inch (419 atmospheres) to pressures of 60 tons per square inch (9145 atmospheres).

In the present paper full details are given of three other explosives, and comparisons are made between them and the explosives which have been so much experimented with in this country. If reference be made to the tables, which cannot be given in this abstract, it will be seen how wide are the differences between the explosives, not only in the absolute volumes of the several gases, but in the variations with reference to the densities at which they were fired.

Thus, for example, comparing Norwegian 105 and Italian ballistites, while in the former the carbon monoxide commences at the density 0·05, with a percentage volume of 38·5, falling at a density of 0·45 to 22 per cent., the carbon dioxide commences with 13·3 per cent., rising rapidly to 31 per cent. In the latter explosive the CO commences at 20·5 per cent., and falls slowly to 15 per cent., while the CO_2 commences a little above 26 per cent., rising also comparatively slowly to nearly 34 per cent.

But there are, in these two explosives, other remarkable differences. Thus, in the Italian ballistite, at a density of 0·05, the volume of methane CH_4 is a mere trace, about 0·02 per cent., and it remains very much lower than is the case with any other explosive, being only 1·9 per cent. at the density of 0·45. With the Norwegian, on the other hand, the CH_4, although the volume at commencement is only 0·04 per cent., is, at 0·45 density, 11 per cent.

Again, as might be expected, from the large quantity of CH_4 found in the case of the Norwegian ballistite, the volume of hydrogen falls from more than 20 per cent. to about 9 per cent.; in the Italian the H rises from about 8 per cent. to about 10 per cent., falling slightly at higher densities.

In both explosives the N is practically constant at about 12 and 16 per cent. respectively, but there is a very great difference as regards the H_2O. In the Norwegian the H_2O is constant at 14 per cent., there being no greater difference than might be expected from errors of observation, while, in the Italian, the H_2O, which commences at density 0·05, with a volume of 29 per cent., falls at a density of 0·45 to about 24 per cent. No other explosive approaches the Italian ballistite in respect to the large volume of aqueous vapour formed, especially at low densities.

In the tables are given the volumes in cubic centimetres per gram of the permanent and total gases, and curves have been drawn representing for the six explosives the observations of these volumes. In the case of five of the explosives there is, with increasing density, a very considerable decrease in volume, but with the Italian ballistite, throughout the range of the experiments, there is hardly any change. Curves representing these volumes are concave to the axis of abscissæ.

In the tables are shown the units of heat, both for water fluid and water gaseous. Curves have also been drawn for the units of heat (water gaseous); the curves in this instance are all convex to the axis of abscissæ, and it may be noted that, where the volume of gas per gram is large, the units of heat are low, and that, where the volumes of gas are rapidly decreasing, the curves representing the amount of heat developed show a rapid increase.

The next point to be considered is, the data being as is shown in the tables, what temperature are we to assign to that generated by the explosion? With the view of studying the question, the author resorted to two methods:—(1) Knowing with very considerable accuracy the units of heat (water gaseous) generated by the explosion, and having determined approximately the specific heat of the gases, the temperature of explosion should be given by the equation

$$t = \frac{\text{gram units of heat}}{\text{specific heat}} \quad \ldots\ldots\ldots \quad (1)$$

(2) Knowing also with considerable accuracy the pressure at any given density, and knowing the pressure p_0 when the volume of gas generated is reduced to the temperature of 0° C., and a pressure of 760 mm. of mercury, the temperature is given by the equation

$$t = \frac{p - p_0}{0\cdot00367 \quad p_0} \quad \ldots\ldots\ldots \quad (2)$$

With reference to equation (1), the specific heat of CO_2 is a very important factor in this determination, and the recent researches of Messrs. Holborn and Austin upon the specific heat of gases at constant pressure at high temperatures having apparently shown that the specific heats given by Mallard and Le Chatelier for temperatures above 100° C. are considerably too high, the author has taken the figures given by the former physicists, which, it may be remarked, up to temperatures of 800° C., are confirmed by Langen.

The specific heats given are, as has been said, those for constant pressure, and to obtain those at constant volume it is necessary to divide by the constant k, connecting the specific heats of gases and vapours at constant pressure and constant volume.

The author gives the values he has used, (1) of the specific heats at constant pressure; these are taken either from Holborn and Austin's paper, or from Landolt, "Physikalisch Chemische Tabellen," 1905; (2) of the constant k; these are all taken from Landolt, pp. 407–8; (3) of the specific heats at constant volume.

Gases, &c.	Specific heat, constant pressure	Value of k	Specific heat, constant volume
CO_2	0·2986	1·282	0·232
CO	0·2425	1·401	0·173
H	3·4100	1·408	2·422
CH_4	0·5922	1·316	0·450
N	0·2497	1·410	0·177
H_2O	0·4210	1·330	0·361

The specific heats calculated from the above data, of the gases generated by the explosion of the six propellants, are given in the tables embodying the results of the whole of the experiments for each propellant, and in the tables are also given the temperatures of explosion deduced from equations (1) and (2), and here again it must be remembered that the temperatures with which artillerists are chiefly concerned are those due to densities varying approximately between 0·17 and 0·23.

The Italian ballistite, which from equation (1) shows the highest temperature, commences at the density of 0·05 with 4943° C., this temperature hardly varying at all until the density of 0·25 is reached, when it slowly but regularly increases to about 5000° C. at $d=0·45$. Cordite Mark I., commencing at 4742° C., with a very slight fall, is practically constant up to $d=0·30$, after which it rises somewhat rapidly to a temperature of 4921° C. at $d=0·45$, and to 5065° C. at $d=0·50$.

When, however, the temperatures given by equation (2) are reached some very remarkable differences are met with.

It is found that at the higher densities and pressures there is generally a very tolerable accordance in the temperatures obtained from the two formulæ, but as the density and pressure diminish the divergence becomes in all cases considerable, but very greatly more with the explosives which develop very high temperatures, and which give rise to large percentages of carbonic anhydride.

The only construction the author is able to put upon the close approximation of temperature given by the two formulæ at high densities and pressures, and the wide differences which exist in some of the explosives at low densities, is that at high densities dissociation of the carbonic anhydride is prevented by the very high pressure, and that the great difference between, for instance, Italian ballistite and nitrocellulose R.R. at, say, the density of 0·1, is due, firstly, to the difference of the temperature at which the nascent gases are generated, and, secondly, to the proportion of CO_2 which is subject to dissociation.

The theory submitted is as follows:—

The nascent gases are generated at temperatures approximately as given by equation (1).

Under the low densities and pressures at the very high temperatures with which we are concerned, the CO_2 and possibly some H_2O are partially dissociated, giving rise to the fall in temperature exhibited by the results obtained from equation (2) at low densities. At high densities, as already pointed out, the two equations give in some cases accordant results, in all cases tolerable agreement; it therefore appears to the author to be reasonable to suppose that the facts he has recorded are due to partial dissociation at low densities and pressures, which dissociation is prevented by the very high pressures ruling at densities of 0·40, 0·45, and 0·50.

As no free oxygen is ever found in the analyses in cooling down, any free oxygen due to dissociation must have recombined, and the heat lost by dissociation regained. The re-combination must, however, be very gradual, as no discontinuity is observed in the cooling curves.

It is then pointed out that a certain amount of confirmation is given to the view taken by the fact that if the explosives be arranged according to the amount of heat generated, derived from equation (1), regard being also had to the amount of CO_2 found, it will be found that the differences between the two formulæ decrease approximately as the factors to which the author has referred decrease, and a table is given showing these differences.

"On the Julianiaceæ, a New Natural Order of Plants." By W. Botting **Hemsley**, F.R.S.

The Julianiaceæ comprise two genera and five species. They are resiniferous, tortuously branched, deciduous, diœcious shrubs or small trees, having alternate, exstipulate, imparipinnate leaves, from about one to three decimetres long, clustered at the tips of the flowering branches and scattered along the short barren shoots. The flowers are small, green or yellow-green, quite inconspicuous, and the males are very different from the females. The male inflorescence is a more or less densely branched axillary panicle or compound catkin, from 2½ cm. to 15 cm. long, with weak, thread-like, hairy branches and pedicels. The male flowers are numerous, 3 mm. to 5 mm. in diameter, and consist of a simple, very thin perianth, divided nearly to the base into four to nine narrow, equal segments, and an equal number of stamens alternating with the segments. In structure and appearance they are almost exactly like those of the common oak. The female inflorescence is similar in structure to that of the sweet chestnut, consisting of an almost closed, usually five-toothed involucre, borne on a flattened pedicel and containing three or four collateral flowers, of which the two outside ones are, perhaps, always abortive.

At the flowering stage, the female inflorescences, including the narrow flattened pedicel and the exserted styles, are about 2 cm. long, and, as they are seated close in the axils of the crowded leaves and of the same colour, they are easily overlooked. The female flowers are destitute of a perianth, and consist of a flattened, one-celled ovary, terminated by a trifid style and containing a solitary ovule. The ovule in both genera is a very peculiar structure. That of Juliania, in the flowering stage, is a thin, flat, obliquely horseshoe-shaped or unequally two-lobed body, about 2 mm. in its greatest diameter, attached to the base of the cell. At a little later stage, in consequence of unequal growth, it is horizontally oblong, nearly as large as the mature seed, that is, 6 mm. to 8 mm. long, and almost symmetrically two-lobed at the top. A vascular bundle or strand runs from the point of attachment to the placenta upwards near the margin into one of the lobes. In this lobe the embryo is tardily developed, and at this stage it is more or less enclosed in the opposite lobe, the relations of the two being as nozzle and socket to each other. It is assumed that the whole of this body, with the exception of the lobe in which the embryo is formed, is a funicle with a unilaterally developed appendage, which breaks up and is absorbed during the development of the ovule into seed.

The ovule of Orthopterygium is very imperfectly known, but the attachment appears to be lateral and the funicular appendage cup-shaped at the basal end, bilamellate upwards, and more or less enclosing the embryoniferous lobe.

The compound fruits of Juliania are samaroid in form, the wing being the flattened pedicel, at the base of which it disarticulates from the undifferentiated part of the pedicel. They vary from 4 cm. to 7 cm. in length by 1½ cm. to 2½ cm. in width. Externally they strongly resemble the samaroid pods of certain genera of Leguminosæ, notably those of Platypodium and Myroxylon. The involucre itself, of the largest fruits seen, is only about 1 cm. deep by 2 cm. wide. It is composed of very hard tissues, and is quite indehiscent. Only quite young fruit of Orthopterygium is known. In this the flattened pedicel is narrow, straight, and equilateral, from 6 cm. to 7 cm. long and about 1 cm. wide.

The nuts of Juliania are almost orbicular, biconvex, hairy on the outside, and have a very hard endocarp. The solitary exalbuminous seed is circular or oblong, 6 mm. to 10 mm. long, compressed, with a smooth, thin testa. The embryo is horizontal, with thin, plano-convex, more or less oblique, obscurely lobed cotyledons, which are epigæous in germination, and a long ascending radicle applied to the edges of the cotyledons.

So far as at present known Juliania is confined to Mexico, and the various species occur in isolated localities between about 17° 40′ and 23° N. lat., and 97° and 104° W. long., and at altitudes of about 1500 feet to 5500 feet.

The habitat of the Peruvian Orthopterygium Huaucui is 2000 miles distant from the nearest locality of any species of Juliania. The exact position of the only place in which it has been found cannot be given, but it is in the Province of Canta, in the Department of Lima, between 11° and 12° S. lat.

PARIS.

Academy of Sciences, September 3.—M. A. Chauveau in the chair.—Observations of the Kopff comet made with the bent equatorial at the Algiers Observatory: M. F. **Sy.** Details of observations made on August 24 and 25. The comet appeared as a round nebulosity, with a nucleus, the lustre of which was comparable to a star of the twelfth magnitude.—Observations of the Kopff comet (1906*c*) made with the bent equatorial (32 cm.) of the Lyons Observatory: J. **Guillaume.** Results for six nights, August 26–31.—The growth of multiform functions: Georges **Rémoundos.**—Description of an autocollimator level with a mercury horizon: MM. **Claude** and **Driencourt.** The description is accompanied with a diagram of the apparatus, for which a greatly increased accuracy is claimed.—The determination of the melting points of the alloys of aluminium with lead and bismuth by means of thermoelectric pyrometers: H. **Pécheux.** The melting points were studied by two couples, platinum|10 per cent. platinum-iridium and nickel|copper. The temperatures given by each couple for eight alloys are stated, and the agreement is sufficiently good for the author to suggest that the nickel-copper couple may render good service for commercial uses.—The action of nascent hypoiodous acid on unsaturated acids. Iodolactones: J. **Bougault.**—Starchy material studied with the aid of our knowledge of the colloidal state: G. **Malfitano.**—The isomorphism of northupite with tychite: A. **de Schulten.**

NEW SOUTH WALES.

Linnean Society, July 25.—Mr. Thomas Steel, president, in the chair.—The botany of north-eastern New South Wales: F. **Turner.** The paper gives a general account of the indigenous vegetation and of the exotic weeds of the country comprised between the New South Wales-Queensland border and 32° S. lat.; the S. Pacific on the east, and 152° 20′ or 151° E. long. From a botanical point of view, the region in question is one of the most fertile and interesting sections of country in Australia, and a census of its semi-tropical flora is estimated to comprehend 734 genera and 1767 species.—A review of the New South Wales species of Halorrhagaceæ, as described in Prof. A. K. Schindler's monograph (1905), with the description of a new species: J. H. **Maiden** and E. **Betche.** The paper contains a list of New South Wales species of Halorrhagaceæ, showing the important changes made by Prof. Schindler, and gives description of a new species, *H. verrucosa*, from Woodburn, Richmond River, the specific name being given from the character of the fruit. Its nearest ally in Schindler's classification is *H. tenuis*, and in Bentham's *H. micrantha*, R.Br.—Notes on the hymenopterous genus Megalyra, with descriptions of new species: W. W. **Froggatt.** A general account of the members of this curious genus of parasitic Hymenoptera is given, with notes on the species previously described, their general structure, and the longicorn beetles the larvæ of which they parasitise. Eight new species are added to the seven previously described from Australia.—Description of a new tick of the family Argasidæ: W. W. **Froggatt.** The common "fowl-tick," *Argas americanus*, has been acclimatised in Australia for more than twenty years. An indigenous species is now described. This Argasid is common in the clay nests of the fairy martin, *Petrochelidon* (*Lagenoplastes*) *ariel*, and is usually to be found under the lining of feathers and grass resting against the clay in the nests containing the young birds, and for some time after the nestlings have flown.—The life-history of *Lestes leda*: R. J. **Tillyard.** The species is shown to be double-brooded. The male assists the female in the act of oviposition, seizing her round the neck. The method of oviposition is discussed, and various statements that have been made by different entomologists from time to time are shown to differ from the results of observations on this species.

CALCUTTA.

Asiatic Society of Bengal, August 1.—Bibliomancy, divination, superstitions amongst the Persians: Lieut.-Colonel D. C. **Phillott.**—*Gentiana Hügelii*, Griseb., re-described: Dr. Otto **Stapf.** In 1835 Baron Karl von Hügel collected this gentian in Kashmir, and the specimens are preserved at Vienna. They have never been examined by writers on Indian gentians, and because Grisebach did not describe them quite accurately the species has never been fully understood. A new description is therefore necessary, and is offered with illustrations.—*Swertia angustifolia*, Ham., and its allies: I. H. **Burkill.** An account of *Swertia angustifolia*, with *pulchella* and *affinis*, *S. corymbosa*, *S. zeylanica*, and the whole of their close alliance, based on an examination of all the material available at the herbaria at Kew, at the Natural History Museum, South Kensington, at the Jardin des Plantes, Paris, and at Shibpur, Saharanpur, Madras, and Peradeniya, Ceylon. Some of the species defined are used medicinally for the true Chiretta.—Notes on some rare and interesting insects added to the Indian Museum collection during the year 1905–6: C. A. **Paiva.** Notes on specimens, chiefly of Hymenoptera and Hemiptera, collected in Calcutta and the Darjiling and Purneah districts, together with a list of the Hymenoptera received from the Seistan Boundary Commission.—*Bulbophyllum Burkilli*: a hitherto undescribed species from Burma: Captain A. T. **Gage.** A description of a new Bulbophyllum from the Burmo-Siamese frontier, Tenasserim, which has flowered in the Royal Botanic Garden, Shibpur.

CONTENTS.

THURSDAY, SEPTEMBER 20, 1906

A TEXT-BOOK OF OPTICS.

Physical Optics. By R. W. Wood. Pp. xiii+546. (London: Macmillan and Co., Ltd., 1906.) Price 15*s.* net.

WHEN a book on optics by Prof. Wood was announced, students expected something interesting, and they have not been disappointed. In his preface the author explains that when he commenced his work Preston's "Theory of Light" was the only advanced English text-book of modern date available. Since that time Schuster's "Theory of Optics" and the English translation of the late Prof. Drude's "Lehrbuch der Optik" have appeared, and Prof. Wood had to consider whether they covered the field sufficiently.

His readers have cause to be glad that he answered this inquiry in the negative, nor will they regret the fact that he has laid special stress on the experimental side of the question, and has devoted considerable space to the account of some of his own work. His apologies for this are unnecessary; many of the experiments so described are beautiful, and students learn more from reading a man's account of his own work than in other ways.

While the book hardly claims, perhaps, to be a complete treatise, it covers a great deal of ground, and in particular deals with a number of matters, such as the laws of radiation, dispersion, fluorescence, and the optics of moving media, which are not so fully treated in some other recent works. A student commencing the study of optics would perhaps hardly begin with this book; he would find, however, in its pages when he came to read them some most instructive views of the subject. The earlier chapters deal with the rectilinear propagation of light and its reflection and refraction. They gain much by the photographic reproductions showing the passage of a wave of sound through an aperture, and after reflection and refraction at a plane surface, and teachers will do well to insist on the utility of the graphic method of studying the changes in wave form, which Prof. Wood uses freely.

The theoretical treatment of the matter is perhaps less satisfactory; it is based essentially on that of Verdet. Schuster's paper on the method of analysing in an elementary manner the propagation of a plane wave might with advantage have been alluded to. In dealing with both reflection and refraction, Fermat's law of minimum time is explained at an early stage, and afterwards freely utilised.

A special point in these early chapters is made of the refraction of light by media of varying density, and the results are used to illustrate and explain the phenomena of mirage. Prof. Wood's arrangement for producing mirage on the lecture table is well worth notice; so too are the experiments on anomalous dispersion, and especially the very beautiful one for showing the anomalous dispersion of sodium vapour.

We come next to the interference of light. The usual elementary account of the phenomena shown by Fresnel's mirrors and by the biprism is given, but it is supplemented with a simple description of how to make a pair of very satisfactory mirrors from a piece of modern mirror glass, or a biprism from some slips of glass and Canada balsam, and we are told that "a prism made in this way works quite as well as those supplied by opticians."

After a reference to the phenomena of light beats and achromatic fringes we pass on to the colours of thin plates and Newton's rings. The section on the polarised fringes produced by two streams polarised at right angles is very interesting, so too is that on the preparation of films for the exhibition of Newton's colours.

Diffraction is treated at first in an elementary way, then by means of Cornu's spiral, and finally, for a few simple cases, by means of calculation; the sections on the grating may be specially commended. In chapter viii. we find an able discussion of the modern interference spectroscopes, and here again, both in the case of the Michelson interferometer and of the echelon grating, the experimental conditions for successful working are carefully discussed. The interferometers of Fabry and Perot, and also of Lummer and Gehrke, are also described. The chapter on double refraction proceeds on ordinary lines. Stokes's verification of Huyghens's law might with advantage have replaced that due to Malus, which cannot give results of great accuracy. In chapter xii., the theory of reflection and refraction, the reader is introduced to Maxwell's equations of the electromagnetic field, which henceforth become his main guide in the theoretical part of the book, though the theory of dispersion is in the first instance developed on the lines of the work of Sellmeirr and Helmholtz.

With regard to optical theories generally, Prof. Wood has from the first adopted the view put forward by Schuster in the preface to his recent book on optics.

> "So long as the character of the displacements which constitute the waves remains undefined we cannot pretend to have established a theory of light."

In dealing with the theory of reflection and refraction, the importance of the part played by surface films is duly noted. From this point onwards the interest of the book becomes greatly increased. An admirable account is given of recent work, much of it due to the author, connected with dispersion and absorption, especially the anomalous dispersion of sodium vapour. The optical properties of metals are developed on the electromagnetic theory, and reference is made to the important work by Rubens and Hagen, who showed that many of the discrepancies between theory and experiment noted by other observers arose from the employment of waves of too short length in the investigation.

After some account of rotatory polarisation, we come to the chapter on magneto-optics. The theory is worked out according to the two lines indicated by Drude; the first hypothesis is based on the existence of molecular currents in the median streams of revolving electrons the motions of which are acted upon by, and react upon, the magnetic forces of the impressed field, while the second hypothesis is that of the Hall effect, in consequence of which an electron thrown into vibration in a magnetic field experiences a force depending on its own velocity and on the strength of the field. The results of the theory are applied to the discussion of the magneto-optics of sodium vapour, taken from a paper by Prof. Wood himself, and also to an explanation of the Zeeman effect.

Chapters on the laws of radiation, the scattering of light, the nature of white light, and the relative motion of ether and matter conclude the book. In connection with this last subject, Prof. Wood points out that all experimental evidence, with the exception of the well-known Michelson-Morley experiment, is in favour of the hypothesis of a stagnant ether, and that the only explanation of this discrepancy, so far as we can see at present, is that due to Fitzgerald and to Lorentz, that a change is produced in the linear dimensions of matter by its motion through the ether.

Sufficient perhaps has been written to show that Prof. Wood has placed students under a considerable debt by the publication of this book, while the publishers are to be congratulated on the manner in which they have produced it.

RESEARCHES IN JAPANESE WATERS.

Ostasienfahrt: Erlebnisse und Beobachtungen eines Naturforschers in China, Japan, und Ceylon. By Dr. Franz Doflein. Pp. xiii+511. (Leipzig: Teubner, 1906.) Price 13 marks.

DR. DOFLEIN adds one more to the long list of books which have been written to give popular accounts of scientific expeditions. In the year 1904 he undertook a journey to the Far East for zoological purposes, and particularly with the object of investigating the fauna of Japanese waters, which is of peculiar interest, not only as possessing remarkable forms of its own, but as containing an admixture of genera belonging respectively to the cold northern seas and to the Indo-Pacific region, which meet in that locality, with a large "deep-sea" element. In the book before us we have a record of the observations and results of this voyage, and of the impressions made on the traveller by the countries he passed through.

The outward passage was an eventful one. In the Red Sea the *Prinz Heinrich*, on which Dr. Doflein had left Naples, was stopped and searched by the notorious Russian auxiliary cruiser *Smolensk*, and the mails were taken from her. The incident was made more exciting by the presence on board of high Chinese and Japanese officials, and created considerable commotion in Europe at the time. Further trouble, however, awaited the *Prinz Heinrich*. Off Dondra Head, in a heavy sea which would probably have sunk her boats if they had been launched, she struck some unseen object, sprang a leak, and only reached Galle Harbour just in time to escape sinking. Her passengers were then transferred to the *Polynesien*, on which they continued their voyage from Colombo, and arrived, after a further mishap in the shape of a breakdown of the engines, at Saigon. From this town, with the beauty of which Dr. Doflein was more struck than with its morals, he travelled by Hong Kong, Macao, Canton, and Shanghai, where he heard of the defeat of the Russian fleet and saw the interned *Askold* in dock, to Nagasaki, and thence by Yokohama and Tokio to Sendai Bay, in the Rikuzen district on the east coast, where his work was to begin.

The reason which had led Dr. Doflein to choose this locality for his investigations was that on the east coast of Japan the warm current known as the Kuro Siwo, or Japan coast current, derived from the north equatorial drift, meets the cold Kurile current from the north on more or less equal terms, and that therefore in this region the relations of the Indo-Pacific and northern faunas might best be studied. On the western side of the islands the Tsushima current, an offshoot of the Kuro Siwo, appears to have little influence on the temperature of the water, which, so far as is known, has here a more predominantly subarctic fauna. The result of the investigations at Sendai was to show that there is no sharp boundary between the southern and northern faunas, and there is evidence that the change from the one to the other is gradual, and takes place all along the east coast of Japan. This is probably due to the fact that the two currents interlace in a complicated manner and change their position with the time of year. Our knowledge of these currents is largely owing to the work of the unfortunate Admiral Makaroff, who perished off Port Arthur. Dr. Doflein's stay in Sendai was brought to an end by bad weather, and he then left for Sagami Bay in the south, where he made his headquarters at Aburatsubo in a small marine laboratory belonging to the University of Tokio.

The fauna of Sagami Bay is extraordinarily rich, probably on account of the abundant food supply owing to the mortality among the surface organisms of the two currents in consequence of the change of temperature when they meet. It has been collected by many naturalists from von Siebold onwards, and Dr. Doflein wisely gave his chief attention not so much to collection as to the observation of the habits and mutual interdependence of the animals, both of the deep and shallow waters. He describes his impressions of the latter in a graphic chapter, and makes some interesting remarks on the meaning of their coloration. There seems to be a large tropical element, brought, no doubt, by the Kuro Siwo. After some weeks' investigation of the shallow-water fauna, Dr. Doflein returned to Tokio to hire a small steamer for deep-water work. The first vessel that he chartered sank off Misaki, near Aburatsubo, and thus wasted precious weeks of fine weather, but with another he was able to do good work, both on the plankton and on the ground-fauna at various depths down to about 900 fathoms. Much material was also obtained for him by Japanese deep-sea fishermen with "Dabo" lines.

In summer the warm Kuro Siwo waters cover the surface of Sagami Bay, but in winter the north-west winds bring down the cold current to overlie it, so that the self-registering thermometers reveal a layer of warm water between two cold layers. In this warm layer the fauna of the Kuro Siwo is found, while the surface layer has a very different and largely vegetable plankton. As has been said, there is great mortality among both these sets of organisms, with the result that the ground-fauna at all depths, from tide-marks downwards, is extraordinarily rich. The broken nature of the sea-bottom, providing a greatly increased surface and variety of habitat, no doubt contributes to the same result. Another peculiarity of the fauna of Sagami Bay is the appearance in very moderate depths, of sometimes as little as fifty fathoms, of forms which have usually been found considerably lower, at 500 fathoms to 1500 fathoms. Doflein accounts for this partly by the suitably low bottom temperature, but more by the stillness of the water. Many of the so-called deep-sea forms are, he says, more properly still-water forms, specially adapted to absence of motion rather than to the other peculiar conditions of the deep sea, and their vertical range would probably be found to be considerably greater were the same attention to be paid to the exploration of intermediate depths that has been given to the investigation of the shore-belt and the deep sea. This surmise appears extremely plausible.

Bad weather and accidents to his apparatus brought the investigations once more to a standstill, and Dr. Doflein left Japan. On his way home he stayed in Ceylon, and he gives an interesting account of his researches on fungus-growing termites there. Some remarks on the spinning ant Œcophylla bring the book to a close. We have read it with great pleasure. The scientific portions are in places very suggestive, the chapters on the ways and customs of various countries, and especially of Japan, are bright and attractive, and the numerous illustrations are often really beautiful.

L. A. B.

BIRD BOOKS FOR BEGINNERS.

A Handbook of British Inland Birds. By Anthony Collett. With coloured and outline plates of eggs by Eric Parker. Pp. xix+289. (London: Macmillan and Co., Ltd., 1906.) Price 6*s.*

A Pocket-book of British Birds. By E. F. M. Elms. Pp. viii+150. (London: West, Newman and Co., 1906.) Price 2*s.* 6*d.*

IF in these days the way is not made smooth for the young ornithologist it is not for lack of books written in his interest. Mr. Collett thinks that there should be a useful place for a book in which the space gained by omitting the sea and shore birds is devoted to a closer account of the inland species, and the chief intention of his handbook is to supply as plain and simple a means as possible for the identification of those birds, and their nests and eggs, which are to be met with in the inland districts of this country, and are therefore more likely to cross the path of the greater number of persons interested in bird life. Knowing his birds thoroughly well, the author has written most charming and interesting accounts of them, and his long experience of them in the field has enabled him to introduce into his sketches much of the individual character and temperament of each species—those little peculiarities a knowledge of which is only to be gained by long acquaintance, and by which the old hand knows his birds at a glance or by a note heard in the distance. When the object is to teach the beginner in the study this intimate knowledge is very necessary, and all birdmen (who will read the book for the pleasure it will give them) will recognise and appreciate the happy touches of description which arise from it.

As the book will, we think, be in some demand, we offer a few suggestions in view of another edition. To give the salient features of the general appearance of a bird as seen at a little distance should not be difficult, but the descriptions here, in many cases, seem to be hardly sufficient. The fieldfare, for instance, is merely differentiated from the missel thrush (in plumage) as having a more distinct grey patch on the lower part of the back; whereas its greyish head, rich brown mantle, and the blue-grey of the patch on its lower back (from which the bird is sometimes called the "pigeon" felt) might have been pointed out as sufficiently apparent to serve as identification marks. The short wings of the sparrow-hawk might have been alluded to, as well as the want in the cirl bunting of the bright chestnut rump so conspicuous in the yellow hammer; the distinctly colder tints easily seen in life of the marsh compared with those of the reed warbler, and the streaked under parts of the adult Montagu's harrier are merely further instances of the kind of recognition marks we wish to indicate.

As the book is intended for readers whose knowledge of ornithology is of an elementary character, something more about the plumage of the chaffinch than the statement that the hen bird is a good deal duller than the cock is desirable, and the want of it is all the more felt, because the following species, the brambling, is said rather closely to resemble the chaffinch, and is described in comparison with it. The whitethroat is described as if it were uniformly coloured on the upper parts, whereas the greyish head contrasts with its rufous-brown back; and as we are dealing with birds seen at a little distance, it would have given a better idea of the cock stonechat to say that he had a black head than that he had a conspicuous black patch on the throat and face. We should not have said that the pied flycatcher had the appearance of being of slender build, nor can we detect that the eggs of the whinchat are usually a good deal greener and deeper in tint than ordinary hedge-sparrows' eggs. The author thinks that the notion that the mistletoe thrush haunted apple trees for the sake of eating mistletoe berries, and hence got its name, is not confirmed by the bird's actual habits; but we have it on the authority of our greatest living ornithologist (an opinion based on personal observations) that the connection of the bird with the mistletoe is no figment, as some have tried to maintain, and that this thrush is exceedingly fond of the luscious viscid berries of the mistletoe.

While fully allowing that the attempt to put a bird's note into syllables is in most cases a failure (so far as people in general are concerned), there are exceptions, and it would surely have been desirable in the interests of the young field ornithologist to give in words as many of the more remarkable bird-notes as lend themselves to this treatment. The "you-tick" of the whinchat and the "twit me-dick" of the quail (from which the birds take local names), the "hweet-tit-tit" of the redstart and the "chuck-chucka" of the red-legged partridge, are a few cases in point. But to take the case of the curlew as here treated, no mention is made of the fact that some of its varied cries have suggested names for it, and the remark that "the cry recalls some of the notes of the plover, but is far more free and powerful," hardly seems to convey an adequate idea of the curlew's characteristic cries. We wonder if the song of the lesser whitethroat would strike most people as more "quiet and unobtrusive" than that of the whitethroat.

The descriptions of the nests and nesting habits are especially successful, and will be most interesting to experienced bird-nesters, as well as useful to the novice. The coloured figures give, on the whole, a good idea of the eggs, although some of the plates suggest three-colour printing, and that one colour has obtained undue prominence. White eggs are merely figured in outline, and the artist has succeeded in representing the characteristic shape of average specimens. An index, which is all that can be desired, and a classified list of breeding species and regular visitors make reference to the different species easy; but we cannot understand the application of the note to the latter, that the visitors are distinguished by italics, for we find very few names so treated, and among them those of both the yellow and the grey wagtails.

Mr. Elms's thin volume, which slides so easily into the pocket that there is no excuse for leaving it behind on a field day or omitting to take it out every morning during the migration seasons, is intended solely for the purpose of reference in the field. All our British birds (properly so-called) are included, the rare and accidental visitors or stragglers to our shores hardly coming within the scope of the book, as the chances of seeing them during a country ramble are very slight. A vast amount of information has been included in the small compass of this pocket-book; the plumage, period of residence in this country, language, habits, haunts, and food are all treated concisely under their several headings, as well as some particulars of the nidification; but in the last respect it is pointed out that the present volume is intended to be used and carried in conjunction with the new edition of Newman's "Bird-nesting and Bird-skinning," which is of the same size and issued by the same publishers, and contains full particulars of the nests and eggs. Some of the observations on bird language, those on some of the gulls and terns, for instance, do not appear to be altogether satisfactory, but this handy little volume (which is furnished with a good index) cannot fail to be of great service to the student of field ornithology.

A GUIDE TO BRITISH DIPTERA.

A Preliminary List of Durham Diptera, with Analytical Tables. By the Rev. W. J. Wingate. Transactions of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne. (New Series.) Vol. xi. Pp. vii+416; with seven plates. (London and Edinburgh: Williams and Norgate; Newcastle-upon-Tyne: F. and W. Dodsworth, 1906.) Price 9s.

THE author, or, as he would probably prefer to be styled, the compiler, of this excellent manual has done himself less than justice, for if, instead of the modest title associated with the name of a single English county, he had chosen some such designation as that at the head of this notice, he would more accurately have expressed the scope of his work and would also, perchance, have brought the latter to the notice of a wider circle of readers.

Little by little budding entomologists in this country are beginning to realise that butterflies and moths and beetles are not the only orders of insects worthy of study, and the number of those who devote their energies to the flies, or Diptera, though still small by comparison with that of the students of the more popular orders, is steadily increasing. As Mr. Wingate truly remarks in his preface, no other order of insects "has so many interesting and varied life-histories, and none so deeply affects the human race, whether as protectors when acting the part of scavengers, or depredators destroying the crops, or scourges carrying the deadly micro-parasite." Unfortunately for the beginner, the bulk of the literature dealing with European Diptera is in foreign tongues, chiefly German, and, Walker's "Insecta Britannica" being hopelessly inadequate and out of date, it has hitherto been impossible to satisfy the natural demand of the novice for a work in English that, while supplying an outline of the structure and classification of Diptera, will at the same time provide the means for the identification of the bulk of the British representatives of the order. The basis for all work upon British Diptera is, of course, Verrall's "List," the second edition of which was published in 1901. In this are the names of 2884 species, and when it is added that Mr. Wingate's tables, which are chiefly derived from Schiner's classical work on the Diptera of Austria, furnish characters for the determination of no fewer than 2210 of these, it will be seen that the present volume should go far towards supplying the British student with precisely the aid that he requires. In addition to those already mentioned, details are also given of a number of species either identified as British since the appearance of Verrall's "List," or which may ultimately prove to be so, with the result that "characters more or less satisfactory are given for 2526 species," with "localities for 626 of these" which Mr. Wingate has himself collected in the county of Durham during the last ten years.

Turning to the actual contents of the volume before us, we find that, after a couple of pages on collecting and preserving, eighteen pages are devoted to a synopsis of the external morphology of Diptera in the form of a description of a "Fly Chart" (Plate i.) or diagram of a hypothetical Dipteron, so arranged as to display all or most of the characters used in descriptions. This is followed by an analytical table of families, which occupies ten pages, and the remainder of the book, with the exception of a few pages of addenda and indices, consists of tables for the determination of genera and species. In addition to the fly chart, which we think would have been clearer had the shading been omitted, characteristic structural details, such as antennæ, wings, legs, &c., are represented in the six following plates.

So much care and thoroughness have evidently been expended upon this work that there is little room for criticism of any kind; a few minor emendations may, however, be pointed out. On p. 198 attention should have been directed to the vertical stripes of longer hair on the eyes of the common drone-fly (*Eristalis tenax*, L.), which are an easily recognised and distinctive feature of the species. Speiser's name Varichæta is used (pp. 212, 228) for the preoccupied Erigone, Rob.-Desv., instead of Ernestia, Rob.-Desv., which Bezzi has recently shown to be the correct designation. It should be noted that *E. strenua*, Mg., is a synonym of *E. rudis*, Fln. The life-history of *Lipara lucens*, Mg., is not "unknown," as stated on p. 361; the larva mines in the heads of reeds. The Phoridæ (p. 383) are placed in their time-honoured position among the Cyclorrhapha, following the Borboridæ (as in Verrall's "List" of 1901), though, as shown by Osten Sacken, the true affinities of these very aberrant Diptera would appear to be with the Orthorrhapha, the more primitive of the two main divisions of the order. The bionomic notes on the strange-looking Hippoboscidæ (pp. 394–5) lack something in precision: *Hippobosca equina*, L., stated to be "parasitic on quadrupeds, especially horses," is a parasite of horses and cattle; *Lipoptena cervi*, L., also described as "parasitic on quadrupeds," is found on red and roe deer; *Stenopteryx hirundinis*, L., so far as the present writer is aware, is met with on young house-martins, not on young "swallows"; and *Oxypterum pallidum*, Leach, is a parasite of the swift, not of the swallow. As already stated, however, these are details of minor importance. By the publication of this work Mr. Wingate has earned the gratitude of all who are interested in British entomology, and it is to be hoped that, as the result of his labours, he may have the satisfaction of witnessing a considerable accession to the ranks of British dipterists.

E. E. A.

OUR BOOK SHELF.

Illogical Geology. The Weakest Point in the Evolution Theory. By George McCready Price. Pp. 96. (Los Angeles, California: The Modern Heretic Company, 1906.) Price 25 cents.

THE author of this book proposes to collect the opinions of his readers, and a printed form is appended on which comments may be recorded. There is little doubt that a writer so much in earnest will make some modifications in his next edition as the result of friendly criticism. But geologists who have taken the pains to base their conclusions on hard work and study in the field, and not on the perusal of each other's text-books, will remain unsatisfied with Mr. Price until he also has undertaken a course of geological observation. In his introduction he offers a munificent sum to anyone who will "show [him] how to prove that one kind of fossil is older than another." It is not until we read his book that we perceive the intellectual difficulty of accepting this sporting proposition. For Mr. Price believes (p. 20) that geologists assume "that in the long ago there were no such things as zoological provinces and zones"; he believes that (p. 30) the inversion of stratified deposits is nowhere proved by physical evidence; that (p. 46) there are "numerous families" of molluscs and brachiopods which disappear suddenly and completely with early Palæozoic times, and yet are found alive now in our modern world; and that (p. 68) the custom of classifying the Tertiary strata by the relative percentage of living and extinct forms that they contain is "utter nonsense." If Mr. Price would join one of the field-parties from some American university, he would soon find that his quarrel must be with natural phenomena, and not with an imaginary hierarchy of illogical geologists.

G. A. J. C.

The Religion of Nature. By E. Kay Robinson. Pp. xii+215. (London: Hodder and Stoughton, n.d.) Price 3*s*. 6*d*.

MR. ROBINSON has written a book that is sure to interest a large number of readers. His object is to show that there is no cruelty in nature, that animals are not self-conscious, and, therefore, that such pain as they feel is not pain of the kind that human beings are familiar with. It is only "the natural bodily protest of a living organism against injury"; and since there is for animals only this painless pain, and since their cruelty is not really cruel, there is in nature nothing antagonistic to the principles of revealed religion.

No one who knows anything about animals can fail to realise that their capacity for suffering is much exaggerated by extreme humanitarians. A highly-bred pigeon will undergo an operation for hernia apparently without feeling it, and directly it is over will begin quietly to eat his Indian corn. Animals do not suffer in anticipation, they do not brood over the past, and the actual torture, as everyone knows, is often far less than the picture of it that haunts the mind before and after. Let us hope, therefore, that all unreasonable humanitarians will read this book. In the opinion of the present writer, though Mr. Robinson fails to prove his main thesis, yet he makes it clear that the sufferings of animals as compared with those of men are as moonlight to sunlight. In fact, the human race has almost a monopoly of misery as distinguished from short spells of pain.

We can only very briefly trace Mr. Robinson's line of argument. A sensitive plant behaves as if it had feeling, but, being a vegetable, it cannot feel. A sea anemone is an undoubted animal, yet it is not on a higher level than the sensitive plant; it only closes when touched. The argument here is a *reductio ad absurdum.* If you recognise consciousness in the lower animals you must also recognise it in plants. To which we may reply, "Why not?" They may have a very dim rudimentary consciousness. Deny consciousness to all animals except men, and you are confronted with greater difficulties than this. We all believe in evolution. Mr. Robinson himself accepts it. Consciousness must, therefore, have shown itself first in a rudimentary form. Evolution does nothing but develop the powers of which we find suggestions in the simplest forms of life. Nothing, therefore, can have its first beginning in the highest form of life; in the more intelligent animals it is difficult to believe that consciousness is entirely rudimentary. Mr. Romanes's monkey that got possession of the key of a chest and tried hard for two hours to unlock it must have had a fair allowance of self-consciousness. Dogs have dreams. Why may they not even when awake think over their recent fights and adventures? Animals learn by experience; pleasure and pain are the great educators for them as for us. Whittle their pleasure and pain down to nothing, eviscerate both the one and the other of all reality, and how could they steer their course amid the rocks and shoals of life?

Mr. Robinson ends by making a damaging admission. Men, he says, can educate animals and elevate them; but education can only bring out what is already present. There is, therefore, in animals, whether wild or domesticated, something beyond that which Mr. Robinson would concede to them.

Carboni fossili inglesi. By Dr. Guglielmo Gherardi. Pp. xvi+586. (Milan: Ulrico Hoepli, 1906.) Price 5*s*.

IT is undoubtedly advantageous "to see oursels as ithers see us," and the British coal-miner has an excellent opportunity of doing so by studying this attractive manual on British coals, cokes, and briquettes from the pen of an experienced Italian works-chemist. The book is divided into four parts. In the first the various coals are dealt with from a theoretical point of view, the methods of analysis, both rapid and exact, being described in detail. In the second part the British coals are described under the head of the various coalfields, numerous analyses being given, with full references to the sources from which they were obtained. In the third and fourth parts the manufacture of coke and of briquettes receives attention, the subject being one of special importance for the future development of Italian industries. The manual concludes with five maps of the coalfields, and with various appendices containing useful information for the coal merchant. The book, which is the first of its kind written in Italian, cannot fail to prove of value to Italian manufacturers desirous of securing the greatest heating effect with the least expense, by supplying them with accurate information regarding the nature of the coals they purchase. It is written with care and impartiality in a concise and lucid style, and, like all the volumes of the well-known series of "Manuali Hoepli," is produced in a tasteful manner at a modest price.

How to Find and Name Wild Flowers. By Thomas Fox. Pp. xvi+265. (London: Cassell and Co., Ltd., 1906.) Price 1*s*. 6*d*.

DOES the natural system of botanical classification present many difficulties to the beginner? Is the Linnean system simpler? Can an easier method of identification than either of these two be devised? If so, what are the advantages and disadvantages? To those interested in these questions, especially the last, this book is offered as an attempt to provide a solution. The primary means of identification are furnished by the month in which the flowers appear and their colour, after which the size and other details of the flower are taken as the most general guide. With what results? Side by side in the same category are found the frogbit, Italian catchfly, floating water-plantain, common feverfew, and the large-flowered winter-green. This series was taken at random, but is probably one of the most extreme instances. Does a non-technical method of discrimination compensate for this mingling of unallied plants? Will the learner be led to associate them together? Will not considerable difficulties arise with regard to the exact size, also with regard to the colour? As for comparison, after becoming conversant with a flora according to one system it is not easy to gauge the merits of another; but to those wishing to identify plants, and to whom the natural system offers great difficulty, this book may be recommended as an earnest endeavour to provide a substitute.

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.*]

American Chemists and the Jubilee of the Coal-tar Colour Industry.

IN justice to our American colleagues, I think it necessary to supplement the paragraph which appears in your "Notes" of last week (p. 496), and is similar to a statement published in the *Times* of September 6, by the following explanation:—

When the international movement was inaugurated here last February at the meeting held at the Mansion House, America was, of course, invited to participate in the scheme which had been adopted at the public meeting, and for the carrying out of which a fund had to be raised. In response to our invitation, a meeting of American chemists was convened in New York and a number of proposals considered, the final outcome being the scheme set forth in the paragraph published in your issue of last week (September 13). From this it would appear that the Americans had cut themselves adrift from the international movement, and had decided to have an independent celebration in honour of Sir Wm. Perkin and his work. From their point of view—the promotion of chemistry in their own country—there was, of course, very good reason for the line of action which they had decided upon taking, but it is also obvious that their scheme, as published, is purely local, and that if this represented their whole project there would have been every justification for the view taken by our executive committee, that the Americans wished to detach themselves from the European movement.

It is necessary, therefore, to add that the scheme published last week does not represent the latest phase of the American celebration. In addition to the objects set forth in that scheme, provision is made for receiving contributions to the Perkin research fund, founded here as part of our scheme, and loyally supported by all the contributing nations, the representatives of which at the last general meeting of the executive committee on July 27 unreservedly added their contributions to the general fund to be administered through our Chemical Society. At that meeting, as also at the general international meeting at the Royal Institution the previous day, the official representative of American chemists, Dr. Leo Baekeland, confirmed in public the cablegram which we had received from the American committee announcing its decision to cooperate with us and to contribute to our scheme.

The American programme, therefore, is not so purely local as it appears when set forth without qualification. The objects which our Transatlantic colleagues are desirous of carrying out in the name of our distinguished countryman will, I am sure, have the entire sympathy of all English chemists, and, for my own part, I can only wish that every success may attend their celebrations next month. At the same time, I may point out that research in this country is very poorly endowed as compared with the munificent foundations for this purpose established by wealthy Americans. We may, therefore, while wishing that the American jubilee will be productive of all the results which they themselves desire, appeal with confidence to Americans to support also that other part of their own scheme which provides for the endowment of our Perkin research fund. R. MELDOLA.

Blair Atholl, Perthshire, September 15.

Horizontal Pendulums and Earthquake Echoes.

I HAVE just finished reading Captain Dutton's book "Earthquakes in the Light of the New Seismology," the preface of which was written in April, 1904, while the date of publication is 1905. I mention these dates because a paper of mine, bearing particularly on chapter vii. of the book, was read before the Physical Society on March 13, 1903, and appeared subsequently in the Proc. Phys. Soc., vol. xviii.; it also was published in the *Phil. Mag.* for October, 1903. I gather, however, that Captain Dutton has not seen the paper, and as I am not certain of his exact address I am addressing you.

To be candid, I say that Prof. Milne has not considered the effect of resonance sufficiently, if at all, in computing the tiltings represented by his seismograms. Certain screws are placed in the base-plate of a Milne seismograph partly for levelling purposes and partly to give the base a known tilt. Prof. Milne has argued thus (*vide* almost any British Association report): if a tilt of 1″ given to the base displaces the end of the boom 1 mm., then a seismogram of 10 mm. amplitude indicates a tilt of 10″, if it indicates a tilt at all. On this assumption Prof. Milne discusses the tilting theory and discards it (the theory), and also on this view Captain Dutton's seventh chapter is based. That it is a wrong view my diagrams as well as ordinary mathematics show.

I have also given a more prosaic explanation of Prof. Milne's "earthquake echoes" than is to be found in either the British Association reports or in Captain Dutton's book, pp. 235–6. The tilt represented by any seismogram is a function of the boom period, the wave period, the log. decrements of the free vibration of the boom, and of the earth wave, and is, in general, very much smaller than that which is given in the British Association reports. Earthquake echoes may be regarded as interference effects between the free and forced vibrations. I notice that in the diagrams in my paper referred to the fifteen-second wave diagram which shows these interference effects best has been turned round with regard to the others. With the exception of this one, the artificial vibrations all start to the right, and are continued regularly until the end of the diagram is reached, when obviously the swing of the boom dies away naturally.

C. COLERIDGE FARR.

Canterbury College, Christchurch, New Zealand, July 21.

IN a report to the British Association in 1899 I directed attention to the fact that as an earthquake dies its seismograms indicate that it does so in a series of more or less rhythmically decreasing impulses. These, I suggested, were more likely to result from reflection than from interference, and therefore they were provisionally called echoes. Four years later (*Phil. Mag.*, October, 1903) Dr. C. Coleridge Farr discussed the terminal wave group as interference effects between the free period of the recording boom and the period of the ground. Theoretical considerations show their existence, whilst an ingenious experiment carried out by Dr. Farr shows that it is not difficult to reproduce wave groups strikingly similar to those shown in many seismograms. On the two sides of a pillar carrying a pendulum with a period of 16·5 seconds Dr. Farr attached two boxes filled with sawdust. Two chains connected by a rope passing over pulleys hung over the centre of each box. This arrangement was worked up and down at a fixed speed, so that while one side of the pillar was loaded the other was unloaded. By working this arrangement, tiltings were given to the column representing groups of waves with periods varying between twelve and twenty seconds. The resulting diagrams gave three results:—

(1) The amplitudes were greater than those due to steady loading.

The inference is that a horizontal pendulum does not correctly measure the amplitudes of the greater portion of a teleseismic disturbance, a conclusion long recognised by most seismologists. Why, therefore, it may be asked, are columns of figures relating to amplitudes continually appearing in earthquake registers? One reason is that they roughly give relative magnitudes for movements recorded at widely separated stations, and are, therefore, of great value in determining origins. When expressed in angular measure, if the corresponding periods of movement exceed two minutes it is likely that the pendulum has closely followed the tilting which has been recorded. Other reasons may be adduced to indicate that "amplitudes" have a value, and it is, therefore, desirable that they should be retained in registers.

(2) Although the period of the forced vibration was varied in different experiments, the resultant diagrams showed that the pendulum followed the tiltings of the pier.

The converse of this is found in the observation that pendulums with different periods will record the same periods for groups of waves in a given earthquake.

(3) The diagrams showed marked interference effects. For example, forced vibrations of fifteen seconds acting on a pendulum with a period of 16·5 seconds yield a series of throbbings very similar in appearance to many seen in a seismogram.

Although I entirely agree with Dr. Farr as to the existence of interference effects of this description, this by no means excludes the existence of reflection effects or echoes. To commence with, we will consider the first great echo, or Yuri Kaishi. The Yuri Kaishi, or return shaking, which frequently occurs about four minutes after the first shock, was recognised and christened long before the invention of modern seismographs. You feel it, you may see its effects, and, within a meizoseismic area, a seismograph is not required to give evidence of its existence. To regard it as an imaginary reinforcement of earth movement due to a want of synchronism in the period of the same and that of a horizontal pendulum is out of the question. The Yuri Kaishi rattles doors and windows, and causes people to leave their houses. My own view of the phenomena is that it is similar to what is seen when a bullet is dropped into the middle of a large tub of water. Waves travel outwards to the sides of the tub, where they are reflected, after which they converge at the centre from which they started. In nature, the reflecting surface may possibly be represented by the roots of mountain ranges. As these may be at varying distances from the origin of the disturbance, the reflections will give rise to complications at the focus. The transmitting medium I take to be that material beneath the heterogeneous superficial covering of our earth which transmits large waves with a constant velocity of about 3 km. per second.

A megaseismic primary and its echoes may be transmitted to very long distances, and as they travel may by reflection at other surfaces be still farther broken up into minor wave groups. Two wave groups within a megaseismic area might at a great distance from an origin be represented by four groups, and so on. This matter has not yet been carefully looked into, but evidence exists that wave groups increase in their number with distance from an origin (British Association Report, 1897, p. 68).

In support of the explanation I offer for the Yuri Kaishi it may be mentioned that the time interval between it and its primary is in those cases where we know the distance between an epifocal area and a supposed reflecting surface,

...ch as might be anticipated. As an illustration of this I will take the Californian earthquake of April 18. This originated along lines of great length on the western side of that country. The reflecting surface I take to be the Sierras, 200 miles distant. A wave group would travel to the Sierras and back in about four minutes, and this is approximately the time interval between the two first large wave groups in the few seismograms I have of that disturbance.

In offering these suggestions I concur with Dr. Farr that very frequently terminal vibrations of an earthquake present characteristics suggestive of interference effects, but it is premature to suppose that all the peculiarities of a seismogram are to be explained in the same manner. Rhythmical beats at an origin may result in rhythmical beats at a distance. JOHN MILNE.

Shide, Isle of Wight, September 5.

Remarkable Rainbow Phenomena.

ON Monday, September 3, a very heavy thunder-shower passed from west to east over the parish of Deerness, Orkney, from 5.30 p.m. to 6.25 p.m. When the dark nimbus cloud to the west had lifted its pall, the sun came out in great brilliancy. A rainbow now began to form to the north-east, but instead of the ordinary bow there was one of a bifurcated nature. Two stumps which coalesced on the horizon gradually developed into two magnificent bows, which met on both horizons, viz. north-east and south-west, but were about five or six degrees apart at the apex. All the colours of a radiant bow were present in both, and both had the colours arranged in the order of the primary bow. The secondary bow also appeared with the colours reversed and the same bifurcation, but in this case it extended only to about thirty or thirty-five degrees above the horizon, as secondaries generally do. As I had never seen or heard of anything like this, my first impulse was to find a cause. When the double rainbows were at their best, there was a bar of stratus cloud extending across the middle of the sun, and in breadth about one-sixth of its diameter. The two primary bows remained complete from 6.30 p.m. to 6.35 p.m., and without the arc of the apex for about another five minutes.

At first the bow to the south was the more complete, and finally the one to the north. However, after the sun had crept from behind the bar of cloud there were still double stumps clearly visible. If the cause here attributed be correct, then the only explanation of the bifurcated rainbow being visible after the cloud passed is, that from the points of the heavens where the rainbows were the bar might still be dividing the sun's rays. Nothing in my meteorological books indicated that this phenomenon had been previously seen. On inquiring as to what others had seen after the thunder-shower, two friends, one five miles and the other three miles almost directly west of me, saw only a perfect bow and its secondary. Others nearer the position I occupied saw what they called four rainbows, but had observed neither the coloration nor bifurcation clearly enough for descriptive purposes. M. SPENCE.

Deerness, Orkney.

The Mixed Transformation of Lagrange's Equations.

MR. A. B. BASSET, in a letter to NATURE of August 2, states that the theory of the mixed transformation was first given by himself in 1887, and refers to his treatise on "Hydrodynamics," vol. i., p. 171. If he will kindly look at my essay for the Adam's prize, pp. 61–4, he will find an elimination similar to that which he speaks of. The resulting modified functions appear to agree term for term. There is also the introduction of a "modified function" by which we can use Lagrange's equations for some of the coordinates and Hamilton's equations for the others. That essay dates from December, 1876, and was published in August, 1877. The method was afterwards explained without much change in all the editions of my "Rigid Dynamics" which follow that date, beginning with the fourth edition, 1882. E. J. ROUTH.

September 14.

THE RECENT CONTROVERSY ON RADIUM.

THE recent correspondence on the subject of radium, started in the *Times* by Lord Kelvin, has, after lasting nearly a month and causing widespread interest, apparently closed without any very definite conclusion being reached. Whatever opinion may be formed of the merits of the controversy, all must unite in admiration for the boldness with which Lord Kelvin initiated his campaign, and the intellectual keenness with which he conducted, almost single-handed, what appeared to many from the first almost a forlorn hope against the transmutational and evolutionary doctrines framed to account for the properties of radium. The weight of years and the almost unanimous opinion of his younger colleagues against him have not deterred him from leading a lost cause, if not to a victorious termination, at least to one from which no one will grudge him the honours of war. If peace and tranquility now result, and a measure of agreement is arrived at between conflicting views, it will be a result which all concerned will heartily welcome. The most ardent believer in the truth of the new doctrines cannot be other than satisfied that every feature and assumption that is admittedly speculative should be clearly recognised as such and separated from that which is not, if thereby the experimental foundations of the science of radio-activity are freed from further wordy and unprofitable controversy. There seems now to be a reasonable prospect that this has been secured.

Lord Kelvin's opening challenge (August 9) was broad and sweeping. He took exception to the statement, made by the writer in opening the discussion on the evolution of the elements at the British Association at York, that the production of helium from radium has established the fact of the gradual evolution of one element into others, and denied that this discovery affected the atomic doctrine any more than the original discovery of helium in cleveite. The obvious conclusion was that both cleveite and radium contained helium. He also stated that there was no experimental foundation for the hypothesis that the heat of the sun was due to radium, and ascribed it to gravitation.

The challenge was taken up on the other side successively by Sir Oliver Lodge, the Hon. Mr. Strutt, and other well-known authorities, and it soon became apparent that for argument at least Lord Kelvin on his side had to rely practically on himself alone. Prof. Armstrong, it is true, immediately enrolled under Lord Kelvin's banner, and entered the lists with an embracing criticism of physicists in general, whom, he declared, are strangely innocent workers under the all-potent influence of formula and fashion. He made the statement that no one had handled radium in such quantity or in such manner that we can say precisely what it is, and throughout put the word *radium* in inverted commas.

Whether or no his opponents are all as innocent and ignorant as Prof. Armstrong imagines, the fact remains that, except for this *ex cathedra* utterance and a leading article, argument against the accepted view there was little or none except that contributed by Lord Kelvin himself. Prof. Armstrong's letter merely served to provide Sir Oliver Lodge with justification for his favourite theme, which appears to be that whereas chemists have an instinct of their own for arriving at their results, reason is the monopoly of the physicist, whose results the chemist usually manages to absorb in the end. No better argument against the unfairness of this could be provided than by the history of radio-activity itself, which owes at least as much to the chemist as to the physicist. Prof. Armstrong is almost alone among chemists, as Lord Kelvin is among physicists, in his hostility to the new doctrines.

Mr. Strutt in two letters (August 9 and 21) asked what became of the heat generated by the radium admitted to be present in the earth, and recalled the independent evidence of several workers of the continuous renewal of helium from radium. Sir Oliver Lodge directed attention to the magnetic deflection of the α-particle as evidence that material particles are expelled from radium, and in his letter laid perhaps undue weight on the evidence, which is still far from complete, that the α-particle is an atom of helium. The vagueness of this argument, and the fact that the letter raised a doubt whether Lord Kelvin had sufficiently examined the published evidence, a doubt which Lord Kelvin himself promptly dispelled, was the subject of a leading article in the *Times* of August 18. The writer of that article attacked the evidence for the production of helium from radium, using some well-known arguments. The minute quantity of emanation was graphically likened to a bubble rising through a glass of whiskey and soda, and it was held that the results were vitiated by the well-known changes the spectra of gases undergo under the prolonged action of the current, due to occlusion by the electrodes and selective conduction rather than to any transmutation. It may be here remarked that the same arguments were set forth in full by Himstedt and Meyer as a preliminary to their experimental examination of the question, yet Himstedt and Meyer, as the result of their own experiments, were finally forced to the conclusion that helium is in fact produced from radium.

Lord Kelvin in his replies (August 20 and 24) made it clear that he accepted as a fact the continuous evolution of helium from radium, and this admission narrowed very much the issue involved. In reply to a statement of Strutt that if all the helium is removed from radium after an interval a further supply can be extracted, Lord Kelvin remarked simply that the *if* of the statement was wrong. This point was dealt with by the present writer (August 31), who considered the argument could be definitely answered. For helium is produced from the emanation of radium, about which no question of its being really reproduced can exist. For the removal of the emanation is marked by changes in the radio-activity, notably by the β rays, which vanish when the emanation is removed. The recovery of the radio-activity occurs at a definite rate, and is concomitant to the reproduction of emanation, which can at any time be again extracted as before. As there is no question of the radium creating helium, the only point open for argument is the exact character of the decomposition by which it and the emanation which gives rise to it are formed. As there was no further reply to this criticism, it may be taken that the main point of the disintegration theory, that there is a continuous change in the radio-active matter accompanying the radio-activity, is unanswerable.

On the important question as to the character of the decomposition by which the helium is formed, Lord Kelvin in his later letters favoured a view very different from that of mere occlusion, which the original analogy to cleveite suggested. He quoted a statement of Prof. Rutherford in favour of regarding radium as a chemical compound of helium and other elements, and suggested that radium might be made up of one atom of (?) lead and four of helium. In a final letter (September 4) Sir Oliver Lodge pointed out that this was the key of the position. Is radium a compound or an element? It is satisfactory that, after so much fencing with the question, so simple an alternative has been arrived at. Perhaps the most significant thing about the view that radium is a compound is the silence of the chemists. Surely a chemist might fairly be supposed to know whether a change is what is called a chemical change or not, and the fact that it has been left to a physicist to adopt this view seems fair comment. Not even Prof. Armstrong has yet accepted it.

On the second point of his challenge, the denial that the heat of the earth is due to radium, Lord Kelvin naturally had an easier task, for matters connected with the interior of the earth must necessarily remain speculative. If radium did not decompose under the conditions prevailing in the interior it would emit no heat, and would not tend to diminish in quantity, accounting perhaps, although with some difficulty in view of the wide distribution of radium in surface rocks, for the continued existence of the substance at the present time. Mr. A. S. Eve, in a vigorous letter (August 28), stated that he had confirmed the estimate of Mr. Strutt of the amount of radium in the earth's crust by a new method, in which the penetrating radiation from the earth's surface was used as the basis of measurement. Although, of course, in view of the evidence of the independence of radio-active changes upon their environment, it is more of an assumption to suppose that in the interior of the earth radium does not decompose than to take the opposite view, yet clearly here, at any rate, there is plenty of room for legitimate differences of opinion. On the other hand, even the opponents of Mr. Strutt's view cannot deny the potentialities of radio-activity, and the part it might play in cosmical processes under favourable conditions.

The theory that radium is a compound, waiving the qualification *chemical*, will no doubt serve sufficiently well for the present as a point of common agreement. As Sir Oliver Lodge remarked, there is no necessity that the question be settled offhand. As a stepping-stone to further conclusions, it offers advantages to the conservative and cautious. It expresses a bare minimum of established fact which even the most sceptical are unable to invalidate. This minimum, briefly stated, is that radium is undergoing a continuous change intimately connected with its radio-activity, and that in this change helium is produced, and an enormous but definite amount of energy liberated. Whether anything more is known about transmutation now than formerly, whether lead could change into gold or gold into silver with an emission of energy similar to that evolved from radium, whether this or similar energy plays the large share that has been attributed to it in cosmical processes, are questions which may be legitimately discussed and left open, if only for the reason that they are far from decided. They are all admittedly steps into the region of hypothesis.

But what a miserable fraction, even of the known facts, this minimum is! Ostensibly an explanation of radio-activity, it begins and ends with the fact of the gradual evolution of helium from radium. The numerous other products of radium, the volatile emanation and its non-volatile products, known by their characteristic radio-activity, much as minute quantities of ordinary gases and solids are known by their characteristic spectra, the slower changing later products, of which polonium is one, and is chemically as reminiscent of tellurium as its parent is of barium, remain still to be systematically accounted for. On the important subject of the nature of the α, β, and γ rays, and their origin, the view is silent! The fact is ignored that radio-activity is, to use Mme. Curie's happy expression, an atomic property, that is, is independent of the particular state of chemical combination of the radio-element. Radium resembles in the closest possible manner barium, a completely inactive element in the same family of the periodic table, both in chemical nature and in the series relationships of its spectrum. Barium is an element, radium is a compound; but whether uranium and thorium are elements or compounds is undecided. Again, the emission of energy, greater a million-fold than that evolved in any previous material change, remains a mystery in company with the discrepancy between the physical and geological estimates of the age of the earth. The constancy of ratio between the quantities of radium and uranium in all natural minerals is another experimental fact unexplained.

It is the glory of the accepted view that it harmonises and correlates all the preceding problems, offering a simple and unstrained physical explanation of each, capable of being tested by quantitative experiment. In addition, it reaches out in every direction in broad, bold predictions, a few of which, like the production of helium from radium and the constancy of ratio between uranium and radium in minerals, have been brilliantly confirmed by experiment, while the majority simply await more refined experimental methods of attack. Of what other theory could the remark be made, which is attributed to Prof. Rutherford, that when a single experimental fact is established which does not conform to the disintegration theory it will be time to abandon it? The theory would have to be fundamental indeed to pass this test.

The secret of the vague hostility to the new doctrines which the recent controversy has shown to be widely felt is to be found probably in the impossibility of forming from words or reading the least idea of the really startling character of some of the new discoveries. This is particularly true of perhaps the most wonderful of them all, the radium emanation. Even Lord Kelvin in one of his letters speaks vaguely of emanations, while Sir William Crookes, at least until quite recently, employed the word, also in the plural, as a generic term for the *radiations*. Give a scientific man a few milligrams of radium in solution and ask him to perform for himself some of the stock experiments with the emanation, for example, its condensation by liquid air, the concentration on the negative electrode of the active deposit formed by it, the steady decay of its powers after removal from the radium, and the growth of new emanation by the radium, kept, let us say, in another building or another country; then the radium emanation passes from being a phrase to a fact which no theory can safely ignore. The same is equally true of thorium X, radium C, and the numerous other successive products of radio-active change.

It would be a pity if the public were misled into supposing that those who have not worked with radio-active bodies are as entitled to as weighty an opinion as those who have. The latter are talking of facts they know, the former frequently of terms they have read of. If, as a result of the recent controversy, it has been made clear that atomic disintegration is based on experimental evidence, which even its most hostile opponents are unable to shake or explain in any other way, the best ends of science will have been served The sooner this is understood the better, for in radio-activity we have but a foretaste of a fountain of new knowledge, destined to overflow the boundaries of science and to impregnate with teeming thought many a high and arid plateau of philosophy.

F. SODDY.

THE MYSTERIES OF LHASA.[1]

THIS is a new and cheaper edition of Colonel Waddell's account of our recent expedition into Tibet. In its more expensive shape it passed through two editions, and the present one is a marvel of cheapness. Not very many of the illustrations in the issue of last year are omitted in this year's reprint, and the type is the same, so much so, indeed, that it has not been considered necessary to remove from the letterpress references to photographs that have not been reproduced (see, for instance, pp. 369, 374, 406, and 411). It is not often that one can buy a handsomely printed book of 550 pages, with more than 150 illustrations, eight excellent maps and plans, and a very good index for a few shillings.

One of the most alluring things about the book is its title. The contents bear out this title only to a limited extent. It is true that we have here a description of Lhasa and its sights of much the same kind as a guide-book would give of a European city and its sights; but not much of this is very new. We have had descriptions, and even photographs, of Lhasa and its palaces before. What people mean when they speak of the mysteries of the place may include this, but it refers in the main to something very different. The author is well aware of this. He refers in his preface to the curiosity stimulated by the belief that somewhere behind the mighty Kanchenjunga there would be found a key to unlock the mysteries of the world; and the belief in the possibility of this is widely diffused.

The ball was set rolling, though this is not generally known, by the famous Earl of Chesterfield, the author of the well-known letters to his son. This was done in another work of his entitled "The Economy of Human Life," published in 1751. Unwilling at that date to give his views of life and religion under his own name, he wrote anonymously; and the method he adopted was to prefix to his book an elaborate introduction, in which he describes Lhasa, its palaces and its libraries, tells us how the Emperor of China, fully convinced that there could be found in those libraries ancient books of wisdom, sent a learned minister, "of a grave and noble aspect," and armed with an autograph letter from the Emperor to the Grand Lama, to discover them; tells us further how the minister found many "curious pieces of antiquity," and how the most ancient of them all was precisely the original of this "Economy of Human Life"; and finally explains the very curious ways in which this ancient MS. was translated, and then sent to him, who now gives it to the world. It is all very well done—as romance; but it was taken in sober earnest. The book went through more than fifty editions, and has been often translated. No one seems to have divined, until last year, that it was merely an English book of the eighteenth century. The editor of the last English edition (1902) still speaks of it as "this ancient wisdom"; and its great success led to no less famous imitations purporting to be the work of the so-called Mahatmas of Tibet. On these interesting delusions the author merely states that inquiries of learned Tibetans he happened to meet with, and such cursory examination as was possible of the libraries passed on the road, led to no result. Such negative evidence is not of much value. He might have added that the mystery is not in Tibet at all, but in certain phases of European thought.

In this connection it is noteworthy that Colonel

[1] "Lhasa and its Mysteries, with a Record of the Expedition of 1903–4." By L. A. Waddell, LL.D., C.B., Lieut.-Col. Indian Medical Service. Third Edition. Pp. xx+530. (London: Methuen and Co., 1906.) Price 7s. 6d. net.

Waddell gives us the translation of a Tibetan prophecy, copied by himself a year before our expedition was heard of, and that he adds: "How the astrologers of Tibet were able to predict this distressful storm which was in store for their country, so long before it happened, and to specify that it should occur in this very year, is amazing." This is good evidence, not, indeed, of any mystic power in Tibet, but that the astrologers there know the tricks of their trade as well as any Zadkiel. The prediction is beautifully vague. A Chinese or a Russian *coup d'état*, or a civil war, would have suited it equally well, but it was apparently designed to fit some internal commotion. From what Colonel Waddell tells us of the headstrong character of the Grand Lama, and of the cabals and intrigues at Lhasa, that was a highly probable event.

The volume is really a very readable and clear other hand, it seems a pity that Colonel Waddell scarcely does himself justice. We have some interesting and sometimes (no doubt quite justifiably) pungent remarks on the Lamaist system as seen from the outside—the squalor, dirt, and ignorance of the poor, the intrigues and cruelties of the Government, the backward state of trade and agriculture, the decline in population, and so on. We have accounts of the services in the churches, of the images, of the roadside texts, of the appearance of the monasteries, and of one curious hermitage and its ghastly inmates; but of the inner meaning of the religion, the central truths, or what are held as truths, which give to all these outward matters a meaning, which at one time at least must have afforded strength and vitality to the system, we learn little or nothing. Some passages translated from the Litany (pp. 403–4) have both poetic beauty and religious feeling. Perhaps

Camp under Nojin Glacier in Kharo Pass, 16,200 feet. From "Lhasa and its Mysteries.

account of the British invasion of Tibet. To that, eighteen chapters out of twenty-three are devoted, the others being a popular introduction on the history of Tibet and descriptions of Gyantse and Lhasa. The account of the expedition, which thus makes up the bulk of the book, is most interesting. The expedition seems to have been excellently planned and excellently carried out; but no serious opposition was offered until too late, and the desperate bravery of the hastily raised Tibetan peasantry, badly armed and badly led, was no match for the highly trained troops of the little English army, with its superior organisation, guns, and generalship. Only on two occasions did there seem any possibility of even temporary disaster for the invaders. The description of these two anxious moments makes exciting reading, and is quite in the style of the best war correspondents.

In what is told us of Lamaism in Tibet, on the this may be partly due to Colonel Waddell's fine translation; but the absence of anything either superstitious or childish is striking. The texts on the wayside, put up for the edification of passers by (p. 210), are good, sound sense. Both of these, and they are the only passages quoted, seem at utter variance with the kind of tone and spirit described as animating the Lamas. The mystic spell, as it is called on p. 29, *Om! Mani padme. Hung!* is there translated "Hail! Jewel in the Lotus flower!" and reference is made to the figure of the Spirit of the Mountains on p. 23; but that figure represents the god, not as in, but as standing on the top of, a lotus, and the expression seems to us odd and forced if it really conveys that sense. Why should the Spirit of the Mountains be called the jewel in the lotus? The lotus is not a mountain flower. This at least requires explanation, and Colonel Waddell, as a Tibetan and

Buddhist scholar, might, no doubt, had he wished to do so, have quoted a passage from some work held in authority in Tibet giving the explanation required.

There is a charming report in one of the closing chapters of an interview the author had with Gahldan Cardinal, who had been appointed Regent by the Dalai Lama on the eve of his flight. He is described as a man of striking presence, as one of the most learned and profound scholars in Tibet, and at the same time as a man of strong character and skilled in affairs. There are evidently some Lamas who read their books: and though their views and ours may be altogether different, there can be little doubt but that we also, if they were only made accessible by good translations, should find in them valuable materials for the history of that Eastern culture which it is day by day becoming more and more important for us to understand. We are gratified to hear that the able writer of this delightful book is intending to devote the whole of his time in future to these studies; and we trust that he will succeed in unravelling for us some more, and deeper, mysteries of Lhasa.

MINING GEOLOGY.[1]

THE literature of economic geology is by no means inconsiderable, for since the publication in 1884 of John Arthur Phillips's classic work on ore deposits, much attention has been devoted to the study of mineral deposits, and in the United States, in particular, theories of the formation of such deposits have been propounded with bewildering frequency. Prof. Park's text-book under notice, which covers the ground that is gone over in the elementary course in the subject at the University of Dunedin, New Zealand, will, therefore, undoubtedly prove useful to the mining student.

The author deals with the subject in nine chapters. The first contains a brief summary of geological principles, and the following chapters are devoted respectively to the classification of mineral deposits, ore veins, the dynamics of lodes and beds, ore deposits considered genetically, the theories of vein formation, ores and minerals considered economically, mine sampling, and the examination and valuation of mines. The chapter dealing with the genesis of ore deposits is of special interest. The perplexing problems by which the subject is surrounded are judicially dealt with. The fascinating theory of lateral secretion to which great support was given by Sandberger's brilliant researches, although strongly opposed by Prof. Stelzner, of Freiberg, and by Prof. Posepny, of Przibram, found much support in America in a more or less modified form. Posepny's ascension hypothesis has not been endorsed by succeeding investigators in its integrity, and American geologists have gradually developed a conception lying somewhere between the theories of Sandberger and Posepny, with a distinct leaning towards the teachings of the latter. The mode of formation of mineral veins is, however, still very far indeed from being understood. The facts recorded by Prof. Park appear to show that the majority of ore deposits are genetically connected with igneous intrusions which may be plutonic or volcanic. Circulating underground waters and gases are the principal agents concerned in the dissolution, primary concentration, and deposition of vein matter. Ore deposits do not necessarily occupy pre-existing fissures and cavities. Vein-filling was in many cases effected by metasomatic replacement. Vein-filling waters are ascending waters, but not necessarily deep-seated. The mineral contents are derived from rocks contiguous to the zone of fracture or zone of metamorphism. The accessory agents of dissolution are heat and pressure, aided by dissolved alkaline minerals. Precipitation from the ascending waters takes place in more or less orderly horizontal zones in accordance with the laws governing solution and precipitation. Lastly, secondary enrichment is, in the majority of cases, due to the migration of mineral contents from a higher to a lower level, through the agency of descending waters.

Geyser crater at Whakarewarewa, New Zealand, showing siliceous crustification. From "A Text-book of Mining Geology."

Some interesting observations on the action of ascending alkaline waters in New Zealand are recorded by the author. Around Lake Rotorua ore deposits of the solfataric class can be seen still in process of formation on a scale of considerable magnitude. At the hot springs the sinter encrusting the walls of the fissures and pipes from which the waters escape at the surface is hard and chalcedonic, and arranged in layers which often present a fine, ribbon-like structure.

[1] "A Text-book of Mining Geology." By James Park. Pp. ix+219, with 78 illustrations and 3 plates. (London: Charles Griffin and Co., Ltd., 1906.) Price 6s.

A striking illustration showing this siliceous crustification at the geyser crater at Whakarewarewa, New Zealand, is given by the author. Hand specimens of the harder sinters cannot be distinguished from much of the ore at the outcrop of the Martha lode at Waihi. In places the sinters contain finely disseminated marcasite and traces of gold and silver.

NOTES.

A SHORT time ago a petition was presented to the Dean of Westminster asking permission to place in Westminster Abbey a memorial tablet commemorating the life and influence of Mr. Herbert Spencer, but though the appeal was supported by many men of science and letters it was rejected. The reason why the Dean withheld his consent to this unobtrusive memorial of a great philosopher is not clear; and the *Daily Chronicle* has recently revived interest in the movement with the object of inducing him to reconsider his decision, or, failing this, to secure some other national memorial of Spencer's work. From the opinions of a number of distinguished men published in our contemporary, it is evident that much disappointment is felt at the failure to find a place in the Abbey for a simple memorial tablet to Spencer, but there is a difference of opinion as to whether steps should be taken to establish a national memorial to him in some other form. Among the men of science who consider it would be a reproach to leave Spencer's memory unhonoured are Lord Avebury, Prof. Clifford Allbutt, Dr. Bastian, Sir Michael Foster, Mr. Francis Galton, Sir Joseph Hooker, Prof. M'Kendrick, and Prof. Poulton. There is, however, a strong feeling, expressed by Sir Norman Lockyer, that while no national memorial to Darwin exists outside Westminster Abbey, it would be undesirable to attempt to raise one to Spencer by public subscription. Lord Kelvin goes so far as to remark:—"I have never been of opinion that the philosophical writings of the late Mr. Herbert Spencer had the value or importance which has been attributed to them by many readers of high distinction. In my opinion, a national memorial would be unsuitable." Sir William Huggins also hesitates to support a general movement to provide a national memorial, though he agrees that a memorial tablet in the Abbey would appropriately commemorate Spencer's work. In the absence of this form of recognition, it would seem that the best way for admirers of the philosopher to show their appreciation of his work would be to establish a lectureship or scholarship in sociology, natural science, or principles of education, to issue, as suggested by Dr. A. R. Wallace, a cheap edition of his works, or in some other manner to further the objects to which he devoted his life. A movement with an end of this kind in view might be made of international interest, and would doubtless receive liberal support.

THE King has appointed a Royal Commission "To inquire into and report upon the practice of subjecting live animals to experiments, whether by vivisection or otherwise; and also to inquire into the law relating to that practice, and its administration; and to report whether any, and if so what, changes are desirable." The members of the commission are:—Viscount Selby (chairman), Colonel A. M. Lockwood, M.P., Sir W. S. Church, Bart., K.C.B., Sir W. J. Collins, M.P., Sir J. McFadyean, Mr. M. D. Chalmers, C.B., Mr. A. J. Ram, K.C., Dr. W. H. Gaskell, F.R.S., Mr. J. Tomkinson, M.P., and Dr. G. Wilson, with Captain C. Bigham, C.M.G. (secretary). The offices of the commission, which will not sit until toward the end of October will be at Chapel Place, Delahay Street, S.W.

THE Engineering and Machinery Exhibition, which was opened at Olympia on Saturday by Sir Alexander Binnie, president of the Institution of Civil Engineers, is of wide scope, and contains a fine display of British machinery. Some interesting exhibits have also been sent by American and Continental firms. The most striking feature is an electric fountain and air circulator, which occupies the centre of the hall. It is the invention of Mr. James Keith. The fountain is 33 feet in height, and it is surrounded by a shell 15 feet in diameter. In the pedestal beneath are six large electric fans, and air is drawn in from the ground-level, washed, cooled, and re-circulated at the rate of 22,000 cubic feet of air per minute. The illuminations connected with the fountain are brilliantly effective. Numerous other interesting novelties are shown, and the display of machine tools is particularly good. At the luncheon following the opening ceremony, Sir William White, president of the exhibition, pointed out that the basis of the exhibition was mechanical engineering, which was maid-of-all-work to all other branches of engineering. The exhibition was no common enterprise, and the public could not fail to be impressed by the extraordinary variety of machinery applied to the needs of modern life, but also by the keen competition going on in the mechanical industries all over the world. Mr. Bennett Brough, who proposed the toast of the visitors, and Prof. Silvanus Thompson, who replied, also testified to the great value of the exhibition. Special facilities are being afforded to students to visit the exhibition, and an excellent course of popular lectures has been arranged. The exhibition will remain open for a month.

THE death is announced of Dr. H. Cohn, extraordinary professor of diseases of the eyes in the University of Breslau, distinguished by his studies in school hygiene.

THE new Japanese pharmacopœia is to be published shortly. The names of all drugs and chemicals will be given in Japanese characters only. Foreign preparations which have been patented under fancy names will be excluded.

IT is reported from Hong Kong that at 10 a.m. on Tuesday, September 18, a typhoon which sprang up there caused enormous damage to shipping and great loss of life. The storm lasted for two hours.

THE death is announced of Dr. Morache, professor of medical jurisprudence in the Bordeaux Medical Faculty; and of Prof. Leon Prunier, director of the Pharmacie centrale des Hôpitaux civils in Paris, at the age of sixty-five. Prunier's scientific work touched upon many branches of chemistry; his book "Les Medicaments chimiques" (in two volumes) was a recognised treatise in France.

THE Association des Industriels de France contre les Accidents du Travail intends offering a prize of 8000 francs for an international competition for a new galvanic battery or accumulator which, while having a large output for its size and weight, must not be dangerous in use. Inquiries should be addressed to the director of the society, rue de Lutèce, Paris, who will supply further particulars, and to whom competitors must send their descriptions and drawings.

A COMPLETE change of weather set in during the past week, and the drought which continued with such persistence during the closing week of August and the first fortnight of September was at length thoroughly broken. Rain fell on several days over the entire country, and the rainfall in the aggregate now almost equals the average for the month in many parts of England. Temperatures are again in agreement with the normal, and in the past week the exposed thermometer at Greenwich fell below the freezing point on two consecutive nights.

THE fifth biennial meeting of the International Commission for Scientific Aëronautics will be held this year at Milan, from September 30 to October 7. A programme for continuing the meteorological exploration of the atmosphere will be adopted (says *Science*), and it is expected that the president of the commission, Prof. Hergesell, will state the results of soundings of the atmosphere, which he has just executed near Spitsbergen from the Prince of Monaco's yacht, and that Messrs. Teisserenc de Bort and Rotch will give an account of the second Franco-American expedition which they sent last winter to the tropical Atlantic for a similar purpose.

WE learn from the *Times* that the arrangements for the international balloon race which is to take place on September 30 have been completed. Sixteen balloons will be employed in the race, and the aëronauts will represent Great Britain, France, Germany, America, Italy, Belgium, and Spain. The arrangements for the race have been made by the Aéro Club of France, and the start will be made from the Place de la Concorde, Paris. The moving spirit in the contest is Mr. Gordon Bennett, who offers a challenge cup, value 500*l.*, and 500*l.* in cash for the winner. The prizes will be awarded to the aëronaut who goes the furthest distance. The longest distance yet made in any of these expeditions has been 1200 miles, from Paris to Kieff, in Russia, but it is possible that under favourable conditions that record may be broken.

A CONFERENCE of members of the Museums Association and others interested in museum work will be held at Chester on Saturday afternoon, September 22, for the purpose of discussing subjects of common interest to those concerned in the work of museums, art galleries, and kindred institutions. The following papers will be read and discussed :—The nature of the archæological collections in the Grosvenor Museum, Chester, R. Newstead; the nature of the natural history collections in the Grosvenor Museum, Chester, A. Newstead; the comparative method in the exhibition of museum specimens, J. A. Clubb; museum taxidermy, and the status of the taxidermist, J. W. Cutmore.

THE Hull Municipal Museum recently purchased the extensive geological collection formed by the late Mr. George Lether, of Scarborough. Mr. Lether was well known as an enthusiastic collector, and for many years he was engaged in making a collection of the smaller species to be found in the fossiliferous deposits which are so well represented around Scarborough. The Kelloways Rock, Calcareous Grit, Coral Rag, Cornbrash, the Millepore limestone and Scarborough limestone were well known to him, and from these various strata he obtained the collection now at Hull. It is particularly strong in the smaller gasteropods, but in addition contains a fine series of sea-urchins, terebratulæ, ammonites, corals, &c. The collection is one of exceptional value, and is a welcome addition to the local geological collection in the Hull Museum.

REPORTS of disturbances in the earth's crust continue to be received. During the past few days the following shocks of a severe character have been felt:—*September* 12, Santiago de Chile. Between 1.20 a.m. and 5 p.m. numerous earthquake shocks were felt in the region situated between the provinces of Santiago and Maule. The shocks are attributed to the Chillan volcano, which is in full activity. Near the mouth of the Bio-Bio River an upheaval has been produced, leaving part of the bed of the river dry. *September* 13, Sicily.—At 10.43 a.m. a slight shock of earthquake was felt at Palermo, and was succeeded by other shocks later. The inhabitants at Termini and in the neighbouring district are in an indescribable state of panic. All the houses in Trabia are cracked, and many have collapsed. Slight shocks were felt at Rioja, Chilecito, and Santiago del Estero. A more violent shock occurred at Tinogasta, followed by loud rumbling. *September* 17, Shemakha, Transcaucasia.—An earthquake, lasting ten seconds, was felt at 3 p.m. The disturbance appeared to move in a direction from north-west to south-east.

THE subject of malaria in Greece was dealt with by Prof. Ronald Ross, F.R.S., on Monday, in the course of an address at a luncheon given at Liverpool to Prof. Savas, of the University of Athens. Prof. Ross said that at the request of the Lake Copias Company (Limited) the Liverpool School of Tropical Medicine had made an investigation as to the prevalence of malaria in Greece. He went out to that country last May, and found a very serious state of affairs. The population was practically confined to the valleys, the mountains being almost uninhabitable, and in these valleys he found a good deal of malaria. The statistics of the whole country showed that out of a population of, roughly, $2\frac{1}{2}$ millions, there were 250,000 cases of malaria every year, and the deaths were about 1760. Last year the number of cases increased to 960,000, and the deaths to 5916. He was of opinion that it was malaria which checked the life of ancient Greece, and that the disease was introduced, or at all events reinforced, at the time that Greece brought natives of Asia into the country. The movement initiated by Dr. Savas to deal with the plague was one which should recommend itself to all interested in the progress of civilisation.

A DETAILED description is given in the *Engineer* (vol. cii., No. 2644) of some interesting models of rock-drilling and boring machinery that have been added to the cases devoted to this branch of mechanics at the Victoria and Albert Museum.

AN interesting incident of a sparrow caught in a spider's web is reported to the *Spectator* of September 8 by Mr. B. G. Tours, writing from the British Consulate in Chinkiang, China. The web was built across a brick arch, and the sparrow, a full-grown bird, flying through it head downwards became caught in it. All its efforts to release itself only served to add to its discomfort, and the bird soon became exhausted and gave up struggling. Mr. Tours then released it, and he adds that it was "looking and evidently being very uncomfortable in his extra clothes of cobweb." During the whole proceeding the very large spider had not attempted to interfere with the bird, and would probably have waited until it was dead before doing so.

IN *Engineering* of September 14 there is a long description, and a large number of excellent illustrations, of the quadruple-screw steam-turbine-driven 25-knot Cunard liner *Mauretania*, to be launched on September 20 from the Wallsend shipyard. The following are the dimensions of the vessel:—length over all, 785 feet; length between perpendiculars, 760 feet; beam, extreme, 88 feet; depth, moulded, 60 feet 6 inches; gross tonnage, 33,200 tons; net tonnage, 11,000 tons; maximum draught, 37 feet; displacement at this draught, 43,000 tons. The *Mauretania* is 160 feet longer than the *Campania*, of 1893, 78 feet 6 inches longer than the fastest of existing ships the *Kaiser Wilhelm II.*—and 80 feet longer than the *Great Eastern*, the greatest of preceding vessels.

IN Cornwall at the present time, owing to the high price of metals, there is great activity in copper and tin mining, and it is interesting to note, in an important article in the *Times* of September 17, the extent to which scientific methods and the latest improvements in appliances are being adopted at the newly started mines. At the Tywarnhaile mine, for example, with the aid of a gas-power plant and electric pumps, the workings have been drained at the rate of 1400 gallons a minute. This speed has never been approached in the past history of Cornish mines. At the Great Dowgas tin mines, pneumatic stamps will for the first time be driven direct by gas power, and winding and pumping will be electrical. At the Alfred mines a central gas-power plant has also been installed. When work was resumed at the Clitters mine some five years ago, those responsible formed the opinion that the costs of working mines in Cornwall were far too high; that values existed in mixed ores far beyond the knowledge of those then concerned in mining and dressing such ores; and that great improvements in mining and dressing methods were possible. It has been proved that these impressions were true, and future developments in the application of modern scientific methods to the ancient Cornish mines cannot fail to be watched with interest.

THE seventeenth annual general meeting of the Institution of Mining Engineers, held at Hanley on September 12–14 under the presidency of Sir Lees Knowles, was very largely attended, and an interesting programme of visits and excursions was arranged. The report of the council showed that the membership of the institution now amounts to 3034. Mr. Maurice Deacon (Chesterfield) was elected president for the ensuing year. Three papers were read. Mr. W. D. Verschoyle described a new pocket transit, which was really a combined prismatic compass and clinometer, ingeniously arranged for observing very steep angles. Mr. T. Trafford Wynne gave a detailed description of the gypsum deposits of the Dove Valley. The discussion on this paper was well sustained. Mr. Bennett H. Brough pointed out that the author in his introductory sketch of the occurrence of gypsum had omitted to refer to the Paris deposits, which produced two-thirds of the world's supply. The speaker suggested that there was considerable room for improvement in the manufacture of plaster of Paris. Scientific progress had hardly touched the technology of this material, and the temperature of burning and the degree of fineness received no attention. The methods of testing gypsum were now to be investigated by a committee of the International Testing Congress. The charge of want of progress was warmly combated by other speakers, who adduced evidence to show the high degree of scientific method followed in several plaster works in this country. In conclusion, a paper was read by Mr. E. B. Wain and Mr. J. T. Stobbs on the Cauldon Low and Manifold Valley, North Staffordshire, a district of considerable geological interest, in which a large quarry of Carboniferous limestone of very pure quality is worked, and where at one time the famous Ecton copper mine was of great importance.

THE liverworts of Japan have attracted the attention of bryologists on account of the special peculiarities of certain species referable to well-known genera. Mr. A. W. Evans describes and figures a few new or interesting species, mostly collected in the province of Tosa, in vol. viii. of the Proceedings of the Washington Academy of Sciences. A species of Harpalejeunia is interesting as forming a link between that genus and Drepanolejeunia.

TRACING the development of the State Forest Department in West Prussia, Dr. Koenig attributes the foundation of the present system to the personal interest and direction of Frederick the Great. With regard to the extent of forest, the writer is disposed to believe that more land might with advantage be afforested, notably the sandy and other unprofitable areas, provided the land were acquired by the State. The article appears in *Schriften der naturforschenden Gesellschaft* in Danzig, vol. ii., part iv.

IN the *Indian Forester* (July) the editorial article bears testimony to the foresight of the present Commander-in-Chief in India in demanding the preparation of working plans for cantonment forests in India, and summarises a similar scheme drafted by the United States Forest Service for the Military Department for a forest reservation at the military academy army post at West Point, New York. Following on previous references to types of forest rest-houses in India, Mr. E. P. Stebbing deals with those met with in Assam, that from descriptions and illustrations are no more satisfactory than those provided in Burma.

WITH reference to the maintenance of the Imperial Department of Agriculture in the West Indies, an editorial notice appears in *Tropical Life* on the work of botanical and experimental stations. It is appropriate to find in the same number a biography of Dr. J. C. Willis, who has done so much towards bringing the agricultural community in Ceylon into its present prosperous condition. A note on the camphor industry contains a description of the Formosan method of distillation, and the opinion is expressed that the present price of camphor could be reduced to one-third or less before the Formosan monopoly would be endangered.

THE *Museums Journal* for August is entirely occupied with the report of the recent conference at Bristol and an illustrated account and history of the museum buildings of that city. In the latter, the development of the museum and art-gallery is carefully recorded by Mr. W. R. Bacher during a period approaching a century and a half—1772–1906. It is well known that the Bristol Museum possesses a number of natural history treasures, among them an example of the typical southern race of the bonte-quagga, or Burchell's zebra, now apparently extinct, and unrepresented in the national collection.

IN the twenty-first Educational Leaflet, dealing with the scarlet tanager, the U.S. National Association of Audubon Societies (as represented by its president, Mr. W. Dutcher) strikes an important note in asserting that its objects are not limited to the protection of birds, but embrace the awakening of an interest on the part of the agriculturist (as well as the student) in bird-life generally. Undoubtedly this is the right way of looking at the subject, and if it were inculcated and adopted in this country (together with some relaxation of the law in regard to species held to be harmful by practical people), we should probably hear fewer objections to bird protection. The coloured plate shows the male and female tanagers in their respective liveries of black and scarlet and greenish-yellow, and also the cock bird in process of reverting for the winter to the comparatively dull plumage of his mate.

In an article entitled "The Negro Brain," published in the September issue of the *Century Illustrated Monthly Magazine*, Dr. R. B. Bean rejects the doctrine that the negro is the brother of the white man. After demonstrating that the male Caucasian brain is not only larger than that of the negro, but also differs in shape and by the smaller proportionate amount of grey matter and of connecting fibres, the author sums up as follows:—"The white and the black races are antipodal in cardinal points. The one has a large frontal region of the brain, the other a larger region behind; the one is a great reasoner, the other preeminently emotional; the one domineering, but having great self-control, the other meek and submissive, but violent and lacking self-control when the passions are aroused; the one a very advanced race, the other a very backward one. The Caucasian and the negro are fundamentally opposite extremes in evolution." These premises being admitted, it is clear (despite the fact that a negro may occasionally display exceptional mental powers) that to attempt to educate the two races on the same lines is neither more nor less than folly. Incidentally, the author shows that the American negro, in place of being entirely of the Guinea type, includes representatives of the Bushman and of the Bantu (Kafir) types.

In *Canary and Cage-bird Life* for August 31 Dr. A. R. Galloway records a case of cross-breeding in poultry which well exemplifies the Mendelian law. The two breeds crossed were the silkie bantam and the Pekin bantam, the former characterised by the pure white hair-like plumage, bluish-black skin, and small rose comb and crest, while the latter has the plumage cinnamon-buff, the skin pinkish, and the comb simple. Four years ago, when a silkie cock was mated with a Pekin hen, the hybrid chicks—between twenty and thirty in number—were all buff, although with a tendency to small dark markings. Nevertheless, the buff may be regarded as the dominant colour in the cross, but in the hens, at any rate, the black skin and small rose comb and crest of the silkie were apparent. During the present summer a first-cross buff cock paired with a buff hen of the same cross, and, of the eight chicks thus produced, one was a pure white silkie, two were pure buff Pekins, and five showed intermediate characters with regard to type, colour of skin, and colour and character of feather. This is a close approximation, considering the limited nature of the trial, to Mendel's law, which should give two pure silkies, four intermediates, and two buff Pekins. The five intermediates were as follows:—one a buff Pekin with blackish face and silkie-type of feather; one buff Pekin with blackish face and two or three quills white in each wing; one variegated buff Pekin showing about one-third of plumage white, with Pekin-type of face and silkie-feathers; two dark speckled grey, with blackish faces and a good deal of black markings on the feathers.

Some curious results of the Californian earthquake are recorded by Prof. Campbell, director of the Lick Observatory, in No. 108 of the Publications of the Astronomical Society of the Pacific. Fortunately, as recorded in these columns on May 10, the observatory itself was not injured. Subsequent work has shown that the meridian circle and the polar axis of the 36-inch refractor show no sign of having shifted. The period of the earth vibrations was so long that the buildings and the instrument foundations had time to follow the movement without undue strain. There is some fear, however, that the financial affairs of the university and the observatory may be somewhat crippled by the huge losses incurred in property, &c. It is evident from the report that the neighbourhood suffered severely. The motion was chiefly of the horizontal shearing type, and we read of a public road which crossed the fault-line at right angles having its contiguous ends permanently displaced some 17 feet. A large tree standing on the edge of the fissure is 24 feet from the small roots it left behind it. A barn which stood exactly over the fissure, with some four-fifths of the structure on the west side, was badly wrecked, but the part of the foundations and superstructure situated on the west side remain, whilst the foundation lying east of the fissure has moved southward, under the barn, through 18 feet. Many similar instances of movement are recorded. About twenty miles westward of Mount Hamilton, on the fault-line, the maximum shift is about $8\frac{1}{2}$ feet. As all the displacements referred to are in thick, loamy soil, which would tend to lag, it is probable that the shear in the underlying rock stratum is still greater. Some interesting questions as to farm boundaries, latitudes, and azimuths may be expected to arise. A commission, including Profs. Campbell and Leuschner, has been appointed by the Governor to study the scientific aspects of the phenomenon.

In a letter from Glasgow, Mr. A. Mclance suggests that lead should be found in radio-active minerals containing radium. In a paper by Mr. Boltwood in the *Philosophical Magazine* for April, 1905 (p. 613), evidence is given of the existence of lead in all radio-active minerals. Mr. Mclance points out that if the atomic weight of radium is taken as 258, as found from spectroscopic observations by Runge and Precht, and the combined atomic weights of the five helium atoms into which the radium atom is believed to dissociate are subtracted from it, the atomic weight of uranium is obtained.

A sumptuous catalogue of telescopes and accessories has been published by the firm of Carl Zeiss, of Jena, under the specific designation "Astro: 8." Especially compiled for scientific amateur astronomers, the catalogue only deals with telescopes of less aperture than 8 inches. Several new constructions are now catalogued and illustrated for the first time. In addition to the numerous azimuthal and equatorial telescopes, the catalogue contains illustrations and prices of a large variety of eye-pieces, sun oculars, prominence and other spectroscopes, position micrometers, the stereo-comparator, &c., and should be consulted by all astronomers in need of telescopes or accessories.

In No. 72 of the *Chemiker Zeitung* Dr. P. N. Raikow, of the University of Sophia, describes a simple method of boring any number of small holes through glass tubing, both thin and thick, watch glasses, flasks, &c. The part which it is desired to pierce is carefully warmed up in a Bunsen flame, and then a red-hot needle worked bradawl-wise against the particular spot, which naturally must not be so hot that any slight pressure causes the walls of the vessel or tube to be forced out of shape. The broken stem of a thermometer is said to provide an especially good handle for the eye end of the needle to be inserted into.

OUR ASTRONOMICAL COLUMN.

Jupiter's Sixth Satellite.—A telegram from Prof. Campbell, published in No. 4119 of the *Astronomische Nachrichten*, states that Jupiter's sixth satellite was re-observed by its discoverer, Prof. Perrine, on August 26·9656 (G.M.T.). Its position angle at that time was 209°·92, and its distance from Jupiter 1734″.

Holmes's Comet (1906*f*).—In No. 4121 of the *Astronomische Nachrichten* Prof. Max Wolf states that he has measured the position of Holmes's comet on the plate secured on August 28. He gives the exact position, for 1906·0, at the time of discovery, and this shows that corrections of +6·79s. and +28″·2 are necessary to Dr. Zwiers's ephemeris. As the comet is extremely faint, mag. = 15·5, a continuation of the ephemeris is not given here, but will be found in No. 4085 of the *Astronomische Nachrichten*.

Observations of Solar Phenomena, 1906.—The results of the observations of sun-spots, faculæ, and prominences made during the first semester of the present year at the Catania Observatory are published by Prof. Mascari in No. 8, vol. xxxv., of the *Memorie della Società degli Spettroscopisti Italiani*.

The mean daily frequency of spots was higher during the second than during the first quarter, the respective numbers being 5·68 and 4·50; the faculæ behaved similarly. For prominences the reverse was the case, there being a mean daily frequency of 4·38 prominences during the first quarter and 3·47 during the second. Discussing the results in relation to the time of the solar maximum, Prof. Mascari places the epoch of maximum spots at 1905·2, and that of faculæ and prominences in the last quarter of 1905 or the first quarter of 1906.

Observations of Jupiter.—The observations of Jupiter made by Mr. Denning during the last opposition showed that the rotation period of the Great Red Spot and its Hollow, in the south equatorial belt, between March 24 and May 4, was 9h. 55m. 40·6s., a period practically conformable with that of system ii. of the ephemerides. On observing the phenomena on August 9, however, he found that they were far in advance of their predicted places, an observation confirmed by the Rev. T. E. R. Phillips. From this it appears that the rotation period between May 4 and August 8 was only 9h. 55m. 33·8s. Mr. Denning supposes that the conjunction of the dark material, forming the south tropical disturbance, with the Red Spot, in June last, may have caused the marked acceleration of the latter, as it has done on several former occasions. The present increase of velocity is, however, much greater than any previously observed, and these features appear to have been observable for seventy-five years (the *Observatory*, No. 374).

In the September number of the *Bulletin de la Société astronomique de France* M. Flammarion directs attention to a remarkably sudden change in the visibility of the north equatorial band on Jupiter. This band has been diminishing since the end of 1903, and an observation made by M. Benoit, at Juvisy, on April 10, 1906, showed that it was almost completely invisible. After its conjunction with the sun, Jupiter was observed again on July 17 by M. Quenisset, who was astonished to find that the north equatorial band was completely reformed, being even broader, and at some points darker, than the south equatorial band. A drawing, made by M. Quenisset on July 23, is reproduced with the article.

The Kodaikanal Observatory.—An interesting popular account of India's solar physics observatory, situated at Kodaikanal, on the Palani Hills, appears in the July number of the *Madras Christian College Magazine*. Mr. Monteith Macphail, the writer of the account, lately visited the observatory, and was evidently impressed with its situation and its work. The altitude of the observatory is about 7700 feet, in an atmosphere of exceptional transparency, and amid beautiful surroundings.

Although located in Madras, the institution was founded, and is supported, by the Government of India, thus having a national and not merely a provincial status. Its chief *raison d'être* is the continuous study of the sun, with the ultimate idea of elucidating still further the indicated relationships between solar and terrestrial atmospheric phenomena. To a country like India, the value of possessing the fullest possible knowledge of these relationships cannot be overestimated, and that is the reason why the Government of India has seen fit to found and to support this observatory and its equipment in the most favourable situation at its command. Sun-spots, their spectra, and prominences on the solar limb, are observed visually, and spectroheliograms of the solar disc and limb are taken on every day on which the atmospheric conditions are suitable. Magnetical and seismological records are also taken.

CHEMISTRY AT THE BRITISH ASSOCIATION.

It was somewhat noticeable that the trend of the proceedings in Section B this year was in the direction of applied chemistry; general problems on the theoretical side of the science came under discussion in Section A; if this indicate either that this section is becoming alive to the importance of chemistry to physics or a rapprochement of the two sections, it is a good sign, but it is not satisfactory if it mean the neglect of broad considerations by the chemist.

Reports were presented by Mr. S. S. Pickles, on the chemistry of rubber; on that of gums, by Mr. H. H. Robinson; and on the hydrolysis of sugars, by Mr. R. J. Caldwell. These gave rise to more or less interesting discussions and were a valuable feature of the meeting. Discussion also centred round a paper by Dr. T. A. Henry, on the production of hydrogen cyanide in plants. The joint discussion with the physiologists on diet was of great interest, although it was mainly developed in physiological and sociological directions.

The proceedings opened on the Thursday, August 2, with an important paper by Messrs. S. Leetham and Wm. Cramp, who have been engaged in perfecting an apparatus for the production of an active mixture of gases which may be used for bleaching and sterilising purposes, particularly in bleaching flour. The apparatus consists of an alternator, transformer, ozoniser and spark box, the two latter being in series on the high-tension side of the transformer; on passing a current of air through the ozoniser and then through the spark box a gaseous mixture is produced, containing minute amounts of ozone and oxides of nitrogen, which has a very remarkable bleaching and sterilising action on flour; the process is already one of considerable commercial value. The bleaching action appears to be an oxidation effect.

The authors have studied in great detail the behaviour of the different types of electric discharge and the influence of such factors as the number and distance apart of the discharge points, shape of the points, the air velocity and the frequency. The conclusion arrived at is that ozonisation is not a mere induction effect. In commenting on the paper, Prof. Armstrong dwelt on the importance of manufacturers taking interest in science, and referred to the work as an illustration of the advantages of such co-operation.

Following a short paper by Prof. van Romburgh, of Utrecht, on the 1:3:5-hexatrien, reports were read of the committees on dynamic isomerism, on hydro-aromatic substances and on aromatic nitro-amines. The rest of the morning was devoted to inorganic chemistry, papers being contributed by Mr. A. Vernon Harcourt, on the effect upon the concentration of a solution of the presence of an excess of undissolved salt; by Mr. G. Beilby, on the crystallisation of gold in the solid state; and by Prof. H. A. Miers and Miss F. Isaac, on the temperature at which water freezes in sealed tubes; this is found to be very considerably below that at which solidification takes place in open vessels.

The greater part of Friday, August 3, was devoted to a discussion on the production of hydrogen cyanide in plants, introduced by Prof. Dunstan, who pointed out that in the case of both *Lotus arabicus* and *Sorghum vulgare* the cyanide was formed only during the early stages of growth, and that it was missing in the mature plant. The fully-grown Lotus vetch is much used as a fodder plant in the Nile valley, but many fatal cases of poisoning have been caused through its use in the immature state. Hydrogen cyanide has also been detected in Java beans, of which there are several varieties; the maximum amount is found in the dark beans, and it is only safe to use the light bean. In the flax plant, which also affords hydrogen cyanide, the maximum amount is produced at an intermediate stage when the plant is from 4 inches to 5 inches high.

Dr. Henry followed with an account of the glucosides containing the hydrogen cyanide, which have been grouped together as cyanogenetic glucosides. They are allied to amygdalin, the active principle in bitter almonds, which is therefore the oldest known representative of the group. The list at present comprises, besides amygdalin, sambunigrin, prulaurasin and a glucoside, prepared artificially from amygdalin by Fischer, known as mandelnitrileglucoside, all of which are resolved by acids into glucose, benzaldehyde and hydrogen cyanide; further, dhurrin, phaseolunatin, lotusin and gynocardin.

The plants containing these glucosides also contain enzymes, which resolve them—when the plant is macerated with water—into hydrogen cyanide, glucose and a third constituent. The question was raised as to the *rôle* of the hydrogen cyanide, whether it acted protectively or whether it played a part in the production of proteid from nitrates. Dr. Greshoff, of Harlem, dealt with the question from the botanical side, and put forward a list of all the species of plants known to yield hydrogen cyanide, which will be of great value to future workers.

A paper on the utilisation of atmospheric nitrogen by plants, read by Mr. Thomas Jamieson, described what the author regarded as special organs in plants adapted for the direct absorption and assimilation of nitrogen from the air. His conclusions were most severely criticised by Prof. Potter from the botanical side, and by Mr. A. D. Hall and others.

The report on caoutchouc, presented by Mr. S. S. Pickles, contained a general survey of the chemistry of this remarkable product.

Prof. Karl Harries, of Kiel, in a communication read by Dr. Crossley, dealt with the products obtained by submitting caoutchouc to the action of ozone, and then distilling the ozonide with steam, viz. lævulinic aldehyde, lævulinic acid and hydrogen peroxide. Harries concludes that caoutchouc is a polymer of a 1:5-dimethyl-cyclo-octadien. Prof. W. A. Tilden described his observations on the behaviour of isoprene, prepared from oil of turpentine; when kept it gradually polymerises, being converted into a substance having many of the properties of caoutchouc. He also contributed a paper on the constituents of *Dyera Costulata*.

Mr. H. H. Robinson followed with a brief account of the chemistry of gums, dwelling especially on gums from India and the colonies which afford acetic acid when exposed to the action of moist air. He suggested that by partially hydrolysing the inferior Indian gums they might be made of greater industrial value. In the subsequent discussion, Mr. S. H. Davies stated that constitution had so far been found to have little bearing on the technical value of gums, viscosity being the quality chiefly required.

In his report, Mr. R. J. Caldwell collected and critically discussed the literature bearing on the hydrolysis of sugars, a subject of considerable interest at the present moment on account of its bearing on the theory of ionic dissociation and the nature of solution. Nearly 150 papers have been published on the subject, so that it is very difficult for a new worker in the field to acquaint himself with the literature. Mr. Caldwell has made a brief abstract of the essential points in each paper, and classified them in historical order under a number of appropriate subheadings. He sums up the evidence as to the nature of the change, and points out the unsatisfactory character of the argument based on the dissociation hypothesis that it is brought about by the hydrogen ions of the acid. He is inclined to believe that the facts are to be explained by an association hypothesis.

A large part of the morning of Tuesday, August 7, was devoted to a joint discussion with Section I (physiology) on the factors which determine minimal diet values. This was opened by Dr. F. G. Hopkins, F.R.S.; Prof. Dunstan and Prof. Armstrong spoke on the chemical side. It was generally agreed that the subject was of supreme importance, and one that should be attacked conjointly by chemists and physiologists. Dr. Hopkins dealt chiefly with the standards of minimal diets put forward by Atwater, Voit and Chittenden respectively. These are incorporated in the following table:—

Investigator	Energy value in calories per diem	Protein per diem
Atwater	3500	125
Voit	3050	118
Chittenden	2600	55

The methods and results of these workers were considered and criticised in detail. While Atwater's standard was thought to be too high, it was generally agreed that Chittenden's values were too low. Voit's standard was accepted as the most probable.

Mr. Seebohm Rowntree's well-known experiments carried out in York were referred to, and it was pointed out that in studying actual dietaries of poor families averages were used in compiling statistics, a method which is open to criticism, as the bread-winner—owing to the self-denial of the woman—as a rule, gets far more than his share, so that the diet of the average working man is actually in most cases far richer in protein and has a greater energy value than is imagined.

Attention was directed by Dr. Hopkins—and this point was particularly emphasised by Prof. Armstrong—that it was not justifiable to consider merely the gross amount of protein, but that the nature of the protein had also to be taken into account. Thus, for example, wheat is probably not the best form of protein, its main constituent, glutaminic acid, being, so far as our present knowledge goes, of relatively little value as a tissue former compared with other amino-acids. Maize protein is perhaps of even lower value, whereas rice and oats, among the cereals, appear to be the especially valuable sources of protein. Prof. Armstrong particularly referred to the need of making detailed study of foodstuffs, our present method of referring to the nitrogen content generally multiplied by a factor as protein giving no true guide as to the relative value of foods, inasmuch as protein is a highly complex material, made of ever-varying units, the nutritive value of which taken singly varies within wide limits.

The rest of the morning was devoted to agricultural chemistry, Messrs. A. D. Hall and C. T. Gimingham contributing a paper on the action of ammonium salts upon clay and kindred substances, following which Dr. E. J. Russell read a communication by Dr. F. V. Darbishire and himself on oxidation in soils and its relation to productiveness. These authors have devised an apparatus for measuring the rate of absorption of oxygen; the power of absorbing this gas possessed by all soils appears to be due mainly, though not entirely, to the activity of micro-organisms. The rate of oxidation does not entirely depend on the amount of organic matter present in the soil; moisture is essential, and as it increases so also does the rate of oxidation. The rate is also increased by the addition of calcium carbonate or of sugar. For a series of similar soils, of which the cropping power is known, it is found that the most productive has the highest rate of oxidation, and that the others follow in the same order for both properties. The parallelism holds also for soils which have been artificially treated; it is essential, however, that the soil conditions should be aërobic. The authors suggest that the rate of oxidation affords a measure of the bacterial activity, which is closely connected with productiveness.

The last paper read was by Mr. W. Popplewell Bloxam, on a new method of determining indigotin. After pointing out the need of a method of controlling the still very crude processes in vogue for extracting indigo, and the importance of determining the daily yield of indigotin obtained in an ordinary factory from known weights of green plant, the existing methods of analysis were discussed and the uncertainty of the results they afford alluded to. In the author's method, the indigotin is sulphonated by treatment with fuming sulphuric acid (containing 20 per cent. sulphur trioxide); the solution is then diluted, and the potassium salt of indigotin tetra-sulphonate precipitated by means of potassium acetate. Finally, the amount of indigotin in the salt is estimated by titration with potassium permanganate or titanium chloride. The author concludes that the present process of manufacture is a wasteful one, the highest efficiency attained not reaching 50 per cent., whilst on the average only 25 per cent. of the indigotin in the leaves is extracted.

THE PHYSICAL GEOGRAPHY OF VOLCANOES.[1]

IN my discourse this evening I shall confine myself to that branch of vulcanology to which I have paid particular attention, viz. the naked-eye study of volcanoes and their various constituent parts, their relations to one another and to adjacent rocks and to other objects; how they got to their present position and what effects they produce; in other words, the physiography or physical geography of volcanoes. As this subject is itself too large, I propose to take up the late eruption of Vesuvius, alluding to other volcanoes and their eruptions only by way of illustration, comparison, or contrast.

FIG. 1.—Vesuvius from Cook's Eremo Hotel near the Observatory, April 26, 1906. Shows the rounded top of the cone and the ash slides on it. Colle Umberto I in the foreground.

The south-east side of the Bay of Naples, which consists of the Sorrento Peninsula and the island of Capri, is a branch of the Apennine Chain; it consists largely of Apennine limestone of Cretaceous age, and is not volcanic. The north-west side of the Bay, on the contrary, is almost entirely volcanic. Thus the island of Ischia is subject to severe earthquakes, and contains Monte Epomeo, which has been twice in active eruption in historic times; the islands of Procida and Nisida contain craters; the Phlegræan Fields consist of numerous cones and craters, one of which, Monte Nuovo, was formed as recently as the sixteenth century. Moreover, Naples itself is built on volcanic strata. The whole district is subject to changes of level.

Coming now to Vesuvius, it is a matter of common knowledge that it consists of twin mountains, of which one, Somma, is part of an old crater ring of gigantic size which no longer forms part of the working cone, which it partly surrounds, and from which it is separated by a great valley, called in different portions Atrio del Cavallo and Valle d'Inferno, while Vesuvius, the present active cone, occupies the southern part of the great crater which was formed by the destruction of that side of the Somma crater ring, probably in the Plinian eruption which destroyed Pompeii and Herculaneum in A.D. 79, or possibly in some earlier unrecorded eruption. The observatory is situated on a projecting spur forming part of the old Somma ring, but separated from that mountain by a deep valley, the Fossa Vetrana, at the upper part of which took place the prolonged eruption which lasted from 1895 to 1898, and which built up a considerable hill, the Colle Umberto I°. Photographs of this place, taken in 1888, showed the scoriaceous or cindery lava of 1872, coulées of slaggy or ropy lava in 1898, a moving mass of scoriaceous lava and the growing cone in the same year, while a photograph of the latter, taken at night by the light of the incandescent lava streams themselves, excited much interest, and it was followed by another showing the same cone in 1906 covered, and its surface obscured, by a thick coating of ash from the last eruption.

In the Strombolian type of eruption the explosion takes place from more or less liquid lava, of which portions are hurled into the air, and by their rotation often assume pointed or even globular forms, which are permanently preserved by the solidification of the mass while in the air. In the Vulcanian type, the materials, which are affected by the explosion, being already solidified, the ejecta are chiefly fragmentary, varying from dust of microscopic fineness to "bread crust bombs" weighing several tons. The latter owe their name to the characteristic crackings on the surface caused by the contraction of the crust when suddenly projected into the cold air, perhaps aided in some cases by the expansion of gases set free in the interior owing to the sudden reduction of pressure.

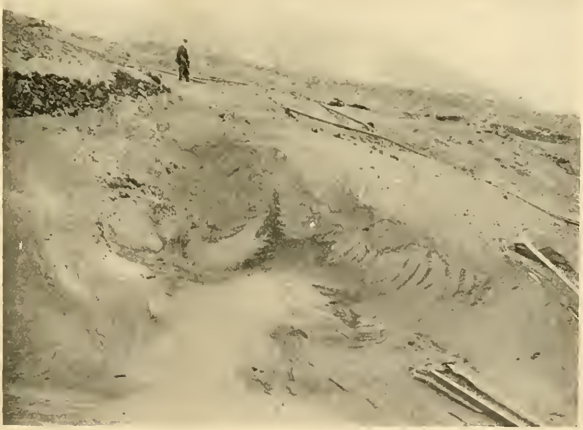


FIG. 2.—Vesuvius. Ash slide carrying away Cook's Railway. April, 1906.

[1] Substance of a discourse delivered before the British Association at York on Friday evening, August 3, by Dr. Tempest Anderson.

The Pelean type goes a stage further. In it a large proportion of the eruptive magma is blown to fine powder by the expansion of the gases it contains, and thus a mixture is produced of volcanic gases and incandescent dust in which each particle is surrounded and cushioned by an extremely thin layer of gas at a very high temperature, and therefore excessively mobile. The whole mass is therefore endowed with the mobility of a liquid, and under the influence of gravity rolls down slopes on which ordinary solids would lodge. This explanation of the hot blast which destroyed St. Pierre was first advanced by Dr. Flett and the lecturer in 1902, after witnessing an eruption of Mont Pelée, and it has since been generally adopted.[1]

In that year the Wallibu Valley at the foot of the Soufrière, in St. Vincent, was filled by such an incandescent avalanche to a depth of 80 feet, and the Rabaka Valley to a still greater depth. The torrential tropical rains, descending these valleys after the eruption, came in contact with this hot ash and caused various secondary phenomena, such as steam explosions, falls of ash, and gushes of boiling mud, which the lecturer compared with analogous, though somewhat different, phenomena during the late eruption of Vesuvius.

This eruption, as is usual with those of Vesuvius, presented features both of the explosive and effusive types, *i.e.* explosions took place from the central crater, while a great fissure traversed the cone from north to south, and lava was discharged both to the north into the Atrio del Cavallo and also from, chiefly, three or four more *bocce*, or mouths, along the fissure to the south, which descended in the direction of Bosco Reale, Bosco Trecase, and Torre Annunziata.

The chief interest of the eruption of Vesuvius, however, undoubtedly centred round the explosions, the ejecta, and the secondary phenomena in connection with them. The volcano was in unusual activity in April and May, 1905, and had never been absolutely quiet since that time. From April 4 to April 8, 1906, and to a less degree later, a series of explosions took place which enlarged the great central crater to an average diameter of more than a quarter of a mile (as measured by Prof. Loczy), removed the highest central part of the cone, and thus reduced the height of the volcano by about 350 feet, as measured barometrically by the lecturer's party. The resulting débris was distributed in part over the flanks of the cone, while a larger amount of smaller material was carried to the other side of Somma as far as Ottajano and San Giuseppe. In these villages it attained a depth of 3 feet to 4 feet, and broke down the roofs of many houses, and more than one church. In that of Giuseppe, about 250 persons, who had taken refuge, were buried by the débris and met their death. The crater as seen by the lecturer's party on two ascents was oval or heart-shaped, the longer diameter being north and south, the walls sloping somewhat at the top, while lower down they were precipitous, especially towards the south side. At the north side the slopes were somewhat more gentle and the crater wider, while the lip was much lower, and broken down into a sort of plain some yards wide. This section of the crater corresponds exactly with a diagram in a report by the Academy of Sciences of Naples on the eruption of 1737. This eruption seems to have been very similar to that of the present year, and, as in this case, several persons lost their lives at Ottajano. There can be little doubt that the projection of fragmentary material in the direction of Ottajano was in both cases principally due to the shape of the crater when thus, so to speak, re-excavated. A contributing effect was the south-west wind, which blew so strongly as to carry some of the finer material as far as Nola. The wind's effect was to be clearly seen in Naples, where several inches of dust were deposited.

The larger ejected blocks fell chiefly during the earlier part of the eruption on the slopes of the cone and round its foot, where they were mingled, and to a large extent covered up, with much ashes and scoriæ. Here were to be seen the most interesting phenomena of the eruption, viz. the great ash slides. The cone was previously almost smooth and very regular in outline. It consisted of lava streams and dark-coloured ash; in April, 1906, it was thickly covered with whitish ash. This, when it attained a certain thickness, peeled off in veritable avalanches and slid down the mountain. The tracks present a radial appearance, and did so before any rain had fallen. It seems likely that the well-known umbrella-like markings on volcanic cones of tuff (consolidated ash), which have usually been attributed solely to erosion by rain, may in some cases, at any rate, be due to this cause. The avalanches were of sufficient power to carry away the Cook Railway. In one part below the funicular station the rails were bent like wire, and remained for a hundred yards or more along the sides of the avalanche track at right angles to their former position. They were kept together by their fish-plates, but had been entirely stripped of the sleepers. No stratification or particular structure in the materials brought down was noticed. A look out was kept for Lava del Fango (mud lava), which has often caused much damage after Vesuvian eruptions, but there had been no rain to form it before the lecturer's arrival, and comparatively little fell during his visit, so that only very small flows were seen. Prof. Lacroix, however, was fortunate enough to observe a large stream of mud above Ottajano, and he remarked that the resulting breccia was a little harder than the result of the dry avalanches, but presented no particular stratification or other structure by which it could be distinguished from the products of a dry avalanche of the same materials. Consequently no light is thereby thrown on the question whether many tuffs, such, for instance, as those which entomb Pompeii, were deposited, dry or wet.

The lava of this eruption also deserves mention. Flows occurred from the north and south ends of the fissure through the cone above mentioned. That to the north flowed into the Atrio del Cavallo in the early part of the eruption. It was soon covered up with fragmentary ejecta, and at the time of the visit only a few fumaroles remained to mark the course of the fissure. On the south side of the cone three or four *bocce*, or mouths, opened along the fissure, the streams coalesced, and the lava flowed thus for more than half a mile. It then divided into branches, which to a large extent destroyed the villages of Bosco Trecase and Bosco Reale, and nearly reached Torre Annunziata. It crossed and filled up a cutting on the Circumvesuvian Railway.

The discourse concluded with a number of photographs of explosions from the crater taken by the lecturer during his stay of five nights at Cook's Eremo Hotel, near the observatory.

[1] See Anderson and Flett, Phil. Trans., series A, vol. c ., p. 353 *et seq.* (1903); also Anderson, *Geographical Journal*, March, 1903.

THE ASCENT OF RUWENZORI.

MR. DOUGLAS W. FRESHFIELD gives in the *Times* of September 13 some authentic details of the success of the Duke of the Abruzzi's expedition to Ruwenzori, from a letter received by him from Signor Vittorio Sella, who accompanied the expedition. Signor Sella wrote to Mr. Freshfield under date July 22, from Fort Portal:—

"His Royal Highness, accompanied by two Courmayeur guides, climbed all the five highest snowy peaks of Ruwenzori and took from them observations with a mercurial barometer besides a great many bearings with a prismatic compass. Captain Cagni carefully measured a base-line near Bujongolo in order to ascertain the exact distance between the highest peak of Kiyanja (which he climbed) and the rockshelter Kichuchu. His Royal Highness will therefore be able to publish a really good and complete sketch map of the snowy portion of the chain. Following in his Royal Highness's footsteps I ascended several high peaks and took many photographs and panoramas. I also secured many pictures in the forests and valleys of Mubuku and Bugiogo (the largest tributary of the Mubuku), and some telephotographs of the chain from near Butiti. The weather, however, was very trying to our patience. From June 12 to July 7 we had not a single really fine day.

"His Royal Highness from his barometric observations will soon be able to calculate and give the correct heights of the crowning peaks of Ruwenzori, which are several hundred feet higher than Kiyanja and situated north-west of it. They have no connection with the Mubuku Glacier."

Mr. Freshfield finds that a rough sketch plan of the snowy group, sent by Signor Sella, coincides closely with the diagram of Lieut. Behrens, R.E., published in the *Geographical Journal* for July last, and concludes that "there seems little doubt that the highest summits measured by our engineers are identical with the Duke of the Abruzzi's Ruwenzori." Hence the height of the Ruwenzori range may be taken as 16,625 feet.

The chief topographical discovery made by the Italian expedition, apart from its mountaineering successes, seems to be that the northern fork of the Mubuku, called by Signor Sella the Bugiogo, is of hitherto unsuspected importance. Its stream flows round a bend, which conceals its sources from the lower valley. Beyond this lies a basin penetrating far into the heart of the chain, at the head of which, and on the actual watershed, the highest peaks stand.

THE TORONTO MEETING OF THE BRITISH MEDICAL ASSOCIATION.

THE annual meeting of the British Medical Association, held on August 21–25 at Toronto by invitation of the Canadian Branch, under the presidency of Dr. Reeve, the dean of the medical faculty of the university, was a marked success. The city is a fine one, and the university buildings in the Queen's Park are admirably adapted for the work of a congress, combining convenience and beautiful surroundings. About 1600 members and visitors attended, the British contingent numbering 200 or thereabouts. Canadian hospitality was lavish, and we all carry back pleasant memories of our visit to this great country. In addition, good work was done, and the attendance at the numerous sections was well maintained.

A combined meeting of the sections of physiology and pathology discussed the pathology and physiology of the cell nucleus. The discussion was opened by Prof. Adami, of McGill, in a paper giving an excellent survey of the subject. The conclusions formulated were that (1) the nuclear matter conveys and determines, or controls, the inherited peculiarities of the individual, this conveyance being through matter contained in the chromatin loops or chromosomes, while it may be that these individual loops, varying among themselves, determine particular conditions; (2) the nucleus is essential, not merely for the vegetative activities, but also for the higher metabolic activities of the cell and their due coordination; (3) the nucleus is not merely the vegetative centre of the cell, but is involved in its functional activities; (4) the higher syntheses, those associated with growth and those governing specific cellular enzyme actions, are determined and initiated by the nuclear matter; (5) the nucleus is the centre or source of the higher cellular activities, and the nuclear material possesses in itself potentialities superior to those of any ordinary constituent of the cell body; (6) the presence of preformed cytoplasm is essential for the continued existence and growth of the nucleus—each becomes essential for the continued existence of the cell as a whole.

Dr. Ford (Johns Hopkins University) read a paper on an antitoxin for poisonous fungi. He concluded that the toxic agent of the *amonita* was of the nature of a glucoside, and that an antitoxic serum could be prepared with it. It was pointed out in the discussion that this idea was somewhat revolutionary, as hitherto it had been impossible to obtain with glucosides an antitoxic substance.

Several papers were read on cancer. Dr. Clowes (Buffalo) had found that in experimental cancer in mice spontaneous recovery often occurred, and that such animals are immune to further inoculation. This was confirmed by Dr. Bashford (London), who stated that there is no evidence that cancer is on the increase, nor that it is endemic in districts. He had never obtained any transference by mere contact, *i.e.* cancer is not contagious. Prof. Gaylord (Buffalo) detailed some remarkable instances which seemed to show that certain malignant tumours in rats and mice are contagious. As a result of the discussions on cancer, it is noteworthy that the parasitic theory of the origin of cancer seems almost to have been abandoned by pathologists.

Prof. Hewlett and Dr. de Korté (London) read a paper on a beri-beri-like disease occurring in monkeys. The facts observed suggested that beri-beri is an infective disease due to a protozoan parasite, and conveyed by urinary infection. Dr. Ruffer (Egypt) detailed observations on the occurrence of organisms indistinguishable from the cholera vibrio in persons who had not been in contact with cholera.

Prof. Woodhead (Cambridge) stated that he had found opsonins in varying quantity in different milks, facts suggestive of certain lines with regard to treatment.

A combined discussion between the sections of physiology and medicine on over-nutrition and under-nutrition, with special reference to proteid metabolism, was opened by Prof. Chittenden (Yale). As is well known, Prof. Chittenden suggests that half the proteid usually regarded as necessary to support physiological equilibrium is all that is required. Prof. Halliburton (London) did not think that the experiments were conclusive, and suggested that the minimum diet of Prof. Chittenden did not leave any margin for that "reserve force" so necessary to ward off attacks of disease. It might be that in the excess of proteid beyond that required to maintain physiological equilibrium there might be traces of substances which yielded this reserve force. Dr. Robert Hutchison (London) considered that the proteid question could only be solved by cooperation between physiologists and physicians. We wanted to know, not the proteid minimum, but the proteid optimum. There was a danger in sailing too near the wind; we could get along with one lung or one kidney, but two of either organ were preferable. High feeding is responsible for cure in tuberculosis and neurasthenia.

The address in surgery was delivered by Sir Victor Horsley, who took as his subject the technique of operations on the central nervous system. He showed how, by means of Prof. Vernon Harcourt's inhaler, chloroform could be administered in known amount up to 2 per cent., that during some period of the operation the amount of chloroform could be reduced to 0·5 per cent., and that the administration of oxygen stopped venous oozing.

The Senate of Toronto University conferred the honorary degree of LL.D. on, among others, Sir W. Broadbent, Bart., Sir Thomas Barlow, Bart., Sir James Barr, Sir Victor Horsley, Prof. Clifford Allbutt, Prof. Halliburton, Dr. Donald Macalister, and Prof. Aschoff, of Freiburg.

R. T. HEWLETT.

A LARCH SAWFLY IN CUMBERLAND.

THE Board of Agriculture and Fisheries recently directed attention in the Press and its journal to the attack of the sawfly (*Nematus erichsoni*, Hartmann) upon larches. So far, serious damage has only been reported to the Board from Cumberland, where the health, if not the life, of an extensive plantation is said to be in danger. This insect is commoner than is supposed, but does not, as a rule, occur in large numbers in this country. There are very few collectors of these insects, hence we are apt to look upon species as rare which really have a wide distribution.

Cameron, in his work on British "Phytophagous Hymenoptera" (vol. ii., p. 51, 1885), only records the insect from an unknown locality. Dale mentions it as occurring at Glanvilles Wootton. It has also been seen on larches near Esher, at Wye, Great Staughton, and Budleigh Salterton. It is widely distributed over Europe, where it is now and then sufficiently abundant to become harmful, especially in Germany. Hagen also records it from the United States.

The adult sawfly has a black thorax, the abdomen red, with the basal seventh and ninth segments black. The legs are dull reddish, with most of the tibiæ white, and the posterior feet and apex of the femora black. In length it is about half an inch. The male has not, apparently, been described.

The larvæ are nearly three-quarters of an inch long when mature, and feed upon the leaves from the *beginning* of July to the end of August. In colour they are shiny grey or dark grey, with the back darker grey except on the second segment. The skin is covered with short, black tubercles, and the spiracles show as brown spots. The legs are spotted with black, and the head is shiny black.

When mature the larvæ fall to the ground and spin their cocoons amongst moss, grass, &c., beneath the trees. The cocoons are more or less cylindrical in form and brown in colour. Many may occur close together. Fortunately these larvæ are preyed upon by several hymenopterous parasites. It is probably these that cause its sudden disappearance in localities where it has occurred. It is, nevertheless, as the Board of Agriculture advises, "of the utmost importance that outbreaks should be discovered at an early stage so that they may be suppressed while still of restricted extent"—an axiom that applies to all insects and fungi that are likely to cause harm to man's crops, trees, or stock.

The Board is preparing an illustrated account of this insect, which will be published in the October issue of its journal. Many such isolated outbreaks of insect pests of greater importance might with advantage be treated in a similar manner. F. V. T.

SOME RECENT PALÆONTOLOGICAL PAPERS.

DURING the wide range of field-observation covered by the Austrian Geological Survey, numerous new localities for fossils come to light, while the collections brought to Vienna from outside the Empire furnish the members of the Reichsanstalt with rich material for comparison. R. J. Schubert (*Jahrbuch der k.k. geol. Reichsanstalt*, 1905, p. 613) has continued his comprehensive research on the otoliths of fishes, which is finely illustrated with photographic plates. In the *Verhandlungen* of the same body (1906, p. 124) he summarises his results, which are shown to have a bearing on the geographical conditions of Miocene and Pliocene times in Europe. For instance, in accordance with what we know of the Congeria-beds, the otoliths in these strata are found to belong to the Sciænidæ, a family haunting especially the mouths of large rivers, and even penetrating into fresh water.

Franz Toula (*Jahrbuch der Reichsanstalt*, 1905, p. 51) also throws new light on the Congeria-beds of Vienna by describing Pelamycybium, a new genus of fish, which has been discovered in them. He discusses a wide range of literature on allied forms of tunny. In the current volume for 1906, p. 1, O. Abel investigates the fishes with greatly developed fins that have been recorded from various formations, and states that the Triassic genera Thoracopterus, Bronn., Gigantopterus, and Dollopterus are the only ones that can be referred with certainty to the flying-fish. The two last-named genera are new to science. All these fossil forms are constructed outwardly on the type of the modern Exocœtus. The species of Chirothrix with large fins, and other members of Smith Woodward's Chirothricidæ, are believed by Abel to have been incapable of flight. It is hard, moreover, to have to note that a species known as *Engraulis evolans* is similarly rejected. Zoologists will be interested in the general discussion of the flight of fishes and its origin (pp. 55–84), and the comparison between true flying-fish and others with expanded pectoral or ventral fins. The author, to avoid misconception, would prefer to speak of "parachute-fish" rather than of "flying-fish." There is no indication that any fossil example used its pectoral fins more effectively for flight than is the case in modern times. The memoir is fully illustrated; and the realisation of flying-fish gleaming in the Triassic sunlight adds a new fascination to the ancient European sea.

G. Stache (*Verhandlungen, ibid.*, 1905, p. 292) directs the attention of zoologists as well as palæontologists to his Sontiochelys, a new chelonian from the Cretaceous of Görz, the affinities of which are with living forms in Australia and Brazil, rather than with fossil Jurassic forms in Europe.

O. Abel (*Jahrbuch, ibid.*, 1905, p. 375) has described a cetacean, *Palaeophocaena andrussovi*, from the Middle Miocene of the Taman peninsula in the Black Sea. This early form has led him to examine the living Phocæna of the Black Sea, and to assign to it the specific name *relicta*. The author points out the differences between it and *Ph. communis*, and urges that it arose in the Black Sea area as a direct descendant of the Miocene type. Phocæna is absent from the Mediterranean, while the two dolphins found with it in the Black Sea, *Tursiops tursio* and *Delphinus delphis*, abound there, and Herr Abel is thus supplied with additional grounds for his contention. He also describes (p. 393) a Miocene transitional form between Halitherium and Metaxytherium.

Passing to the primates, we note that Prof. Rzehak (*Verhandlungen, ibid.*, 1905, p. 329) gives a preliminary account of a lower jaw belonging to a being of the Spy and Krapina type, from Ochos, near Brünn in Moravia. Every addition to our knowledge of this early type of man in Europe, Wilser's *Homo primigenius*, is to be welcomed, especially as it seems not so long ago when the Neanderthal calvarium was the sole representative of the race. The features shown by the lower jaw of a child found in a cave at Shipka, and hitherto regarded as exceptional, are interestingly repeated in that of the adult from the Ochos cave.

T. Fuchs (*ibid.*, p. 198) defends the organic character of the honeycomb-markings known as Palæodictyon, in opposition to the views of Capeder in 1904, who reproduced artificially a fairly similar structure.

Prof. Yokoyama sends a paper on Mesozoic plants from Nagato and Bitchu (Journal of the College of Science, Imperial University, Tokyo), illustrated by three beautifully executed plates. The work confirms the author's previously expressed opinion that a Rhætic flora occurs at Yamanoi.

Part iii. of vol. xxxii. of the Records of the Geological Survey of India is mainly concerned with palæontology. Prof. Diener, of Vienna, describes the permo-Carboniferous fauna of the Subansiri valley in Assam, adopting Waagen's term "Anthracolithic" for beds of the two systems considered jointly. Mr. G. E. Pilgrim reviews the distribution of *Elephas antiquus*, which he regards as having originated in the Pliocene of Europe, reaching India somewhat later in geological time, as glacial conditions set in across Europe. In neither area, however (p. 218), did it leave any direct descendants. The paper is accompanied by five handsome plates. Prof. Diener, in a second paper, points out that a bed of Triassic limestone in Byans, 3 feet thick, represents the Noric and Carnic faunas, the forms from distinct horizons becoming mixed in so small a thickness of sediment.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

PROF. WILHELM WIEN, professor of physics in the University of Berlin, has been invited to occupy the physics chair in the University of Berlin, in succession to the late Prof. Drude.

Science states that by the will of the late Mr. T. Kearney, of Freno, his entire estate, amounting to about 200,000*l.*, is bequeathed to the department of agriculture of the University of California.

THE authorities of the Leland Stanford University, which suffered severely through the San Francisco earthquake, are reported to have decided to sell the jewels of Mrs. Leland Stanford, bequeathed to them by their late owner, for the purpose of restoring the University library; the value of the jewels is estimated at a million dollars.

BIRKBECK COLLEGE will commence its eighty-fourth session on Wednesday, September 26, when Sir Edward H. Busk, Vice-Chancellor of the University of London, will give the opening address. The college has added considerably to its appliances in recent years, and the physical, chemical, biological, and metallurgical laboratories are well equipped. Courses in mining, metallurgy, and assaying are given both in the day and evening.

THE council of University College, Bristol, has offered the chair of chemistry, just vacated by Dr. Travers, F.R.S., to Dr. Francis Francis. Dr. Francis studied at

University College, Liverpool (now the University), and at Erlangen, and has been assistant professor at University College, Bristol, since 1903. He has published many papers in journals of chemical societies, both in England and Germany, among his most recent papers being one on benzoyl nitrate, which describes a new method for the nitration of organic compounds.

The annual report of the South Australian School of Mines and Industries for 1905 shows that excellent progress in technical education is being made at Adelaide. The number of students enrolled was 1507, and the number of subjects taught was forty-five, courses having been started during the year in agriculture, building drawing, dairy work, motor management, veterinary science, and flower culture. The report contains a detailed account of the laying of the foundation-stone of the new metallurgical building on October 3, 1905.

From among recently made foreign appointments we note the following:—Dr. Emil Bose, lecturer in physics of Göttingen University, to be professor of physical chemistry in the Danzig Technical High School; Dr. Alfred Kalähne, of Heidelberg University, to the physics chair of the same institution; Dr. Taddäus Godlewski to be extraordinary professor of general and technical physics in the Technical High School, Lemberg; Dr. K. Fries to be a departmental director of the chemical institute of Marburg University in succession to Prof. R. Schenck, who has received an appointment in Aachen; Dr. Franz Waterstradt, scientific assistant to the German Agricultural Society, to be extraordinary professor in the University of Breslau; the lecture courses on inorganic and analytical chemistry of the Faculté des Sciences of Paris University, which Prof. Ribau is giving up on his retirement from active academic life, have been deputed to MM. Paul Lebeau and G. Urbain, while M. L. Ouvrard has been appointed director des laboratoire d'enseignement et de recherches chimiques of the same faculty.

The new laboratory of physical and electrochemistry which has been presented to the University of Liverpool by Mr. E. K. Muspratt will be formally opened on Saturday, October 13, by Sir William Ramsay, K.C.B., F.R.S. Besides many eminent English chemists, the following distinguished foreign men of science have accepted invitations to be present:—Profs. Ostwald (Leipzig), Abegg (Breslau), Cohen (Utrecht), Goldschmidt (Christiania); also Prof. Lash Miller (Toronto). Addresses will be delivered by Sir William Ramsay and Prof. Ostwald. The distinguished guests will be entertained to dinner by the University Association on October 12, and by the Liverpool section of the Society of Chemical Industry on October 13. The new laboratory contains twenty-one rooms, and has been specially built and fitted for work in physical and electrochemistry. Its electrical equipment includes an 80-kilowatt motor alternator, a 30-kilowatt motor generator for direct current, a 10-kilowatt charging set (all by Messrs. Siemens Bros.), and a 36-cell Tudor accumulator battery. The name of the new laboratory is to be "The Muspratt Laboratory of Physical and Electrochemistry."

On Wednesday, October 3, Sir William Ramsay, K.C.B., will give a public lecture at University College, London, on "The Chemical Nature of Electricity," and on October 4 Prof. L. W. Lyde will give an introductory lecture on "Geography as a 'Corollating' Subject in School Work." These two lectures are open to the public without payment or ticket. Among the courses of free lectures shortly to be commenced at the college are the following:—Six lectures, open to the public without payment or ticket, on the "History of Statistics and the Nature and Aims of Modern Statistical Methods," by Mr. G. U. Yule, on Wednesdays at 5.30, commencing Wednesday, October 10; ten lectures on "Recent Development in the Teaching of Arithmetic and Elementary Mathematics," by Mr. F. L. Grant, on Saturday mornings at 10 a.m., beginning on Saturday, October 13; ten lectures on "The Hygienic Needs of the Scholar," by Prof. Henry Kenwood, on Thursday evenings at 7.30 p.m., beginning on Thursday, October 11. This course and that on mathematics are open, without fee, to all teachers in London schools. Teachers wishing to attend should apply for forms to the Executive Officer, London County Council Education Offices, Victoria Embankment, W.C. Forms must be returned not later than Saturday, September 22.

Speaking at Hawarden on Monday on the objects and advantages of education, Mr. Wyndham remarked that "it was right to include science in the curriculum because we are now living in an age of science. In the sixteenth century people lived in an age of literature, and the minds of men were attracted toward the old books written in Greek and Latin." This difference between the needs of the two ages was pointed out by Sir Norman Lockyer in an address at the Borough Polytechnic Institute last December, printed in Nature of March 29 (vol. lxxiii., p. 521), as the following extract from the address clearly shows:—"We must arrange our education in some way in relation to the crying needs of the time. The least little dip into the history of the old universities will prick the bubble of classical education as it is presented to us to-day. Latin was not learned because it had the most magnificent grammar of known languages. Greek was not learned in consequence of the transcendental sublimity of ancient Greek civilisation. Both these things were learned because people had to learn them to get their daily bread, either as theologians or doctors or lawyers, and while they learned them the 'nature of things' was not forgotten. Now what is the problem of to-day? We are in a world which has been entirely changed by the advent of modern science, modern nations, and modern industries, and it is therefore perfectly obvious that if we wish to do the best for our education it must be in some relation to those three great changes which have come on the world since the old days."

SOCIETIES AND ACADEMIES.

London.

Royal Society, May 31.—"On the Main Source of 'Precipitable' Substance and on the *Rôle* of the Homologous Proteid in Precipitin Reactions." By Prof. D. A. **Welsh** and Dr. H. G. **Chapman**. Communicated by Dr. C. J. Martin, F.R.S.

Conclusions.—(1) The homologous proteid is not wholly removed from the superfluid of a precipitin interaction, whether it is more than sufficient or less than sufficient to neutralise all the precipitin present.

(2) Conclusive evidence that the homologous proteid is sensibly diminished in similar circumstances has not been obtained.

(3) The substance that is thrown out of solution is derived mainly from the anti-serum.

(4) The character of an anti-serum depends upon two factors which are mutually independent, (*a*) the precipitable content, (*b*) its precipitability.

(5) The precipitable content is indicated by the maximum precipitum obtainable from a given amount of the anti-serum.

(6) Its precipitability is indicated by the minimum amount of homologous proteid that will completely neutralise the precipitin in a given amount of the anti-serum.

(7) The solid content of precipitin anti-sera is increased relatively to that of natural sera.

June 28.—"On the 'Kew' Scale of Temperature and its Relation to the International Hydrogen Scale." By Dr. J. A. **Harker**.

In 1887 the International Committee of Weights and Measures adopted as the standard thermometric scale the *constant-volume hydrogen thermometer*. By far the majority of temperature measurements are made by means of mercury thermometers. The ideal mercury thermometer would be one which, when subjected to any steady temperature, would assume immediately a steady reading identical with that given by the hydrogen thermometer at the same temperature. This ideal is, as might be expected, not attained by any known mercury-in-glass thermometer, and the amount of the departure from the ideal at different temperatures depends on the particular kind of glass employed.

For many years thermometers have been verified at Kew Observatory in large numbers annually, their indications being referred to the *Kew Scale* of temperature. It has recently become a matter of interest to determine to what degree of accuracy the *Kew Scale* may be considered as identical with that of the hydrogen thermometer, and this memoir gives an account of some experiments undertaken at the National Physical Laboratory with a view to elucidate this question.

The usual type of Kew standard thermometer is an instrument having a range from below 32° to above 212° F., and is usually divided only to 1° F.

For the purpose of this research it was thought desirable, after studying the behaviour of a number of these old thermometers, to construct new standards, having a more open scale and capable of being read to higher accuracy, and to treat these from the beginning in a definite and systematic manner.

The readings of a Kew standard are always understood to apply to the thermometer in a vertical position when immersed in water up to the reading, and the instruments are always intended to be used as "fixed" rather than as "movable zero" instruments. That is, the normal procedure to measure any temperature on the Kew scale would be *first* to determine the zero and *afterwards* the temperature in question, applying to the latter a constant correction for any deviation of the zero point from its nominal correct value, 0° C. or 32° F., and ignoring all subsequent zero changes.

The main conclusions of the work are:—

(1) The departure of the natural scale of the "Kew" mercury-in-glass thermometer from the international hydrogen scale is very small at all temperatures.

(2) For measurement of temperature *differences* over ordinary ranges, such as in calorimetry, the results obtained directly or indirectly from a Kew standard may be considered as hydrogen temperatures without application of any correction.

(3) In some instances when defining the temperature at which certain standards have their definite value, such as, for example, the temperature 62° F. for the British standard yard, the temperature scale to which the measurement referred was not definitely specified. This research renders it probable that if the instrument were a good English glass thermometer approximating to a Kew standard, the error made in considering its indications as identical with the hydrogen scale would be within the limits of accuracy of length measurements.

(4) For the ordinary ranges of meteorological and clinical thermometers reading to 0°·1 F., many thousands of which have been verified at Kew annually for many years past, the temperatures as given on the Kew certificate may be considered as hydrogen temperatures.

(5) The table appended gives the mean departure from the hydrogen scale of the "Kew" scale of temperature as

Differences in Degrees Centigrade.

	Kew glass. $T_{Kew} - T_{Hyd.}$	Verre dur. $T_{VD} - T_{Hyd.}$	Jena glass. $T_{16'''} - T_{Hyd.}$
0	+0·000	+0·000	+0·000
10	+0·000	+0·052	+0·056
20	+0·000	+0·085	+0·093
30	−0·005	+0·102	+0·113
40	−0·010	+0·107	+0·120
50	−0·010	+0·103	+0·116
60	−0·010	+0·090	+0·103
70	−0·015	+0·072	+0·083
80	−0·020	+0·050	+0·058
90	−0·025	+0·026	+0·030
100	−0·000	+0·000	+0·000

observed in this investigation, the figures being rounded to the most probable 0°·005 C. For comparison purposes the figures for French "Verre Dur" and for "Jena Glass 16'''" are added in parallel columns, it being understood that each glass is treated in the manner prescribed for it, the Kew glass being a "fixed zero" scale and the other two "movable zero."

PARIS.

Academy of Sciences, September 10.—M. A. Chauveau in the chair.—Variations in the gravitation constant in the Simplon Tunnel: Marcel **Brillouin**. A *résumé* of the various corrections required by the crude readings of the instrument used. The complete work will be published in the *Recueil des Savants étrangers*.—The experiments of M. Villard and his theory of the aurora borealis: Carl **Störmer**. In his memoir published in 1904 on the motion of a material point carrying a charge of electricity, and continued in two recent notes in the *Comptes rendus*, the author has developed a theory which not only explains the phenomena experimentally observed by M. Villard, but also predicts others not yet observed, and renders doubtful certain of M. Villard's conclusions regarding the aurora borealis. The experiment of M. Villard, in which the magnetic field is due to two equal and opposite magnetic poles, is considered in detail in the present note, and the trajectories worked out for several cases, diagrams being given. The author draws the conclusion that Birkeland's theory is not shaken by M. Villard's paper.—The atomic weight of silver: P. A. **Guye** and G. **Ter-Gazarain**. Reasons are given for showing that the atomic weight of silver should be lowered from 107·93 to 107·89.—A case of formation of anthocyanine under the influence of the puncture of an insect (*Eurrhipara urticata*): Marcel **Mirande**.

CONTENTS.

THURSDAY, SEPTEMBER 27, 1906.

SOME RECENT WORKS ON PHILOSOPHY.

(1) *Herbert Spencer.* By Prof. J. Arthur Thomson. English Men of Science Series. Pp. ix+284. (London: J. M. Dent and Co., 1906.) Price 2s. 6d. net.

(2) *Reconnoitres in Reason and the Table-book.* By Norman Alliston. Pp. 280. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1906.) Price 5s. net.

(3) *Eine Untersuchung über Raum, Zeit und Begriffe vom Standpunkt des Positivismus.* By Eberhard Zschimmer. Pp. 54. (Leipzig: Wilhelm Engelmann, 1906.) Price 1s. 6d. net.

(4) *Beiträge zur Einführung in die Geschichte der Philosophie.* By Rudolf Eucken. Pp. iv+195. (Leipzig: Verlag der Dürr'schen Buchhandlung, 1906.) Price 3.60 marks.

(5) *Apollonius of Tyana, and other Essays.* By Thomas Whittaker. Pp. 211. (London: Swan Sonnenschein and Co., Ltd., 1906.) Price 3s. 6d. net.

(6) *Das Gefüge der Welt, Versuch einer kritischen Philosophie.* By Hermann Graf Keyserling. Pp. viii+382. (Munich: F. Bruckmann A.-G., 1906.) Price 5 marks.

(7) *The Sub-conscious.* By Joseph Jastrow. Pp. ix+549. (London: Archibald Constable and Co., Ltd., 1906.) Price 10s. net.

(1) "YET this much is conceded by most," writes the author, "that Herbert Spencer was an unusually keen intellectual combatant, who took the evolution-formula into his strong hands as a master-key, and tried (teaching others to try better) to open therewith all the locked doors of the universe—all the immediate, though none of the ultimate, riddles, physical and biological, psychological and ethical, social and religious."

It is from that standpoint that his work is here viewed, and the subject could not have fallen into better hands than those of Prof. Thomson, who writes clearly, argues cogently, and never fails to leave his reader interested and informed.

A fourth of this volume deals with Spencer's life and characteristics; the rest discusses and criticises his chief contributions to several scientific and philosophic problems. Prof. Thomson notes, of course, his want of indebtedness to previous writers, *e.g.* the fact that he read nothing of Locke and Mill, and that when he borrowed the term "social statics" from Comte he knew no more of the great positivist than that he was a French philosophical writer; he notes, on the other hand, the great influence exerted on Spencer by von Baer's formula "expressing the course of development through which every plant and animal passes—the change from homogeneity to heterogeneity." The main criticisms passed on Spencer in the course of the work are these:—(*a*) In accepting the von Baer formula, Spencer thought of the germ-cell and other lowly structures much too simply; for the germ-cell is far from being homogeneous, and as for the spermatozoon, students of physics "tell us that the picture of a *Great Eastern* filled with framework as intricate as that of the daintiest watches does not exaggerate the possibilities of molecular complexity in a spermatozoon, whose actual size is usually very much less than the smallest dot on the watch's face." (*b*) Spencer does not prove his case that sperm-cells and germ-cells do not possess powers fundamentally unlike those of other cells—at any rate, they may be *very* unlike them. (*c*) Spencer argued, "No inheritance of acquired characters, no Evolution." Prof. Thomson thinks the transmission of acquired characters is not proven, that there is a strong presumption that they are not transmitted, and that the scientific position should remain one of active scepticism, leading on to experiment. (*d*) As to the general philosophic position of Spencer, he holds that he was not a materialist, but was at the same time guilty of gross materialisms, *e.g.* in his universal evolution-formula, which is wholly in terms of matter and motion.

(2) Mr. Alliston wishes to rouse us all from our dogmatic slumber, and here submits to the play of his dialectic a number of ordinary beliefs too hastily accepted. Thus, for example, in his essay on contraries, with which this volume opens, he assails the common practice of distinguishing contraries as positive and negative, and so establishing what proves to be a false precedence among them. He contends that any one of two contraries always refers by implication to its opposite and depends on it for point. With some contraries, he goes on to say, no mean is possible. Aristotle is wrong in making courage the middle term between rashness and timidity.

"Rashness is really opposed to caution, and not to timidity, of which courage is antonym; and in short, in any example from this source of three chosen terms, it will be found that one of them is not strictly in the same category as the other two, but expresses differences of another kind."

The essay on the limits of determinism elaborates the thesis: "Everything that happens, happens necessarily; but it has got to happen first," *i.e. before* an event happens there is a real choice of possibilities, and thus "before a man has come to a decision, the motive or adequate cause necessitating it cannot be present, or as adequate it would have already brought about the event." Other essays deal with eventuality, the perversity of the will, force, personal credit, the abstract idea, and the like. Mr. Alliston is always acute, ingenious, and convincing so far as he goes, and one wonders only how a complete metaphysic from his pen would read.

The later part of the volume contains a number of disconnected paragraphs and aphorisms, more or less paradoxical, on a number of topics that seem to interest Mr. Alliston. So long as he does not take himself too seriously, and so long as he remembers that Mr. Chesterton is our one chartered acrobat, there is no harm in his indulging the *cacoethes scribendi* in this fashion.

Z

(3) Herr Zschimmer here discusses some of the fundamental conceptions of philosophy from the standpoint of positivism, the principle of which is "first facts, then words." There is nothing very novel in the statement or argument of the volume, much of which is occupied with criticism of isolated points in Kant, Schopenhauer, and others. Time and space, it appears, are severely actual, and when a clock strikes the hour of four, and we remember the strokes as distinct though they are identical in tone, what causes this "ist eben das mit ihnen verschmolzene, Mitgegebene Zeittatsächliche." Consequently "pure," "*a priori*," "forms of perception," and many other beloved formulæ become unnecessary nonsense.

Towards the end of the book there is a somewhat elaborate account of the formation of concepts (*Begriffe*). The author defines *Begriff* as "die im Vergleich von Vorstellungen hervorgebrachte Verknüpfung eines Gemeinsamen Bestandteiles mit anderen Elementen (Merkmalen des Individuums) zu verschiedenen individuellen Systemen." The relation between the triangle before me and the concept of triangle is not badly discussed, the question, *e.g.*, as to what prevents me from regarding the essential and conceptual elements in my perception of the triangle before me as the concept of triangle generally. Causality and similar problems are rather hastily dealt with, and no part of the book displays remarkable depth or insight.

(4) Prof. Eucken's writings are all so excellent and stimulating that to commend him is needless and gratuitous. The present volume is a second and enlarged edition of "Beiträge zur Geschichte der neuern Philosophie," which appeared in 1886. In its newer form it contains, unaltered, some essays on old German philosophy, *e.g.* on Paracelsus and Kepler, and one "Über Bilder und Gleichnisse bei Kant." Two other essays, one in commemoration of Adolf Trendelenburg, and another on the various schools of philosophy, have been considerably changed; altogether new are those entitled "Bayle and Kant" and "Gedanken und Anregungen zur Geschichte der Philosophie." Bayle (of dictionary fame) and Kant seem to our author very similar in their outlook on life; according to Bayle, he writes, "a great contradiction has been set up in human nature: truth and virtue are demanded of us, and the demand finds an expression in the laws of conscience and of thought, but it cannot have its own way and produce a corresponding reality: knowledge entangles itself in irresoluble contradictions: moral judgment, it is true, is saved from these, but in man it cannot overcome the natural force of the instincts and the passions." How very similar this is to much Kantian doctrine will be at once apparent.

(5) Three of the six essays in this volume are historical, and deal with Apollonius of Tyana, Celsus and Origen, and John Scotus Erigena. They consist for the most part of a running analysis of some works, not too widely known, of patristic and scholastic times, and as their author has studied the neo-Platonists to some purpose, his account is not lacking in subtlety.

The other three essays are constructive. One of them, entitled "Animism, Religion and Philosophy," seems cast in a Comtean mould, and elaborates the thesis that man's thinking on the causes behind or immanent in the visible order of things goes through three stages, the animistic, the religious, and the philosophical. The author has apparently no faith in religion as the satisfaction of a permanent and legitimate craving of human nature. He confidently believes that philosophy has transcended the historic religions, and that, though it is the height of rashness to forecast the future of religion, whatever form religion may take, it will be the right and duty of philosophy to maintain its independence. Another essay, on the classification of the sciences, reprinted from the pages of *Mind*, amends Comte's well-known list of positive sciences, *e.g.* by omitting astronomy, by inserting animal psychology and human psychology, and by offering, as preferable to Comte's linear series, a circular scheme, in which one may, proceeding according to the didactic order, start with formal logic, go round the objective sciences, come back to the subjective sciences, and end with metaphysics.

The last essay, "Teleology and the Individual," is the most suggestive in the book. The author concludes that "the strength of the ancient and modern philosophies derived from Plato and Aristotle lies in their having retained the teleological point of view, conceived in a scientific sense, within a highly speculative system, but not at the summit"; that we may conceive the possibility that permanent individual subjects may have successive lives through which may be seen a teleological order; and that, though there are systems of ends, mutually adapted so as to form one system, this system has no end, and there is, therefore, no evolution of the universe as a whole.

There is a great deal of strenuous thinking in this book. Its merits will, we trust, not be obscured by its strong anti-theological bias.

(6) This work professes to be no more than an introduction or an overture to a music which has still to be composed. Its author writes in an excellent style, and is very well informed on a great variety of subjects, from modern views of matter and electricity to the æsthetic ideas of William Blake and Mr. Walter Pater. The philosophies that have chiefly influenced him are those of Plato, Kant, and Mr. Houston S. Chamberlain (the author of a German work on Kant), whose name is probably not so familiar in this country as those of the other two; but this *fidus Achates* lauds him on almost every page. That the book is laid down with no distaste for the author or for Mr. Chamberlain is creditable to both.

An analysis of the first two chapters will show the point of view. The author discusses some of the vain attempts to introduce unity into our view of the universe; the relations of different forms of force to one another, *e.g.* the impossibility of bringing gravitation into relation with electricity; the difficulty of arriving at consistent views of æther. In the end he comes to the conclusion that matter, force, and life are three ultimate and distinct categories for thought; it is impossible, for example, to resolve life and matter into force. Their unity can only be a formal one, *i.e.* the unity of law which pervades them and which is apprehended by man. Just as in mathematics "we can from the projection of a very complicated figure, one for example whose extremities may lie in infinity, derive without error the laws according to which it is composed," so we can project the complicated universe on the human mind, and trace the laws which are its formal framework. The second chapter discusses the two great formal schemes of thought, the logical and the mathematical, and a preference is given to the mathematical as being synthetic and not analytic. This leads naturally to a discussion of continuity and "discreteness," and the relation between these two is compared in a suggestive fashion with that between geometry and arithmetic, perception and thought, being and becoming. From the mathematical standpoint there is given also a new expression for life, which represents it as the hypotenuse of a right-angled triangle of which the two sides are matter = being and force = becoming.

Later chapters discuss the problem of spirit and the large question of freedom. An epilogue asks, What is truth? and it appears that in the existence of an abstract, objective truth our author has no faith. Amid much fancifulness and some obscurity there is not a little that is instructive and highly interesting.

(7) The main conclusion of the work before us is that man does not live by consciousness alone. "The processes of perception of the external world," writes the author, "are in the ordinary use of our faculties as typically sub-conscious as conscious in their mode of functioning." This is revealed in many ways; there is, for example, the well-known experiment in which two equal lines have added to them pairs of shadowy strokes, divergent and convergent respectively, the result being that the one line appears considerably longer than the other.

"Now reduce the shadow-strokes to such a degree of faintness that the eye fails to detect their presence, and continue to judge (naturally with diminished confidence) which seems the longer, and it will be found that the undetected shadows incline the judgments in accord with the illusion which their observed presence induces."

Further, when we talk of crystal-gazing, thought-reading, dissociated consciousness, and the other phenomena so often exploited by charlatanism, we have to remember that, obscure and weird as at first sight they appear, they often reveal themselves on analysis to be but "the exaggerated elaboration of possibilities inherent in every human mind."

Prof. Jastrow discusses all these problems in a very sane and convincing manner, and his work is a valuable contribution to the subject. Occasionally the treatment is a little prolix. The first part deals with the normal aspect of the subconscious, the second with the abnormal, and the closing chapters discuss the theory of the matter. Dissociation is explained as "the partial presence, with impaired relations, of factors normally fully associated and integrally co-ordinated"; and to show precisely in what such impairment of relations is seen, he defines the three privileges of mature psychic procedure as "incorporation, orientation and initiative." The theory which meets with his most vehement opposition is that of the subliminal self, which he finds to be "but slightly restrained by exacting allegiance to the large body of normal data," and which further indulges in all manner of mediæval epicycles whenever facts refuse to fit themselves to it. His main objection to the subliminal self lies in the difficulty of accounting for its maintenance amid the evolutionary conditions under which our consciousness has reached its present form.

SEA-FISHERIES ADMINISTRATION AND RESEARCH.

British Fisheries. Their Administration and their Problems. A Short Account of the Origin and Growth of British Sea-fishery Authorities and Regulations. By James Johnstone. Pp. xxxi + 350. (London: Williams and Norgate, 1905.) Price 10*s.* 6*d.* net.

THIS book may be described as a summary and critical analysis of all that has been or is being done for the sea-fisheries of this country by means of legislation and scientific investigation. The first part of the book deals with the history of legislation, and the second part with scientific investigation.

The history of the early legislation is a record of failure, as was proved by the repeal of more than fifty repressive Acts (mostly relating to herring trawling) at the suggestion of the Royal Commission of 1863. That commission, of which Huxley was a member, took a very optimistic view of "the resources of the sea." The Trawling Commission of 1882 was not quite so optimistic; at least it showed that certain inshore grounds had been affected by too much beam trawling. Finally, the Select Committee of 1893 was definitely pessimistic. It felt "that the subject of the diminution of the fish supply is a very pressing one, and the situation is going from bad to worse."

Mr. Johnstone has a good deal to say about the constitution of the various sea-fisheries committees, and finds that, "on the whole, the system of local regulation of the fisheries, as originally contemplated by the Sea-Fisheries Regulation Acts, cannot be said to be very successful." Where amalgamation has taken place "the administration has been most successful"; but "it is generally agreed that the system under which the regulation of the fisheries is obtained by rates levied on the maritime counties is not altogether a fair one."

The author is lavish in his praise of the Fishery Board for Scotland, its administration, scientific work, and "perfect system" of statistics, and has, by way of contrast, some very hard things to say about the English authority, its "inertia," lack of scientific investigation, and imperfect statistics. As for the former body, one's admiration, though genuine enough so far as it goes, is tempered by reflections on the very questionable success of its wholesale closure policy. In regard to the English official statistics, Mr. Johnstone's severe criticism rather "misses fire" at present, when definite steps have been taken to improve them. It is difficult to see how he can have read the report of the inter-departmental committee of 1902, in which the recommendations for improvement—which have since been largely carried out—were made, and yet say of that report that "it left the question of statistics in almost exactly the same state as it was."

In the second part of this book the life-histories of fishes are dealt with in a chapter of twenty-five pages of large type, and necessarily very briefly. In another chapter, on the metabolism of the sea, an account is given of the work of Hensen and Brandt in regard to the quantitative estimation of the resources of the sea. There are also important and well-reasoned chapters on the impoverishment of the grounds, the destruction of immature fish, and marine pisciculture.

The following contribution to the discussion of that perennial puzzle, "What is over-fishing?" may be worth quoting:—

"If a boat (either steam trawler or smack) catches fewer fish in the course of the year, it can mean nothing else than this, that *on the portion of the sea-bottom swept by her trawl-net there are fewer fish now than was formerly the case*, that is, the density of fish per unit of area in the North Sea fishing grounds is less than it was thirty years ago. This is a real impoverishment of the fishing grounds."

The author sums up the present situation as regards the relation of scientific research to legislation in the following words:—

"It would appear then that we are not yet prepared to give thoroughly convincing reasons for the adoption of legislative restrictions on those modes of fishing in which small fishes are destroyed to a notable extent. At the same time there can be no doubt that what we do know of the life-histories of fishes does justify us in recommending the adoption, as a tentative measure, of some of the remedies proposed—say the imposition of size-limits on the fishes landed in certain districts," &c., but he thinks that on the whole "it is better to press for investigation on a much more adequate scale than has hitherto been contemplated before recommending any drastic change in the fishery laws."

Students of fishery problems will be familiar with most of the arguments and criticisms in this book. These have appeared before in one form or another, but have never been more incisively stated than in the present volume.

AN ENCYCLOPÆDIA OF PHYSICS.

Handbuch der Physik. By Dr. A. Winkelmann. Zweite Auflage. Dritter Band, Erste Hälfte: Wärme, pp. viii+536; Vierter Band, Zweite Hälfte: Electrizität und Magnetismus, I., pp. xiv and 385–1014; Sechster Band, Zweite Hälfte: Optik, pp. xii+1404. Illustrated. (Leipzig: Barth.) Prices 16, 20, and 30 marks.

PORTIONS of the second edition of this well-known handbook have already appeared and been noticed in these columns. The characteristic of the treatise is that each part is written by a specialist (under the general editorship of Dr. Winkelmann), and consequently it partakes of the nature of an encyclopædia.

In the heat part appear the following sections:—thermometry (Profs. Pernet and Winkelmann); expansion of solid bodies, liquids and gases, thermoelectric and electric resistance, measurement of temperature, specific heat (Winkelmann); thermal radiation and conductivity (Graetz). Throughout there is carried out a very complete system of references to original sources, with critical comments. This is certainly very well done in general; but in the account of constant pressure gas thermometers we look in vain for any reference to the thermometer of Prof. Callendar, and discover no recognition of the work of the same experimentalist in the development of methods of temperature determination based upon the measurement of electrical resistance. We presume that it is intended to recur to this subject in some other portion of this voluminous treatise.

In the electrical part appear the following sections:—electrical conductivity of electrolytes, by Dr. R. Luther; electricity and gases (ionisation and electrification, characteristics of the electrical current, migration of ions, kathode and canal rays, forces on ions, thermal, chemical, and optical actions), by J. Stark; radio-activity, by J. Stark; atmospheric electricity, by H. Gerdien; thermoelectricity, by Dr. F. Braun; thermal effects of currents, by M. Cantor; Pyro- and piezo-electricity, by Dr. F. Pockels; theory of the galvanic cell, by M. Cantor; electrolysis and migration of ions, by R. Luther; electrical endosmose and convection currents, by L. Graetz; galvanic polarisation and accumulators, by M. Cantor.

From this summary it will be seen that many of the sections relate to subjects in which there has been a tremendous amount of work done in recent years. The subject of radio-activity has, indeed, been *originated* since the previous edition appeared, and so rapidly is progress taking place in our knowledge of this subject that it may be considered a moot point as to what extent it is advisable to introduce such quickly changing matter into a volume which has the stability that a treatise of this kind necessarily possesses. The references extend into the year 1904; but even so it is impossible to praise this section as representing the present state of knowledge. The best that can be said is that there is not much recorded which is now known to be untrue. We think this is much as it should be. An encyclopædia should contain little which has not been sifted and sifted again until there is little doubt of it being an established fact. To more protean volumes should the task be left of pourtraying the latest phases of any department of knowledge.

These remarks apply—though perhaps not so completely—to other sections of the volume. The subject-matters happen throughout to be those in connection with which development is now most pronounced; but at the worst we have here a magnificent account of the branches of physics named above.

The optical portion is probably of more stable character than the rest, although here also have great developments to be recorded. We think that the inclusion of such subjects as photography (fifty-five pages) has helped to swell the volume to unnecessarily large proportions. The technics of a special branch such as this seems scarcely at home in its surroundings. We welcome in particular the articles of Drude on the nature of light, on the theory of light for transparent media at rest, for absorbing media, and, finally, for media in motion.

The book is replete with references to original papers, and may be taken as being as complete a handbook for the professional reader as has yet appeared.

GARDEN-BOTANY.

Hortus Veitchii, a History of the Rise and Progress of the Nurseries of Messrs. James Veitch and Sons, together with an Account of the Botanical Collectors and Hybridists employed by them and a List of the more Remarkable of their Introductions. By James H. Veitch. Pp. 542; illustrated with fifty photogravure plates. (Chelsea: James Veitch and Sons, Ltd., 1906, for private circulation.)

THIS is one of the most sumptuous volumes which have ever emanated from a business house, but if it were simply a business publication it would claim no special notice in these columns. It is, in fact, a most important contribution to the history of horticulture during three-quarters of a century or more, and a valuable work of reference for the systematic botanist and the hybridist. It illustrates in a remarkable degree the service which the enterprise of a great commercial firm is capable of rendering, and in this case has rendered, to botanical science. As the author appropriately says:—

"To the representatives seeking unknown plants at one period or another in almost every clime, fortune has not invariably been kind, but the work of such men as Thomas Lobb, William Lobb, the late John Gould Veitch, Charles Maries, and E. H. Wilson has been a gain in every way; whilst the efforts in hybridising and selecting of John Dominy, John Seden, V.M.H., and John Heal, V.M.H., have given a wider interest to all cultivators."

With the history of the firm and its various members as given in the introduction to the present volume we are not here concerned, but we may indicate that it would furnish valuable data for Mr. Galton's science of eugenics. The biographical sketches of the twenty-two travellers employed by the firm are so interesting that we could have wished them longer. Whilst very many of the plants introduced into cultivation by the energy and zeal of these men have proved of first-rate importance from a gardener's point of view, as shown, amongst other things, by the fact that no fewer than 422 plates representing Veitchian introductions have been published in the *Botanical Magazine* under the editorship of the two Hookers and their successor, Sir William Thiselton-Dyer, thousands of herbarium specimens have been generously presented to the national botanical establishments and to individual botanists engaged in the study of particular groups.

When we come to the section relating to the hybridists who have achieved success in Messrs. Veitch's nursery we are again disposed to regret that fuller details were not given, but in view of the magnitude of the book and the immensity of the task we are by no means surprised that the author has felt it necessary to give indications only. Certain it is that the students of hybridisation, variation, and heredity will find inexhaustible materials for study in the results obtained by Messrs. Veitch. It is a noteworthy fact that at the present time, when orchids are so popular, greater interest is felt in the hybrid "creations," in the production of which John Dominy was the pioneer, than in new introductions. When we read of a thousand pounds and more being paid for one of these specimens we can but regret that orchid lovers do not contribute more to encourage scientific research into the history and nature of the plants in which they take such keen interest. The list of species of orchids introduced by Messrs. Veitch occupies no fewer than forty-seven pages. A large proportion of these were described by Lindley, by Reichenbach, and subsequently by Rolfe, and short descriptions and historical notes are afforded in these pages. Orchid hybrids are treated in like manner, the particulars relating to them filling fifty-seven pages, exclusive of an appendix giving historical details, and occupying six pages of small type. The information here given will be of special value to those engaged in the study of hybridisation.

Space will not allow us to do more than mention the sections relating to stove and greenhouse plants, to which eighty-three pages are devoted, to the various species and hybrids of Nepenthes, the ferns, the coniferous trees, the deciduous and evergreen trees and shrubs, the herbaceous plants, the bulbous plants, the Amaryllis, the Begonias, the greenhouse Rhododendrons, the Streptocarpus, and, lastly, the fruits and vegetables, all exclusively the result of the enterprise or of the skill of Messrs. Veitch and of their assistants. With such a vast amount of material it is evident that severe compression has had to be effected, but even so the record is a marvellous one. Happily an excellent index is provided.

Throughout it is obvious that great pains have been taken in the preparation of the volume, the solid worth of which is enhanced by the excellent manner in which it has been produced.

OUR BOOK SHELF.

Avogadro and Dalton. The Standing in Chemistry of their Hypotheses. By Dr. Andrew N. Meldrum. Pp. 113. (Edinburgh: W. F. Clay, 1904.) Price 3s. net.

THIS book may be read with interest by all chemists, and with special profit by students who have got into confusion with the difficult piece of chemical history of which it treats.

Dr. Meldrum sets himself to define the true relationship and standing of the hypotheses of Dalton and Avogadro. Prof. Japp, in his preface, states that he has nowhere else seen the true ratiocinative order of precedence of the molecular and atomic hypotheses "expounded with such wealth of illustration and with so exhaustive a knowledge of the fundamental literature of the subject." This praise is, we think, fully deserved. Dr. Meldrum brings stern logic to bear on the question, and approaches his task with a grim earnestness which imparts an unintentional tinge of humour to his book. He is no respecter of persons, and he handles with some severity all those who, in his opinion, have been unfaithful to the facts. "The atom," says Dr. Meldrum, "in the modern theory of chemistry is a 'dependency of the molecule.'" "Avogadro's hypothesis being the fundamental hypothesis of chemistry, other doctrines concerning molecules and atoms are to be subordinated to it." "The atom can be defined with reference to the molecule; it is doubtful if any other definition is sufficient." These quotations will perhaps suffice to indicate Dr. Meldrum's view. Dalton's hypothesis came first, but since 1858, when Cannizzaro appeared on the scene, Avogadro's hypothesis has been the fundamental one. We do not think that this can be seriously contested, taking the words strictly in the sense intended by Dr. Meldrum. At the same time there is surely some danger of a too pedantic insistence on this question of "ratiocinative precedence." If we look upon the progress of chemistry, and not merely on its present state, it is hardly a crime to speak of that hypothesis as fundamental which has been the immediate cause of another that has ultimately proved more general, comprehensive, and fruitful, and whilst no doubt there has been some laxity on the part of chemical writers in their choice of words, the great fact that Dalton came first, and that without Dalton there is no reason to suppose there would have been an Avogadro's hypothesis, will still be regarded, we suspect, as a justification for some of the statements which Dr. Meldrum criticises so severely.

In saying this we do not wish for a moment to underestimate the service which Dr. Meldrum has rendered by giving us this very searching and able review of the bases of modern chemical theory.

A. S.

Die radioaktiven Substanzen und die Theorie des Atomzerfalles. By Prof. Paul Gruner. Pp. 103. (Bern: A. Francke, 1906.) Price 1.60 marks.

THIS little book of 100 pages, we learn from the preface, had its origin in courses of lectures delivered by the author at the University of Berne during the session 1904–5, and is designed to give a complete yet short review of the whole field covered by the title, including the most recent investigations. The subject is presented from the point of view of the disintegration theory, and the phenomena connected with the induced activity are treated at length. The physiological action of radio-active substances, and their existence in springs, &c., are not considered except in passing.

The author is to be congratulated on having fully carried out his intention, and has succeeded in producing a very readable account of the subject from the physical standpoint, which is thoroughly up to date; but the value of the work would have been much enhanced by more diagrams. Only three are included, illustrating the decay and growth curves of the induced activity of radium, and not a single diagram of any experimental piece of apparatus is shown. Practically nothing is said of the methods of measurement in use in the laboratory, although perhaps this is as well in a subject of this kind, where a little knowledge is apt to be a dangerous thing. On the other hand, the author has contrived to compress within the one hundred pages of his book a surprising amount of the best of the most recent literature, and this makes us venture to express the hope that in a future edition the author will rely less on the existing compilations in dealing with the earlier researches, and will extend to the whole literature of the subject the same careful and first-hand consideration he has shown in dealing with the latest researches.

Of criticism or comment there is little or none, but there is evidence of considerable skill in the selection of the material whereby the most important researches secure prominent treatment. With the exception of the recent work emanating from Australia on the α rays, of which perhaps the full bearing has not been sufficiently brought out, the living branches of the subject have been done full justice to. A reference to the parts dealing with the slow transformation products of radium, radio-thorium, the origin and ultimate product of radium, the work in Germany and France on the production of helium from radium and actinium, and radio-tellurium and polonium, shows that the author has included the best of the current work on the most important problems.

F. S.

Introduction to Astronomy. By Prof. Forest Ray Moulton. Pp. xviii+557. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1906.) Price 5s. net.

STUDENTS of astronomy will find in Prof. Moulton's volume an excellent text-book which, by its lucidity and wealth of detail, will enable them to obtain a fairly thorough grasp of their subject.

After two chapters dealing with general outlines and definitions we find a very useful chapter on the constellations, with special paragraphs on the more important stellar groups and simple methods of locating them. Four clearly printed maps, so bound that they open out flat when the book is opened, will be found very useful in the practical work which here and throughout the book is insisted upon as being essential.

Telescopes, their evolution and various types, are then discussed, whilst the earth, its movements, gravitation, and time are dealt with at some length in the four succeeding chapters.

Chapters ix. to xii. deal with the moon, eclipses, the solar system as a whole and its individual members, respectively. The chapter on comets and meteors which follows leaves little, if anything at all, to be said concerning the general phenomena and the historical apparitions of these bodies.

Probably in no branch of astronomy have such rapid advances been made during recent years as in solar physics, and of the results obtained therefrom Prof. Moulton takes the fullest advantage in the forty-nine pages of description and discussion which he devotes to the sun in chapter xiv. Again, as a pioneer worker on the probable evolution of the solar system, he is seen to great advantage in the next chapter, where he describes and criticises the Laplacian hypothesis, explains the work of Sir George Darwin, and summarises the theories advanced by Prof. Chamberlin and himself.

In the concluding chapter we have an epitome of our present knowledge concerning "the stars and nebulas," in which the facts and observations of most branches of sidereal astronomy are clearly stated and discussed.

The numerous questions placed at the end of each chapter and the excellent and up-to-date illustrations add greatly to the value and interest of the volume as a text-book.

W. E. R.

LETTERS TO THE EDITOR.

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

The Recent Radium Controversy.

I shall be obliged by your making the following correction on an accidental misstatement of mine, quoted by Mr. Soddy (p. 517, line 3 from foot of column one) in his very interesting article on "The Recent Controversy on Radium," in your issue of September 20 (p. 516). In a letter to the *Times*, from which the quotation is correctly made by Mr. Soddy, I had written accidentally *four* instead of *five*. The corrected statement is that Prof. Rutherford had suggested that radium might be a compound of one atom of lead and five of helium. This is a suggestion wholly in harmony with chemical science. Rutherford is scientifically cautious in naming lead as possibly one of the ingredients of radium, but he names helium as demonstrated experimentally to be an ingredient, and considers five atoms as rendered somewhat probable by elaborate and important experimental investigations, of which he gives careful descriptions and very complete references in his book on "Radio-activity."

Netherhall, Largs, September 21. Kelvin.

Stress in Magnetised Iron.

In Nature, August 2 (p. 317), I observe under the above title a letter from Dr. Shelford Bidwell re-opening a question discussed in your columns ten years ago. As the originator of the discussion I feel indisposed to let Dr. Bidwell's letter pass unnoticed.

In my first letter (Nature, vol. liii., 1896, p. 269) I directed attention to the fact that certain writers, including Dr. Bidwell, Dr. J. A. Ewing, and Dr. More, had stated explicitly or implicitly that the material of a magnet is subjected to a longitudinal *compressive* stress approximating to $B^2/8\pi$ when H/B is small, whilst other authorities, including Kirchhoff and Prof. J. J. Thomson, postulated a *tensional* stress of like amount. I remarked on the apparent inconsistency, and explained the reasons which led me to regard the last-mentioned view as the more plausible. My letter led to others. Dr. Ewing explained that he had changed his views. He left it, however, uncertain whether he believed that no such stress as $B^2/8\pi$ exists in iron, or whether he took the view that tensional and compressive stresses both exist, but in adjacent portions of the magnet. The latter view seems indicated by the illustration he advanced, viz. that of a man sitting in a clothes basket and pulling the handles. The medium in this case is obviously not free from stress, having a tensile stress in his arms and a corresponding compressive stress elsewhere. Prof. E. Taylor Jones wrote favouring a tensile stress, and referring to work by himself and Prof. Nagaoka on the subject. Prof. L. R. Wilberforce dwelt on the fact that the stress $B^2/8\pi$ most properly associated with Maxwell's name has its seat in a hypothetical ethereal medium, not in the material iron. Dr. Bidwell did not then give his views to the public, so far as I am aware. From his late letter I infer that they have remained unaltered since 1896.

Dr. Bidwell advances illustrations to explain his ideas. His arguments, however, seem really to amount only to this, that if *two* masses of iron, whether bars or spheres, close to one another be capable of *bodily* movement (*e.g.* if they rest on a smooth table or be suspended by long threads), and have between them some compressible non-magnetic medium (*e.g.* a finger), this interposed material will be squeezed if the iron becomes suddenly magnetic. This result is, however, equally consistent with either of the above theories; also it throws no light on the nature of the stress in the *iron.*

If, however, we suppose—as Dr. Bidwell ostensibly does—the two hypothetical masses of iron to be consecutive members of an infinitely long series, which seems the only hypothesis likely to represent the interior of a magnet, and suppose them to be separated by air or by a non-magnetic solid, there is obviously no reason why their centres should approach one another when the masses all become longitudinally magnetised. Number n mass is urged to the right, say, by the attraction of mass $n+1$, but to the left by the equal attraction of mass $n-1$, and there is no reason to move bodily one way rather than the other. If we regard the centres of the masses as fixed, then it is obvious if air gaps separate the mass n when unmagnetised from the masses $n-1$ and $n+1$, that after magnetisation it will—whether of extensible or highly inextensible material—suffer a *tensional stress* in consequence of the attractions exerted by its two next neighbours. If the intervals between n and its neighbours be filled by, say, lead, the lead will suffer no compression unless the mass n lengthens when magnetised. If the mass n lengthens, the lead will suffer compression; but the longitudinal stress in n, though less than if the lead were non-existent, will still be a tension. If we suppose that the poles of the hypothetical elementary magnets are not quite at their ends, and that the elements lengthen when magnetised, so that adjacent ends either meet across an air gap or else exert pressure on an interposed non-magnetic layer, then a compressive stress might be looked for, not merely in the layer, but also in the short terminal parts between the poles and the ends; tensional stress would, however, exist throughout the longer central portions. Whether these various hypothetical cases will do more than serve to show the inconclusiveness of Dr. Bidwell's illustrations is, I realise, very doubtful.

In practice there are usually complications from free ends and want of symmetry. We may, at least theoretically, avoid such complications by taking some endless solid, the simplest being an anchor ring, preferably of small section but large aperture. Is there a "hoop" stress in such a ring when magnetised which did not exist prior to magnetisation, and, if so, what is its sign? If there is a "hoop" tension, then the case is so far analogous to that presented by a ring rotating about an axis through its centre perpendicular to the plane of its aperture. If we imagine a short element of the rotating ring bounded by planes through the axis, the *tensions* across the end faces will give an *inwardly* directed radial resultant which is balanced by the "centrifugal force." A stationary Saturn ring of continuous material, under the attraction of a planet at its centre, similarly gives a case of a compressive "hoop" stress; the *pressures* over terminal faces of an element give an *outwardly* directed resultant, balanced by the planet's attraction and that of the ring on itself. In the Saturnian as in the rotating ring (when reduced to a statical problem), the hoop stresses are really excited by a radial action. Is there anything equivalent to this in the magnetic problem? If there is no radial action there will naturally be a change of aperture, unless, like Dr. Bidwell, we suppose the magnetic material absolutely "rigid." With change of aperture there will be change in the intermolecular distances, and so in the intermolecular forces. It would obviously be difficult to distinguish between the stresses due directly and those due indirectly to magnetisation.

I might add that Dr. Bidwell's remarks on the "uniformly magnetised rod" divided transversely seem to me to confuse tensile with compressive stress. He deduces a stress from iron to air gap, which seems really a tension on the iron. If he supposes the two fragments of iron held so as to prevent them doing more than just touch, he will, I think, realise this. Again, his remarks in reference to his spherical model do not seem to draw a sufficiently clear distinction between stress and strain. A "rigid" body, if such an entity could be realised, might be under stress though exhibiting no strain. On the other hand, in an elastic body the signs even of the stress and strain in a given direction may differ.

During the ten years that have elapsed since the controversy began I have been too busily engaged in other matters to follow the developments of magnetic and electrical theory. I hope that the recognised leaders in these developments will not turn a deaf ear to Dr. Bidwell's appeals for further light. C. Chree.

September 15.

The Rusting of Iron.

DURING the past few months the study of the chemical changes involved in the rusting of iron has been coming to the fore. In 1888 Crum Brown pointed out that iron remained free from rust in an atmosphere of oxygen, carbon dioxide, and water vapour so long as liquid water was prevented from condensing on its surface. Whitney, in 1903, confirmed the opinion that liquid water alone had no effect on the metal at ordinary temperatures. No mention was made, however, of the purity of the iron used. Last year Dunstan, Jowett, and Goulding confirmed these results for polished iron plate (99·94 per cent. iron) in a series of carefully planned experiments. Since iron of such great purity as this is seldom used for commercial purposes, it seemed to me desirable to try the effect of water alone on different samples of varying qualities. Three such were chosen:—(1) cast iron from a piece of old piping; (2) wrought iron; (3) fairly pure iron (99·5 per cent.). The pieces were polished, and measured approximately 1 cm. long by 3 cm. broad and 0·2 cm. thick. They were dropped into flasks of boiling distilled water, and after five minutes the latter were closed with tightly-fitting india-rubber bungs, in the way indicated by Whitney. It was found that whilst the pure and wrought iron were unchanged, the cast iron invariably turned a shade darker in tint. The experiment was varied by employing thin glass tubes instead of flasks, and the surface of the metal was in some cases roughened with a coarse file. After the admission of the iron, the tubes were drawn out and finally sealed off. The results were invariably the same. I have kept these tubes for several months, but no further changes have taken place. This seems to indicate that, whilst neither warm nor cold water has any effect upon the purer forms of iron, they exert some slight action on the coarser cast iron.

Many and various are the theories which have been suggested from time to time to account for the process of rusting. Crum Brown pointed out that carbon dioxide was necessary. This dissolved in the water and attacked the iron, forming ferrous carbonate, $FeCO_3$, or perhaps the soluble ferrous hydrogen carbonate, $FeH_2(CO_3)_2$. The hydrogen gas set free combined with any dissolved oxygen, forming water. The oxygen of the air would convert the ferrous hydrogen carbonate into rust, with the liberation of carbon dioxide. Thus a small amount of carbon dioxide in the presence of water and oxygen would be capable of converting an infinite amount of iron into rust.

During the present year Moody has confirmed this theory by showing that if elaborate precautions are taken to remove every trace of carbon dioxide, pure iron (99·98 per cent.) may be kept for an indefinite time in the presence of air and liquid water without undergoing the slightest visible change. He has also directed attention to the fact that when a piece of pure iron is introduced into a dilute solution of distilled hydrogen peroxide the latter is decomposed slowly, evolving a steady stream of oxygen, whilst the iron is unchanged. This again demonstrates the fact that oxygen and water alone have no action on pure iron.

I have repeated the experiments with hydrogen peroxide, using the different samples of iron already referred to. The peroxide was from Merck, and guaranteed to be pure. It was diluted to thirty times its volume with freshly-boiled distilled water. On introducing the iron, it was found that the pure sample remained perfectly bright, a slow stream of oxygen being evolved. After some hours an odd speck or two of rust appeared. No further alteration occurred even after the lapse of one or two weeks. The wrought iron decomposed the peroxide rather more rapidly, and the specks of rust were more numerous. The cast iron decomposed the peroxide with astonishing rapidity, and in a few minutes was covered with rust. This was, no doubt, due to catalytic action.

We thus see that the purer the iron the less is the action of the peroxide upon it. Had such pure iron as that used by Moody been employed, I have no doubt my result would have exactly coincided with his.

It is not impossible, therefore, that while carbon dioxide, oxygen, and water are essential for the rusting of pure iron, the last two alone may be sufficient to cause rust in the coarser forms, such as cast iron.

J. NEWTON FRIEND.

The Mixed Transformation of Lagrange's Equations.

THE history of the formula

$$L = \mathfrak{T} + \Sigma(\Theta\dot{\theta}) - \mathfrak{K} - V \quad . \quad . \quad . \quad . \quad (1)$$

is as follows. About twenty years ago I read two papers by Lord Rayleigh and Prof. W. M. Hicks in which certain problems relating to the motion of a cylinder in a liquid, which possesses cyclic irrotational motion, were solved. Both authors employed the old-fashioned method of calculating the forces due to the pressure of the liquid; but I at once perceived that some form of Lagrange's equations must exist which would enable the problems to be solved without introducing internal forces. I accordingly examined all the works on dynamics to which I had access, including Dr. Routh's treatises and Prof. J. J. Thomson's recently published papers in the Phil. Trans., 1886 and 1887, but without finding what I wanted. The necessary clue was at length obtained by means of a theorem of Lord Kelvin's published in the Proc. Roy. Soc. Edin., vol. vii., p. 668 (about 1872 or 1873), which enabled me to establish the formula in question.

Dr. Routh ("Rigid Dynamics," pp. 319 and 320, fourth edition) has given some rather formidable determinants, by means of which it is conceivable that (1) might be deduced by a more or less lengthy analytical process; but in their present form I have never been able to make any use of them. The procedure explained in §§ 418–420 could not apparently be employed when the velocities which are to be eliminated are either unknown or would be inconvenient to introduce.

A. B. BASSET.

Fledborough Hall, Berks, September 21.

Suspended Germination of Seeds.

SOME years ago it was reported that charlock seed had germinated upon the site of a Norman church in Kent. Is there any similar record of foxgloves awakening from a long sleep? Last February I removed an ancient wall circling the top of a very bare hill on a north country farm. We took out the large foundation stones. As the spring advanced, the site of the wall became carpeted with seedling foxgloves; if the cattle permit, a thick foxglove hedge will round the crown of the hill next year.

There were no foxglove plants within several hundred yards, and even had there been roots there would be no seed in February. The wall was formerly the fence of an oak wood, which was felled and turned into pasture forty years ago. The seeds were unquestionably as old as that date; but my own strong opinion is that they were right underneath the foundation stones of the wall, and had lain there ever since it was built. I examined the site very carefully, and also noted that disturbance of the neighbouring turf, outside the site, did not produce any foxglove crop. I believe that the oaks were planted and fenced by a man named Stephen Green between 1600 and 1610.

Another less pleasing instance occurred on the same farm. I took some cartloads of turf and loam—top-spit from an old pasture traditionally called the "Barley Field"—and spread it on another part of the grass; whereupon there came up thousands of corn-weeds, such as fumitory and sun spurge, which were previously unknown in the pastures.

H. B. P.

Optical Illusions on Electric Fan.

A REVOLVING electric fan with gilt blade is illuminated by the light from a window. When we look fixedly on the revolving face an irregular patch of greyish-purple colour appears on the yellowish ground. The patch shows an amœba-like motion, and its size seems to increase with the speed of the fan. The border of the patch is coloured pale. In its centre a bright spot is often discerned. If we look at the fan after having closed or turned aside our eyes for a while the patch has disappeared, and it takes a few seconds before it reappears.

Several other experiments on illusion can be made conveniently by means of the fan. If the blade be covered with red papers and revolved slowly, a white paper looked at through the revolving face appears greenish, and a greenish one greyish.

T. TERADA.

Physical Laboratory, Tokyo, August 26.

Aquatic-dwelling Weevils

IN NATURE of September 6 there is a note (p. 472) on Dr. Nelson Annandale's papers on the fresh-water fauna of India, ending with the words "an aquatic weevil, which, so far at any rate as habits are concerned, is altogether unique." If this sentence is intended to mean that water-dwelling weevils were previously unknown it is incorrect.

Mr. J. H. Keys and myself took specimens of the weevil *Eubrychius velatus*, Beck, from a pond near Plymouth in September, 1905, which were as thoroughly aquatic as any of the typical water-beetles (*e.g.* Dytiscidæ), most of their time being spent in crawling under water on the leaves and stems of Myriophyllum. Fowler has an interesting note on this species, to the same effect, in his "Coleoptera of the British Islands," vol. v., p. 373.

Mr. Keys also states that *Tanysphyrus lemnae*, F., and the various species of Bagous are all more or less aquatic.

E. E. LOWE.

Museum and Art Gallery, Beaumont Park, Plymouth, September 11.

Remarkable Rainbow Phenomena.

THE letter of Mr. M. Spence in NATURE of September 20, describing a bifurcated rainbow, reminds me of a similar phenomenon which I saw some time during the winter of 1897–8. On that occasion the phenomenon was not so complete as that described by Mr. Spence, only the left-hand portion of the bow being visible. The arch rose from the horizon as a single column to a height of about ten degrees, and then bifurcated into two distinct branches, which, however, did not extend far from the join.

As I was playing in a football match at the time it was impossible to study the effect at all closely; but, so far as I remember, the lower branch sprang out of the main regular bow, making with it an angle larger than that described by Mr. Spence. My incomplete observations were not alone of much value, but in confirmation of Mr. Spence's fuller description they may be worth recording now.

GEORGE C. SIMPSON.

Manchester University.

Is it not the case that the second rainbow seen by your correspondent (p. 516) was caused by the reflection of the sun in the sea? If this were so, naturally persons some miles west of Deerness, or inland, would not have seen it. I once saw the appearance of double rainbows beautifully manifested in Ranenfjord, on the coast of Norway, and the explanation which I have given is that which found most favour with the passengers on our steamer.

C. S. TAYLOR.

Banwell Vicarage, September 21.

SOME SCIENTIFIC CENTRES.

IX.—THE METALLURGICAL DEPARTMENT OF THE SHEFFIELD UNIVERSITY.

NEARLY fifty years ago Sir John Brown, the famous engineer and steel manufacturer, with Dr. H. C. Sorby, the father of the introduction of the microscope for the examination of thin sections of rocks and of polished or polished and etched surfaces of iron and steel, attempted to establish in Sheffield a school of practical science; but as yet Britain held undisputed sway in the world of engineering and of metals; and the help of science, proffered by these far-seeing men, although just as desirable then as now, was rejected by such easy victors in the wars of commerce. The sum of 200*l*. was spent in advertising, with the result that only one student entered. Several years' perseverance never produced more than five students, so far as Dr. Sorby's memory serves him. Sixteen years later the added personal influence of such men as Mr. Mark Firth, Sir Frederick Mappin, Sir Henry Stephenson, and Mr. J. F. Moss failed to find a response, and although in 1879 Mr. Mark Firth founded Firth College to facilitate university extension work, it was not until 1883 that another special meeting was held, at which Dr. Sorby used the following pregnant words: "I do not see why we should not make the teaching of metallurgy a speciality of the town, nor why we should not make Sheffield the centre of metallurgical instruction."

In 1885 the Sheffield Technical School was fairly launched in a separate building, but as a department of Firth College, with chairs of engineering and of metallurgy both held by the late Prof. W. H. Greenwood. Until 1889 the department of metallurgy was in connection with the Science and Art Department, and its work consisted of courses of lectures on fuel, refractory materials, iron, steel, and general metals, with assaying and experiments in a laboratory fitted with analytical benches, wind and muffle furnaces similar to those in the Royal School of Mines of that date. In 1889, Prof. Greenwood having resigned his chairs to undertake the management of the Birmingham Small Arms Factory, John Oliver Arnold was appointed to the chair of metallurgy which he holds to-day. He began at once to inaugurate revolutionary changes, the fundamental aims of which seemed to be: (1) to increase the science of the metals themselves, the art being then in great preponderance; (2) as the industries of the district were mainly of iron and steel, to pay special attention to these, assured that science could be as truly served and minds as fruitfully trained on metals of immediate interest to the district as on the wider range; and (3) to keep the ideal ahead of having available on a small scale, but by a manufacturing method as distinct from a laboratory method, examples of as many types of metallurgical processes as possible, so that the students might examine the whole course of each process from beginning to end in the comparative calm of an educational establishment. A start was made by erecting a two-hole crucible steel-melting furnace fully equipped as a small works, and differing only from the large works in the city in that theirs would consist of so many dozens or hundreds of holes of the same size. The effect on the attendance was electrical, and the available laboratory accommodation was at once completely filled. A difficulty here arose in that the Science and Art Department objected to the course, but a very simple solution was found in cutting the laboratory adrift from Government control, the public men supporting it guaranteeing against any resulting financial difficulty. It ought in justice to be said that in those days the department did sounder work for pure science than it seems to be the present fashion to acknowledge, although its influence on metallurgy in Sheffield was not good.

The complete success of this first part enabled Prof. Arnold to induce the members of the governing committee to commence the more ambitious part of his scheme, though with some misgivings, and during the session 1890–91 the students had the rare privilege of following the erection of, as well as working, plant consisting of a 25 cwt. acid Siemens furnace, with gas producers and all necessary hydraulic power for lifts, a No. ½ Stewart rapid cupola, foundry with drying stove for sand and "compo" moulds, and a falling weight test apoaratus. As showing the curious features which sometimes govern a problem, although the No. ½ cupola worked well it had soon to be replaced by a No. 1, as when the lining began to wear it was only with the utmost difficulty that even a temporary assistant of the staff could be obtained sufficiently attenuated to be able to effect the necessary repairs, and at any time inspection of the lining was somewhat of an acrobatic performance. A 50-ton Wicksteed mechanical testing machine for tensile, transverse, crushing, bending and torsion tests was installed jointly with the engineering department under Prof. W. Ripper, and whilst this machine formed a solid meeting ground it may also be considered as emblematic of the relationships existing between these two departments from the beginning, namely, that the metallurgical should, so far as possible, make all metallic materials for the engineering department, and in return know of the behaviour of the materials supplied.

In 1890 the technical school, apparently finding it too difficult to impress its needs on the college authorities, became an independent institution, and was thus free to work out its own ideals until 1896, when the two again joined for the purpose of applying for a charter to become a university college, which charter was received in May, 1897. That its isolated progress produced a result acceptable, not only to practical, but to university men, was shown when application was made to enter the then Victoria University (an application to the making of which the present writer was firmly opposed); the report of the University Commission as published in the newspapers distinctly stated that the technical department was the only part fit for inclusion in the university.

It is impossible justly to estimate the influence of the metallurgical department, but the task must be attempted, as therein lies its soul. Thirty or so researches worked out in the department have been published by Prof. Arnold, his staff and students since 1889. "The Influence of Aluminium on Occluded Gases in Steel" (Arnold) was the first subject attacked, because of the many conflicting statements as to this influence. The experience gained in this work made possible the manufacture of a series of extraordinarily pure steels, the first research on which resulted in "The Influence of Elements on Iron" (Arnold), which combated Roberts-Austen's atomic volume theory as applied to steel, and Osmond's theory of the hardness of steel being due to a flint hard β iron apart from any carbon contained. Incidentally the micro-constituents FeS and MnS were discovered. The almost pugilistic vigour of the tone of this paper and criticisms which had preceded it seemed to turn many listeners, used to more gentle ways, into opponents without examination of the arguments, and it undoubtedly took many years to dispel the feeling, which still remains in the minds of some of the more unthinking or erratic, as seen from the way in which in a recent paper simple quotations from a well-known writer were treated in the discussion as attacks on him. "The Chemical Relations of Carbon and Iron" (Arnold and Read, 1893) was the result of work done to examine the discovery of the carbide of iron by Abel and Müller, and their results were fully confirmed, the carbide being obtained in chemically pure crystalline plates. In 1895, in "The Influence of Carbon on Iron" (Arnold), the discovery of the saturation point of steel was

FIG. 1.—Prof. J. O. Arnold in the Micro-laboratory.

announced, and the quantitative composition of Sorby's pearly constituent determined. This paper is admitted on all sides to be a classic.

In 1896, in "The Influence of Impurities on Gold and Copper" (Arnold and Jefferson), the first micrographic investigation of gold alloys was described, and the discovery of brittle intercrystalline cements rendered void atomic volumes as an explanation of the results. 1897 produced "The Influence of Sudden Cooling on Nearly Pure Iron" (Arnold), and "The Permeability of Steel-melting Crucibles" (Arnold and Knowles), which showed a method for quantitatively measuring the volume of gas permeating the walls of crucibles ¾-inch thick during metallurgical operations. "The Micro-chemistry of Cementation" was read in 1898, and the discovery of the cause of the decay of certain metals used in marine construction in connection with the disastrous explosion on the S.S. *Prodano* was given in a report to Lloyd's. "The Diffusion of Elements in Iron" (Arnold and McWilliam, 1899) divided the elements of steel into fixed and migratory groups and confirmed Prof. Campbell's diffusion of sulphide phenomena. During this research two very important phases of carbide interpenetration at different temperatures were discovered, and also a hitherto unsuspected segregation point which has cleared up some of the occasional mysterious failures of the highest grade cutting edge steel.

"The Properties of Steel Castings, Part i." (Arnold, 1901) dealt with pure iron and carbon castings, and showed their unsuitability for general commercial work. "The Micro-structure of Hardened Steel" (Arnold and McWilliam, 1902), amongst other things, first showed the cementite in the so-called austenite martensite structure. "The Elimination of Silicon in the Acid Open Hearth" (McWilliam and Hatfield, 1902) is an interesting study, under works conditions, of chemistry at high temperatures in the reaction of metal and slag on each other, in which a balance point in the composition of the slag was discovered, such that with more base C, Si, and Mn were eliminated from the metal, whilst with more acid C could still be eliminated, but Si and Mn were reduced and returned to the bath. "The Influence of Sulphur and Manganese on Steel" (Arnold and Waterhouse) and "On the Dangerous Crystallisation of Steel" (Arnold) were produced in 1903, and in the latter the author announced his now well-known method for recording results of steel under alternating stress, the stress being greater than the elastic limit instead of less, as is the case in other methods. "Acid Open Hearth Manipulation" (McWilliam and Hatfield, 1904) is another high temperature chemistry study on a 25-ton furnace, with unusual bases, in which also it was shown that the nature of the ingot is not merely a function of its composition as ordinarily determined, but varies with the history of the charge in a special manner shown. "The Thermal Transformations of Carbon Steels" (Arnold and McWilliam, 1904), too complex to describe in a sentence, shows the nature of the transition forms of the constituents of steels by quenching so as to trap several forms in one small section, where they can be studied somewhat after the manner of examining rock changes over a tract of country. Winder and Brunton did early work on open hearth chrome steel castings; Longmuir here worked out what had been borne in upon him by his works experience, resulting in his two researches on "The Influence of Casting Temperature on the Properties of Metals and Alloys"; Baker did his work on "The Influence of Silicon on Iron," and half the work resulting in Ibbotson and Brearley's well-known book on "The Analysis of Steel Works Materials" is of this laboratory. The above is not by any means a complete list, but is intended to indicate the principal and to give a good idea of the original work done, which has been acknowledged by practical as well as by professional men to have had great and important influence.

With regard to the students trained, every works of any importance in the district has its quota of them, and many are reflecting great credit on their school by the success with which they are holding responsible positions. There is no doubt that all firms of importance, having ready at hand well-trained men, formed a potent factor in the signal success with which Sheffield not only repelled the American invasion of high speed steel, but was able promptly and successfully to carry the war into the enemy's territory. The associateship in metallurgy has always been kept up to about the standard of an honour examination, no second classes being allowed, and the fight for the Mappin medal and 15*l*. premium given to the head associate of the year is long and severe. This medal and premium was founded by Sir Frederick Mappin, Bart., who has consistently for more than twenty years used not only his wealth, but his great influence with others, and his foresight and dogged perseverance, in furthering the cause of this technical department. His recent purchase and practical presentation of the adjacent Caledonian Works has enabled the authorities to apply their fifteen years' experience during the erection of a new and magnificent teaching plant, which has been so recently described that it need not have further mention here. Finally, as to the attitude of manufacturers, few who followed with interest the doings of fifteen years ago would have prophesied that steel makers would send for associates at the end of each session, or that some even would ask for "your medallist of the year if possible," but such is the fact to-day.

All Sheffielders asked feel certain that but for the continued success of this and the technical department as a whole, Sheffield would never have successfully demanded a university, and that, indeed, the university inaugurated by the King on July 12, 1905, may be taken as a monument to one of the influences of the technical department. Twice in its history has this progressive department had to sever its connection with constituted authority, and many are looking, somewhat anxiously it must be confessed, to its progress under the cumbrous machinery of university government, with its several forms of outside interference. Change and progress are not now decided upon by those immediately interested, for at least a majority of a governing body, composed of professors of all and sundry, must sanction all decisions, and in its effect on this hitherto uniformly progressive and successful department university government is undoubtedly on its trial, so far as its influence on the application of science to industry is concerned.

EARTH-EATERS IN INDIA.

UNDER the name of geophagy or earth-eating are comprehended a number of customs of very different origin and meaning. In practically every part of the world is found the habit of eating finely divided mineral substances in bulk, and not merely in small quantities as condiments; but the purpose differs no less widely than the condition of the eaters as regards age, sex, or health before and after acquiring the habit. We learn from Pliny that the Romans mixed corn with chalk from near Puteoli; Lemnian and Armenian earths, on the other hand, were famous for medicinal purposes—the use of the former has been continued to our own day; in South America clay supplies the place of food during floods; in Borneo and

Indo-China it is a surrogate for confectionery, and in parts of India, America, and elsewhere its use is due to the perverted taste often found in dyspepsia and hysteria, or to the strange abnormalities associated with pregnancy.

In the paper here noticed[1] the composition of the earth, marl, clay, or shale has been carefully analysed; the main constituents are silica (the percentage varying from 84 per cent. to 22 per cent.), lime (61 per cent. to a mere trace), alumina (26 per cent. to 2·5 per cent.), and ferric oxide (20 per cent. to a mere trace). But as a rule there is little definite information, other authors being content to speak of clay or earth without closer definition. We know, however, that steatite is favoured by the Indians of Hudson's Bay, and ferruginous clay by the Ottomacs, by the negroes of the Antilles, and by the Batanga of West Africa; earth rich in diatoms is used in North Europe, and the New Caledonians resort in time of famine to a mineral rich in lime, and ants' nests, with or without the larvæ, are eaten in Africa. The physiological basis of the habit varies probably in some degree with the different composition of the earths. On the Gold Coast white clay is used as a sweetmeat; in India the taste or odour is often the attractive feature; it may be noted in this connection that steatite (one of the minerals mentioned above) is not only eaten by wolves, reindeer, and other animals, but actually used as bait for attracting them. To the pleasant taste may be due the Roman use of chalk mentioned above; we have a parallel in the Bolivian Indian's use of a sauce of clay with his potatoes. In this category, too, we may range the German workman's "Steinbutter," and perhaps the salty earth used in Persia. In Senegal ochreous earth is mixed with rice, but it does not appear whether this is due to its pleasant taste or to a desire to increase the mass available for ingestion so as to produce a feeling of repletion.

In Rajputana the latter cause is undoubtedly the main factor; for only in times of famine are ashes, powdered steatite, clay or mud mingled with bark-meal. On the other hand, it is not so much actual famine in Persia as the desire to keep the digestive organs at work without suffering inconvenience from an over-supply of nourishment which is said to lead to the use of the two kinds of earth frequently sold in bazaars; one is described as a fine, white, "fatty" clay, the other as forming hard and irregular lumps. The material of ants' nests, like the Bergmehl (Kieselgur) of North Europe, is rich in organic matter, and may have real nutritive value; but on this point little positive information is available.

Especially in India the habit of earth-eating is indicative of a morbid condition, either anterior to the acquisition of the taste or after it has been adopted from imitation or some other cause. The same conditions seem to prevail widely in South America, where not only Indians and negroes, but whites, are slaves to the practice; it is even said that masks are put on children at night to restrain them from pulling mud or plaster from the walls and eating it.

The medicinal use of earths is a wide subject on which a large literature exists; our authors quote, among others, El-Baitar, who gives a list of the earths used in Spain in the thirteenth century; but the use of mineral substances in medicine hardly belongs to the same category as the other facts with which they deal; the same may be said of the ingestion of earths for magical purposes.

The effects on the eater seem to differ widely. In West Africa no bad effects follow, according to some authors; but when the negroes reached the West Indies they found that ill-health resulted from their indulgence in decomposed porphyroid lavas as substitutes for their African earths. In India and South America anæmia and early death seem to follow as a matter of course, but the anæmic diathesis often exists before the habit is acquired, and may be the actual cause of it.

The quantity of earth or clay consumed is often considerable. Half a pound daily is the allowance for the Ottomacs; six ounces is recorded from Bengal. They are sometimes eaten raw, sometimes roasted; one of the most curious features is that the earth or clay is sometimes made up into cups, figurines, and other forms; thus the Lemnos earth used in Spain in the sixteenth century was cup-shaped, so is the clay used to-day in Bengal; in Bolivia figures of saints are among the forms, and the Javanese eat figures of men and animals. In these cases a magical element may perhaps be present. But the commoner form is that of powder; the only edible earth of which the present writer can speak from personal experience was in this shape; it was alkaline and more like tooth-powder than anything else.

N. W. T.

[1] "Earth-eating and the Earth-eating Habit in India." By D. Hooper and H. H. Mann. (*Memoirs of the Asiatic Society of Bengal*, vol. I., No. 12, pp. 249–270.)

NOTES.

DR. L. A. BAUER's resignation from the United States Coast and Geodetic Survey took effect on September 1. As already announced in NATURE, he has accepted the permanent directorship of the department of terrestrial magnetism of the Carnegie Institution of Washington. All his correspondence should be addressed to "The Ontario," Washington, D.C.

AT the annual meeting of the Hull Scientific and Field Naturalists' Club just held, Mr. T. Sheppard, who for thirteen years has been the honorary secretary, was elected president of the society.

PROF. A. H. CHURCH, F.R.S., will give six lectures on chemistry at the Royal Academy of Arts on Mondays and Thursdays, beginning on October 1 at 4 p.m. The subjects of the lectures are:—Paper, canvas, panel, and other grounds; composition and classification of pigments; tests and trials of pigments; selected and restricted palettes; vehicles and varnishes; and methods of painting.

A NOTE from the Rev. Guy Halliday recording the discovery of *Goodyera repens* near Holt, in Norfolk, was referred to in NATURE of September 6 (p. 472). Mr. W. A. Nicholson, honorary secretary of the Norfolk and Norwich Naturalists' Society, informs us that the plant was found at Holt so far back as 1891, and at Westwick in 1885. It has since been noted in two other places in Norfolk.

A REUTER message from Palermo states that earthquake shocks were felt on September 19 at 11.20 a.m. and 1.38 p.m., principally at Trabia and Termini. A message from Lima reports that shocks were felt on September 18 at Huarmey, Alija, and Casma.

AN International Congress for Cancer Research was opened at Heidelberg on Tuesday by the Grand Duke and Grand Duchess of Baden in the presence of numerous representatives of medical, scientific, and municipal institutions of the world. At the same time, a new hospital and scientific laboratories for investigations into the cause and cure of cancer was opened. We learn from the *Times* correspondent at Heidelberg that the new buildings occupy nearly an acre, and are fitted with all the latest improvements, both for the treatment of operable cases and for investigation. The institution has already cost more than 40,000*l.*, which was derived partly from public and partly from private sources.

PROF. HERMANN COHN, the well-known ophthalmologist of Breslau, died recently at the age of sixty-eight. His contributions to ophthalmic science and practice had reference more particularly to the eyesight of school children. He was one of the first to press the needs of many reforms with the object of conserving the pupils' vision, and he was a strenuous advocate of the systematic examination of the eyes of school children, his knowledge and experience in this connection being of the greatest value in evolving and perfecting the practical details of an important branch of work. In 1883 he was honoured by receiving the State gold medal of hygiene. He lived to see much good fruit result from his labours, and it may justly be said that with him there passed away one who served well both his own and future generations.

A PLEA for the preservation of natural scenes and objects in Germany was put forward a couple of years ago by Prof. H. Conwentz, director of the West Prussian Provincial Museum at Danzig, in a work on "Naturdenkmäler," described in these columns in November, 1904 (vol. lxxi., p. 73). By Naturdenkmäler is meant the whole natural landscape, with its various soil formations, its water courses and lakes, its special plant and animal communities, as well as single rare species and individuals of the original flora and fauna. Prof. Conwentz proposed that these results of nature's handiwork in the different States of the German Empire should be placed on record so as to make them known, and that provision should be made for their protection. The Prussian Minister of Instruction has just consented to the establishment of a central office for this purpose. For the present the office will be at Danzig, and will be under the direction of Prof. Conwentz.

IN his presidential address at the annual congress of the Sanitary Inspectors' Association at Blackpool on September 13, Sir James Crichton-Browne dealt particularly with the rapid and remarkable fall in the birth-rate of Blackpool. It was in 1895 that a turn in the tide in the birth-rate of England and Wales was first recorded, since when it has gradually decreased, until in 1904 it dropped to 27·9, the lowest on record. In Blackpool the decline did not begin until 1898, when the rate was 27·74, showing a slight increase on the previous year; but since then it has been precipitous, reaching 20·30 per thousand for 1905. Many facts suggest that this decline in the birth-rate has occurred especially among the more intellectual, more cultured, and more prosperous classes of the community. Bearing in mind that 25 per cent. of the married population produce 50 per cent. of the next generation, and that mental and moral traits are not less hereditary than corporeal appearances, it is impossible to exaggerate the importance of the problems that are raised by the figures adduced. If we are recruiting our population from the poorer and mentally and physically feebler stocks of the community at a greater rate than from the better and more capable stocks, then gradual deterioration of the race is inevitable.

THE "coming of age" of the Royal Geographical Society of Australasia was celebrated at Brisbane at the end of June last by a festival extending over four days. On June 26 a reception and luncheon were given by the Mayor (Mr. J. Crase), and at an evening meeting addresses of congratulation from other societies were presented, and the secretary, Dr. J. P. Thomson, gave an account of the history of the society. At an evening meeting on June 27 a paper by Dr. H. R. Mill, on the present problems of geography, was read. A garden-party was given at Government House in the afternoon of June 28, and at the evening meeting a paper by Prof. R. E. Dodge, Columbia University, on school geography, was read, Lord Chelmsford taking part in the discussion. A conversazione was given on June 30, at which it was announced that a paper by Sir John Murray, on the oceanography of the south-western Pacific, had been received too late for reading at the business meetings, but would be included in the society's Transactions. The Royal Geographical Society of Australasia was founded in 1885, chiefly on the initiative of its present secretary, Dr. J. P. Thomson. Its activities include the whole range of geographical work, and it has published twenty-one volumes of Proceedings and Transactions containing communications, of which "about 80 per cent. are original contributions to geographical literature, the remainder being the result of research work, in contradistinction to mere compilations."

THIS is the season for great hurricanes within the northern tropical belt. Thus far the West Indies have escaped, but the China Sea region was last week the scene of two very violent and destructive typhoons. On the morning of September 18 there does not seem to have been anything in the aspect of the weather at Hong Kong to suggest the proximity of a storm. People went about their business as usual, suspecting no danger, and the authorities at the observatory found nothing in the reports to justify the hoisting of the warning signals, expecting only moderate winds to prevail during the day. At about 10 a.m. the neighbourhood was startled by the sudden bursting of a storm of great violence, which maintained its strength until midday. In these couple of hours it occasioned enormous damage ashore and afloat. Many war vessels, merchant steamers and sailing ships, lighters, junks, and other craft were severely crippled or totally lost, and one of the latest estimates places the loss of life at 10,000 Chinese and several Englishmen and other Europeans. The Governor, Sir Matthew Nathan, has decided to appoint a committee to inquire into the failure of the observatory to give due warning of the approach of the typhoon, but he is confident that Dr. Doberck is not to blame in the circumstances. Four days later, on September 22, news was received of the Philippines, south of Manila, having been struck by a typhoon. The information to hand at present is very meagre, owing to the destruction of the telegraph wires, but a gunboat was driven ashore, and the arsenal and the shipping at Cavité suffered considerably.

A PAPER, by Messrs. B. Stracey and F. W. Bennett, on the felsitic agglomerate of Charnwood Forest, is the most important of the contributions relating to natural science contained in vol. x., part ii., of the Transactions of the Leicester Literary and Philosophical Society.

ACCORDING to the report for 1905–6, the Manchester Museum, Owens College, recently received a valuable collection of mammals from N.E. Rhodesia, but funds are lacking for mounting and encasing a representative series of these in the gallery. The museum will shortly also receive a collection of insects made in the same district. The well-known and extensive series of stone implements collected during the last forty years by Mr. R. D. Darbishire has been presented by that gentleman to the museum. It is satisfactory to learn that the financial condition of the institution has materially improved since the date of the previous report.

PROF. HICKSON'S letter on remarkable cœlenterates from the west coast of Ireland in NATURE of November 2, 1905 (vol. lxxiii., p. 5) is reprinted in a volume just issued on Irish fisheries (Scientific Investigations, 1905, v.). This is followed by a notice of a leach parasitic on torpedoes taken on the Irish coast, and this, again, by the mention of a mollusc of the genus Lamellaria captured in a trawl off Cork. The particular species, which is common to both sides of the Atlantic, is new to the Irish fauna. Finally, Mr. S. W. Kemp adds ten species of long-tailed crustaceans to the marine fauna of Ireland.

THE report of the Danish Biological Station for 1903 and 1904, recently issued at Copenhagen as a translation from Fiskeri-Beretning, deals with the distribution and dispersal of the young and eggs of fishes which at one period or another are pelagic. From the study of the Icelandic seas it has been found that three belts may be distinguished in the neighbourhood of land, the first of which is characterised by the presence of pelagic eggs and the minute fry of species with demersal (deep sea) eggs, while the second is inhabited by the young fry of species with pelagic eggs and the older fry of those with demersal ova. In Danish waters the conditions appear to be somewhat more complex, but, speaking generally, it may be stated that the area within the Skaw approximates in its fauna to the first belt, and that outside the Skaw to the second zone.

WE have to acknowledge the receipt of a copy of the first part of the "Bergen's Museum Aarbog" for the current year. In the first paper Mr. J. Rekstad discusses the terraces and raised beaches of western and northern Norway. Among the more noteworthy remains are nodules, from more than one locality, containing beautifully preserved specimens of the skeleton of young coal-fishes (*Gadus virens*). In a second article Mr. C. F. Kolderup records the occurrence in Norway during 1905 of twenty-three earthquakes, all of which were, however, small and local. The capture, in the middle of January, 1904, of no less than forty-seven killer-whales (*Orca gladiator*) at Bildöströmmen is recorded by Mr. J. A. Grieg, who furnishes an illustration of the landing of one of these cetaceans. Several skeletons were preserved, of some of which the author gives measurements and descriptions. In addition to papers by other authors, Prof. R. Collett communicates notes on bottle-nosed whales (Hyperöodon) and white whales (Delphinapterus).

THE sixth number of the *Kew Bulletin* for this year contains the diagnoses of new plants, published under the title "Decades Kewenses, XLII.," of which one, described by Dr. Stapf, forms the type of a new genus Diandrolyra, order Gramineæ. Mr. J. M. Hillier contributes articles on East Indian dragon's-blood, chiefly the produce of species of Dæmonorops and Ogea gum obtained from the genera Daniella and Cyanothyrsus. The account by Mr. W. Watson of a visit to some well-known Irish gardens makes special mention of the magnificent development of the trees, showing how well the climate is suited to forestry. A historical article on the Sydney Botanic Gardens, written by Mr. J. H. Maiden, is reprinted from the Sydney *Morning Herald*.

THE review of Mr. Luther Burbank's work written by Prof. H. de Vries in the *Biologisches Centralblatt* (September 1) gives the opinions of the foremost scientific plant-breeder on the work of one of the most successful practical plant-breeders. While fully recognising the remarkable acumen of Burbank's judgment and the practical value of his work, Prof. de Vries finds a marked contrast between the aims and methods of the two types of worker. Careful experiment in the cultivation and crossing on a limited scale of pure types with definite characters is the task of the scientific investigator; the hope of the nurseryman lies in the chance possibilities arising out of the production and selection from a vast number of variations; for instance, Mr. Burbank selected his plums from 300,000 hybrids. One of the most important features of Mr. Burbank's work has been the cultivation of remote species with possibilities that have escaped the consideration of less conventional cultivators. The stoneless plum was obtained from crossing some plants, "prunes sans noyau," at one time cultivated in France. An intuitive genius for selection of promising varieties is the key to Mr. Burbank's success.

Two examples of "fluctuating variation" as met with in certain New Zealand plants are noted by Dr. L. Cockayne in vol. xxviii. of the Transactions of the New Zealand Institute. In the first case, two Celmisias were found, one growing on the coast, the other in the alpine region, both very similar, except in the proportions of the leaf and general appearance. The question arises whether they should be regarded as distinct species. This, Dr. Cockayne points out, can best be determined by ascertaining whether the two forms reproduce "true." The second paper refers to leaf variation in *Coprosma baueri*. When exposed to sun and wind, the plant bears glossy, recurved, or rolled leaves, whereas in the shade they are thin, flat, and much larger. There is no question of two species in this case, as the two types of leaf may be observed on the same plant, but it suggests a starting point for the evolution of two distinct species.

ALTHOUGH not far distant from the North Island of New Zealand, the flora of the Poor Knights Islands had not been explored until Dr. L. Cockayne was enabled to get ashore for a very brief period last year. Distinguishing three formations of cliff, tall scrub, and meadow, Dr. Cockayne was particularly impressed by the luxuriance of the foliage of the arborescent plants in the scrub, and especially of the dominant plants *Suttonia divaricata* and *Macropiper excelsum*. Apart from the fertility of the soil and the shelter afforded by the dense growth, it was not apparent why such luxuriance should be developed. Another ecological contribution by the same writer, describing the subalpine scrub of the seaward Kaikouras, in the South Island, is published with the former in the Transactions of the New Zealand Institute, vol. xxviii. The peculiarity of this formation, that lies between the forest and the subalpine meadow, consists in the dominance of the composite shrub, *Cassinia albida*, found only in the Kaikoura Mountains, and in the occurrence of a Ranunculus growing under the scrub that Dr. Cockayne separates as a distinct species, *Ranunculus lobatus*.

THE third and final part of a series of papers on sands and sediments, by Messrs. T. Mellard Reade and Philip Holland, appears in the volume of the Proceedings of the Liverpool Geological Society for 1905–6. The earlier parts were published in the two preceding volumes. The papers describe a number of experiments made upon modern and ancient sediments to determine the behaviour of the particles when suspended in water and in various solutions;

most of the material was also analysed. The principal conclusions derived from their experiments by the authors are:—(1) that in many sediments of all ages extremely fine particles, especially "quartz-dust," play an important part; (2) that most of the quartz-dust has been produced by the collision and abrasion of quartz grains while suspended in water, and that the perfect rounding of some quartz grains, usually assumed to be due to wind action, may be largely due to this subaqueous abrasion; (3) that carbonate of lime may often be present in suspension in considerable amount in natural waters; and (4) that the microscopic suspended matter is probably an important item in the total solid content of the waters of the open sea. In the same volume Messrs. T. Mellard Reade and Joseph Wright have a short paper on the Pleistocene clays and sands of the Isle of Man, which is mainly occupied by lists of the Foraminifera found in the drift.

ON May 15 the city of Nuremberg opened a national exhibition in commemoration of the centenary of its subjection to the Bavarian Crown. The exhibition, which will remain open until October, has proved eminently successful. It contains a good display of Bavarian manufactures, and is of special interest from the admirable manner in which the mineral resources of the kingdom are shown. The mineral deposits represented include the iron ores of the Fichtelgebirge, coal from the Palatinate, iron pyrites and galena from Bodenmais, salt from Berchtesgaden, copper ore from Imsbach, and graphite from Passau.

THE Engineering Standards Committee has issued its standard specifications for material used in the construction of railway rolling stock. This report, No. 24 (London: Crosby Lockwood and Son, price 10*s.* 6*d.* net), covers sixty-two folio pages, and is undoubtedly one of the most complete and valuable of the publications of the committee. It contains specifications for locomotive crank axles and straight axles, carriage and waggon axles, tires, springs, steel forgings, steel blooms, steel castings, copper plates, rods and tubes, brass tubes, and steel for plates, angles, and rivets. In each case specifications are given, with and without chemical analyses. The committee has also issued a standard specification for steel conduits for electrical wiring (report No. 31, price 2*s.* 6*d.* net), and a report (No. 28, price 2*s.* 6*d.* net) on British standard nuts, bolt-heads, and spanners.

IN the Journal of the Franklin Institute (vol. clxii., No. 2) Mr. Clifford Richardson concludes his elaborate memoir on the petroleums of North America, in which he compares the character of those of the older and newer fields. Those of the earlier days of the industry, from the Appalachian field, were paraffin oils, free from sulphur, specially valuable for the production of illuminants. The petroleums of north-western Ohio and Canada, next developed, being sulphur oils, were far less valuable. The California oil is composed of such a series of hydrocarbons, of a non-paraffin nature, that its value is comparatively small. The oils from the more recently developed fields of Kansas and Texas are of variable character. Those from the Gulf Coastal Plain of Texas and Louisiana are so strongly asphaltic as to be of value only for the production of lubricants, for use as fuel, and as gas-oil.

"THE Effects of Civilisation upon Climate" is the title of an interesting article by Mr. S. L. Bastin in the September number of the *Monthly Review*. As the author points out, the subject is by no means new, and is a matter upon which many authorities find themselves at variance. As one instance of how a locality may be influenced by some artificial feature the smoke of London is referred to, the effect of which is visible in the hilly villages of Oxfordshire when the wind is in the right quarter. Again, it is well known that in large cities the average annual temperature is higher than in the surrounding country, while the reduction of the amount of marsh land, *e.g.* in the Fen district, has probably had a decided effect upon the temperature. But these are local instances; whether the climate has changed generally is another matter. Hann and others have shown that there are evidences of changes of small amount sometimes in one direction and sometimes in another, *e.g.* the fluctuations in the size of European glaciers. The author assumes that British winters are later in coming than they used to be, and quotes that of 1894–5, "when the rigours of the season were scarcely felt until February, and were extended well into March." A discussion of this frost in the Journal of the Royal Meteorological Society shows that the cold period commenced on December 30 and ended on March 5, with a break of a week's mild weather from January 14–21. On January 8 the temperature fell to $-3°$ at Braemar, and was below $10°$ over the central part of north Scotland; after February 20 no readings below $10°$ were recorded. As to the influence of forests, we can have no better authority than Hann; they do reduce the mean air temperature, especially during the warmer part of the year, but whether they increase the amount of rainfall, and, if so, to what extent, cannot yet be definitely answered. We hope with Mr. Bastin that special attention will be given to this important subject in the future, and that, with better data at command, valuable conclusions may be obtained.

IN the *American Journal of Science* (vol. xxii., p. 176) Mr. S. E. Moody gives an account of experiments on the hydrolysis of iron, chromium, tin, cobalt, and nickel salts by solutions containing alkali iodide and iodate. In this reaction an equivalent quantity of iodine is set free, the estimation of which may be used for the quantitative determination of any of the above metals. In the case of zinc salts, the hydrolytic decomposition is only partial, and a basic salt is precipitated instead of the hydroxide.

IN the *Annalen der Physik* (vol. xx., p. 677) Dr. E. Marx gives an account of an experimental investigation relative to the velocity of Röntgen rays. It is estimated that the method and apparatus employed permit the velocity to be determined with an accuracy represented by a probable error of 1 per cent. Within this limit the velocity of propagation of Röntgen radiation is equal to that of light. This result furnishes strong evidence in favour of the view that Röntgen radiation consists in electromagnetic pulse transmission through the ether.

THE velocity of the α particle emitted by radium C at various points of its path has been recently measured by Prof. Rutherford (*Phil. Mag.*, xii., 134). After traversing 7·0 centimetres of air the α particle is no longer capable of exerting any sensible photographic action, although its velocity is still approximately four-tenths of the velocity with which it is emitted from the active source. The much more rapid decrease of the photographic effect of the particle towards the end of its path as compared with the alteration in its kinetic energy necessitates the assumption of a certain critical velocity below which the particle is unable to produce the characteristic effects, or of a very rapid decrease in the velocity when this reaches a certain value.

IN the *Zeitschrift fur Elektrochemie* (vol. xii., p. 513) Prof. W. Kistiakowsky points out the existence of a relationship between the surface-tension values of different liquids which is analogous to the well-known Trouton's rule. If k denote the capillary constant of a liquid at its boiling point, m the molecular weight, and T the boiling point on the absolute scale, then mk/T is constant and equal to 0·0116 for about forty non-associated liquids which have been examined. In the case of associated liquids, such as the alcohols and fatty acids, the value of mk/T is much smaller, and on account of the considerable change in the value of the factor it appears to be eminently suited for ascertaining the existence of association in the liquid state of aggregation.

THE report of the principal chemist of the Government Laboratory for the year ending March 31 furnishes some interesting reading. The total number of samples examined at the laboratory at Clement's Inn Passage during the year was 106,779, the greater part being in connection with the revenue departments. In the Customs the increase in the number of samples examined, as compared with last year, was 2389, the Excise showing an increase of more than 18,000. Special attention was given to establishing a systematic check on the "obscuration" of enumerated spirits, that is, the change in the apparent strength of spirits, as determined by the hydrometer, caused by the presence of solid matters in solution. It is noteworthy that, in the case of tea, the evidence of deliberate adulteration was extremely rare. A small proportion of the tea entering the country was declared to be unsound and unfit for human consumption. Such condemned tea does not pay duty, and, after being denatured by the addition of lime and asafœtida, is allowed to be used in the manufacture of caffeine. Little improvement is shown in the freedom from adulteration of the beer supplied by publicans; 11·1 per cent. of the samples taken were found to be diluted. There is good reason, moreover, to believe that a notable amount of butter adulteration takes place in this country. A considerable increase is shown in the quantity of duty-free spirit used in colleges for purposes of research.

SINCE the atomic weight of silver is the basis upon which most of the atomic weights of other elements are founded, even a small change in the accepted value is not without importance. The *Comptes rendus* for September 10 contains a note on this subject by P. A. Guye and G. Ter-Gazarian. Owing to the great improvements in recent years in the methods of dealing with gases, physicochemical methods of determining atomic weights, originally only used as a rough guide for the purely chemical methods, have reached an accuracy at least equalling the latter. If the atomic weights of carbon, hydrogen, nitrogen, and chlorine related directly to oxygen by physicochemical methods be taken as a basis, the value 107·89 is obtained for silver instead of 107·93, obtained by Stas by the use of chlorates, bromates, and iodates. The authors give a summary of the work done by various workers on the latter compounds, and note a possible cause of error in the presence of potassium chloride in the potassium chlorate used. They show that these two compounds, on account of the fact that the chloride forms a solid solution of nearly constant composition, are very difficult to separate. They find that potassium chlorate, purified as far as possible by re-crystallisation, contains 2·7 parts of chloride per 10,000. Applying this correction to Stas's figures, an atomic weight of 107·89 is obtained, nearly identical with the figures of Marignac in the analysis of silver chlorate; of Dixon and Edgar, by the direct determination of the ratio H : Cl; and of Richards and Wells, the ratio Ag : AgCl. In this way the results of the chemical and physicochemical methods are brought into agreement, leading to the conclusion that the atomic weight of silver should be lowered from 107·93 to 107·89.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN OCTOBER:—

Oct. 2. Pallas (mag. 8·0) in opposition to the Sun.
3. 9h. 19m. Minimum of Algol (β Persei).
4. 15h. 35m. to 16h. 52m. Moon occults μ Ceti (mag. 4·4).
6. 12h. 30m. to 15h. 28m. Transit of Jupiter's Sat. III. (Ganymede).
9. 16h. 0m. Jupiter in conjunction with Moon (Jupiter 2° 12′ N.).
15. Venus. Illuminated portion of disc = 0·333; of Mars = 0·976.
18-22. Epoch of October meteoric shower (Radiant 92° + 15°).
23. 11h. 1m. Minimum of Algol (β Persei).
25. 6h. 49m. to 6h. 56m. Moon occults ι Capricorni (mag. 4·3).
,, 19h. 0m. Venus at greatest brilliancy.
26. 7h. 50m. Minimum of Algol (β Persei).
,, Saturn. Major axis of outer ring = 42″·62; minor axis = 4″·73.
29. 13h. 0m. Jupiter stationary.

THE TOTAL SOLAR ECLIPSE OF JANUARY, 1907.—In a letter to the *Observatory* (No. 374), Mr. W. T. Lynn discusses the accessibility and suitability of Andishan as a place wherefrom to observe the total eclipse of the sun which will take place in January next year. This town is situated to the north-east of Samarkand, in the Khanate of Khokand, its approximate position being long. = 72° 17′ E., lat. = 40° 50′ N. It is on the Russian Central Asiatic Railway, about 170 miles south-east of Tashkent. As a new line of railway runs to the latter place from Orenburg, the journey from Europe should prove a comparatively straightforward one. Andishan lies in the fertile valley of Ferghana, at the junction of the river Kara Darya (a tributary of the Syr Darya) and a smaller stream, so that there should be little difficulty in finding a suitable observing site for the eclipse parties. The eclipse will take place on January 14, 1907 (civil time), and the shadow track will be very narrow, thus limiting the choice of stations; the duration of totality will be about two minutes. By an obvious slip, the date is given as January 4 and the duration of totality as two *seconds* in Mr. Lynn's letter, as published in the *Observatory*.

OBSERVATIONS OF PHŒBE IN MAY AND JUNE, 1906.—Circular 118 of the Harvard College Observatory gives the positions of Phœbe, the ninth satellite of Saturn, as determined from six photographs obtained between May 18 and June 28, with the 24-inch Bruce telescope, at Arequipa. The places thus obtained are compared with those given by the ephemeris published in the Nautical Almanac for 1906, the differences (O–C) in R.A. and declination being given.

THE COLOURS OF SUN-SPOTS.—In the September number of the *Bulletin de la Société astronomique de France* M. Th. Hansen, of Praestö, Denmark, states that from many years' observations of sun-spots he is convinced that sun-spots exhibit colours proper to themselves, and not merely the results of instrumental chromatism. He observes that the spot nuclei are rarely, if ever, a dead black, but generally are of a decided violet colour. The preceding part of the spot is most often of a yellow colour, whilst red is generally predominant in the "following" parts, although green is also seen there. On August 11, 1903, a small but dazzling white facula appeared in the centre of a black spot whilst M. Hansen was drawing the same. Two plates showing the colours observed in the large spot of November, 1903, accompany the communication, and M. Hansen suggests that the colours of spots may eventually be differentiated by spectroscopic observations.

COLOURS AND MAGNITUDES OF DOUBLE STARS.—It is a generally accepted statement that when the magnitudes of the components of a binary-star system differ considerably their colours are also very different; similarly a slight difference in magnitude is usually accompanied by a similarity of colour.

Whilst preparing his recently published and valuable memoir on the double stars of Struve's "Mensuræ Micrometricæ" Mr. Lewis has gathered striking evidence that these statements are true, and in No. 373 of the *Observatory* he gives a table of physical pairs, from which it is seen that a gradual increase in the differences of magnitude is accompanied by constantly increasing differences of colour. A discussion of fifty double stars situated in the southern hemisphere corroborates this evidence.

ROTATION PERIOD OF JUPITER'S EQUATORIAL REGION.—In No. 4117 of the *Astronomische Nachrichten* Mr. Denning publishes the rotation periods, derived from a number of spots situated on the equatorial side of the southern equatorial belt of Jupiter, as determined by him at Bristol in the years 1898 to 1905–6 inclusive. From the tabulated statement given it is seen that the rate during 1905–6 was several seconds slower than in previous years. During 1880–3 the rotation period was from eighteen to twenty-seven seconds shorter than during 1905–6.

GEOLOGY AT THE BRITISH ASSOCIATION.

IT is only natural that the salient geological features of the district in which the association meets should in some degree influence the character of the papers presented to Section C. Yorkshire, being rich in glacial and post-glacial problems, it is not surprising that special attention was directed to the more recent episodes in the earth's history. The presidential address dealt with British drifts and the inter-glacial problem, and, after a review of all the evidence bearing on the question, Mr. Lamplugh pronounces that no proof of mild inter-Glacial epochs, or even of one such epoch, has been discovered during the examination of glaciated districts in England, Ireland, and the Isle of Man. The "Middle Glacial" sands and gravels of our islands afford no proof of mild inter-glacial conditions or of submergence. In most cases, if not in all, they represent the fluvio-glacial material derived from ice sheets. Most of the fossiliferous beds regarded as inter-glacial contain a fauna and flora compatible with cold conditions of climate, and, in the exceptional cases where a warmer climate is indicated, the relation of the deposits to the Boulder-clays is open to question.

Prof. Kendall followed the president's address with a full and comprehensive account of the general geological structure of the country round York, and dwelt specially on the glaciation of the Vale of York and the Cleveland Hills. During the meeting the members were enabled to visit the York moraine and study the glacier lakes and overflows in the eastern part of the county under the guidance of Prof. Kendall.

Other local glacial papers dealt with the Kirmington Drift deposits, recent exposures of glacial drift at Doncaster and Tickhill, post-glacial deposits at Hornsea, and the plain of marine denudation beneath the drift of Holderness.

Contributions dealing with drift problems farther afield were presented by Mr. F. W. Harmer, who continued his work on the glacial deposits of the east of England, and in another paper he applied the brilliant results obtained by Prof. Kendall in the Cleveland district to support his theory regarding "Lake Oxford" and the origin of the Goring Gap.

The Rev. W. Lower Carter applied the same results to explain a dry valley which had been a glacier-lake overflow at Cwm-Coed-y-cerig, in South Wales, and gave a detailed account of the local glaciers which formerly existed in the valleys of the Usk and Wye.

Mr. R. D. Oldham brought forward a criterion of glacial erosion of lake basins, and Prof. J. W. Gregory initiated a discussion on the problems connected with the Palæozoic glaciation of Australia, India, and South Africa. He pointed out that in Australia we have evidence of three horizons at which glacial beds occur, the Cambrian, the Carboniferous, and the Pleistocene. The Cambrian glacial beds near Adelaide range 400 miles north and south, and are interbedded with marine sediments containing a rich Cambrian fauna. Evidence of Pleistocene glaciers has only been found on the mainland near the summit of Mt. Kosciusko, the highest mountain of Australia. The Carboniferous glaciation is the most important, and presents points of the greatest interest. While in the State of Victoria there exists undoubted evidence of land ice riding over an irregular land surface, in New South Wales, West Australia, and in India the glacial beds include some that were laid down below sea-level. Beds presumably of this age are also found in South Africa, South America, and perhaps on the eastern flanks of the Urals. Prof. Gregory pointed out the inherent probability of these beds having formed part of a once continuous sheet of glacial deposits. No proof is forthcoming that they were synchronous, and in Africa and Australia the glacial evidence disappears to the north, ending about the southern tropic, and begins again in the northern hemisphere in latitude 17° 20′ N., increasing in strength northwards to Cashmere.

After a critical survey of the three theories which have been advanced to explain this problem, viz. (1) the shifting of the earth's axis (Oldham and Penck); (2) a universal refrigeration of the world due to a change in the composition of the earth's atmosphere (Arrhenius); and (3) local concentration of snowfall in consequence of a different distribution of land and water, Prof. Gregory concludes that the last is alone adequate to explain the facts.

In the discussion which followed, Prof. Edgeworth David and Mr. T. H. Holland argued in favour of Arrhenius's theory, as the cause must have been world-wide, and the phenomena could not be accounted for by local changes in topography. Mr. R. D. Oldham favoured Prof. Chamberlain's adaptation of Arrhenius's carbonic acid theory, and pointed out the analogies between the great revolutionary epochs of the earth's history, all of which are associated with glacial phenomena.

The stratigraphical papers certainly showed a bias towards the Carboniferous period. No less than five papers were read, dealing mainly with the faunal succession and zoning of beds of this age. The recent work of Dr. Wheelton Hind, Dr. Vaughan, Prof. Garwood and others, as detailed in their papers, shows great strides towards the completion of what, at one time, seemed a hopeless problem.

A discussion on the origin of the Trias was opened by Prof. Bonney and Mr. J. Lomas. Prof. Bonney considers the Bunter to be chiefly of fluviatile origin, the rivers carrying the materials having their origins in Scotland, the extreme north of Ireland, and another flowing from the south-west. The Keuper he regards as indicating the setting in of inland-sea conditions, and the Red Marl as having been deposited in a great salt lake. The physical and climatal conditions of the Trias were probably to some extent comparable with those now existing in certain of the more central parts of Asia, such as Persia or Turkestan.

Mr. Lomas compared the Triassic deposits with those now forming in desert regions. He pointed out that the dominant feature of deserts is concentration. The wind acting on loose material concentrates particles of equal size in one place, an arid climate tends to concentrate the salts brought down by rivers in solution in shallow pools held up by the irregular disposition of sand dunes, and animal and plant life is concentrated in those regions where water is more or less permanent. Taking the various divisions of the Trias, he showed that in the Bunter the pebble beds of the Midlands may be compared with those of Lancashire and Cheshire, the only difference being that the former may have been subject to the sifting action of wind, which has removed the smaller sand particles, while the latter has, in part, escaped this action, and has been augmented by material from the south. The Upper Bunter he cited as a striking example of concentration of particles of even size. The Keuper shows evidence of similar sifting, and is characterised by an increasing frequency of Marl bands. These he regards as evidences of shallow lakes, and compares them with similar pools now found in the desert regions of South Africa. The muds forming the floors of these pools, both in the recent and older examples, contain Estheria, and afford impressions of foot-prints, raindrops, and desiccation cracks. The Keuper Marls he compares with the Loess of eastern Europe, and the beds of salt, gypsum, and other salts he regards as the result of evaporation in lakes.

Mr. Holland referred to certain phenomena in the Rajputana desert that supported Mr. Lomas's views with regard to the processes of concentration in arid regions, and gave evidence of the sifting action of wind in India. Similar bands of silt and mud are found filling in hollows in the Archæan rocks. He was not prepared to admit that the features of the British Trias were due only to wind action, but in the main they were due to conditions prevailing in desert regions. Prof. Cole pointed out that, in dealing with the British Trias, we must not forget the great sea eastwards and the likelihood of the establishment of a monsoon system on its margin. This might set up an intense rainy season for, say, three months in the year, followed by a dry season. Sheets of pebbles without well-defined water channels are compatible with general evidence of desiccation. Mr. R. D. Oldham showed that the only agency forming pure sands comparable with the Trias is wind. Mr. Clement Reid compared the peculiar stiff-stemmed flora of the desert with those found in the Trias.

The papers dealing with palæontology were more than usually interesting. Mr. C. G. Danford exhibited and described a fine series of ammonites from Speeton. Mr. A. C. Seward dealt with the Jurassic flora of Yorkshire, and Dr. H. Woodward, in describing a wonderful collection of arthropods from the Coal-measures at Sparth Bottoms, showed what an enthusiastic band of collectors can do, when work is taken in hand in the spirit which characterises the Rochdale geologists.

The report on the fauna and flora of the Trias included an important paper by Dr. A. Smith Woodward on *Rhynchosaurus articeps*, and Mr. H. C. Beasley and Mr. Lomas described the great finds of Triassic foot-prints which have recently been discovered at Storeton, in Cheshire, and Hollington, in Staffordshire.

In petrology and mineralogy great interest was shown in the announcement by Prof. Edgeworth David that diamonds had been found embedded in the matrix near Inverell, New South Wales.

Mr. T. H. Holland demonstrated the peculiar properties of a variety of sodalite from Rajputana. When freshly broken it has a bright carmine colour, which changes to dull grey on being exposed to light. The carmine colour returns when the specimen is kept in the dark. Prof. H. S. Reynolds dealt with the igneous rocks in the district south-west of Dolgelly, and described the occurrence of a picrite from the eastern Mendips.

In general geology Mr. J. Parkinson gave an interesting account of the post-Cretaceous geology of Southern Nigeria, Prof. Cole outlined a scheme of geology suited to agricultural scholars, and Prof. J. Milne discussed certain earthquake relationships.

While the time of the section was fully taken up by the consideration of the above subjects, no less than thirty-seven papers dealing with strictly geological matters were read in other sections. J. L.

ZOOLOGY AT THE BRITISH ASSOCIATION.

THE large attendance at many of the meetings of Section D was sufficient evidence of the general interest of the programme, which included discussions upon the Tanganyika problem, the nature of fertilisation, spicule formation in sponges, the bearing of scientific marine investigations on practical fishery problems, and a number of papers on special subjects, only a few of which can be noticed here.

The Tanganyika Problem.

The discussion on the Tanganyika problem was opened by Mr. J. E. S. Moore, who dealt, first, with the characters of fresh-water faunas in general, pointing out the wide distribution of many fresh-water organisms over the land surfaces of the world. He held that the difficulties in the way of the migration of these animals were so great that their wide distribution could not be attributed solely to such migration. He suggested that in all probability the sea is becoming more salt, and that this change may have been concerned in the production and separation of marine and fresh-water faunas. Whatever the actual cause of separatiun, as the general fresh-water fauna of the globe possessed certain archaic characters it would be convenient to name this the primary fresh-water fauna. To this primary fauna there are added in many places, *e.g.* in the Caspian Sea, animals which have, from their structure and affinities, been obviously derived from the sea, and have an origin independent of that of the fresh-water fauna of the region in which they occur. To these animals Mr. Moore applied the name halolimnic. There are in Tanganyika a number of animals peculiar to that lake, and regarded by Mr. Moore as halolimnic. The mollusca of the lake are represented by certain ordinary fresh-water forms, but, in addition, there are several not closely related to any recognised fresh-water type, nor does their anatomy suggest that they have been evolved from any African fresh-water form; there are four Polyzoa, only one of which is phylactolæmatous, and it may be inferred that the other three are derived from marine forms, while the occurrence of a medusa is also suggestive in this connection. There are three possible explanations of these faunistic peculiarities:—(1) that they are due to direct modifications of the general African fresh-water fauna; (2) that they are constituted by the presence in the lake of the remains of an extinct fresh-water fauna; (3) that they are due to the presence of halolimnic elements. Mr. Moore regarded the last as the correct explanation, and referred to the similarity of the shells of certain Tanganyika gastropods to those common in Jurassic seas. The evidence points to Tanganyika having been isolated a long time from the sea.

Mr. W. A. Cunnington gave a brief account of the third Tanganyika expedition, from which he had recently returned. 115 fishes are now recorded from the lake, 102 of which occur nowhere else. Twelve species of prawns (of which only one has been found elsewhere) are all specialised in the direction of reduction of gills, and the four species of crabs are all endemic. These facts are probably to be explained by the long isolation of the lake. It is curious that no Cladocera were met with in Tanganyika, though they are abundant in Victoria Nyanza and Lake Nyassa.

Prof. J. W. Gregory considered that there are no evidences of marine rocks in the plateau of equatorial Africa, though it is evident that the plateau is of great antiquity. The idea of the occurrence of the sea in the Tanganyika valley should be abandoned. He suggested that the "halolimnic" fauna is rather to be explained as a part of an ancient lake fauna at one time widely distributed over Africa, but now surviving only in Tanganyika.

Prof. Pelseneer pointed out that the external resemblances of shells are often illusory, and the results to which they lead quite uncertain, therefore only the study and comparison of the internal organisation of the molluscs can throw light on the question at issue. Messrs. Moore and Digby have suggested that some of the Tanganyika molluscs have affinities to certain marine forms, Chytra being related to Hipponyx and Capulus, Spekia to Lamellaria, and Edgaria (=Nassopsis) to the Architænioglossa; but Prof. Pelseneer held that there are really no affinities, in the usual sense of the word, between these forms, but only distant resemblances, such as are common to all the Tænioglossa, to which group these "halolimnic" forms belong. Nor do they present archaic characters to a greater extent than other fresh-water genera not "halolimnic," such as Ampullaria and Paludina. Prof. Pelseneer concluded that all the "halolimnic" gastropods belong to the family Melaniidæ or to closely related types, as is shown by their radulæ, otocysts, &c., and by special details of their biology—their fresh-water habitat and viviparity. The study of two genera (Giraudia and Lavigeria) the organisation of which has only just been investigated supports this conclusion. Both have in their otocysts multiple otoliths, one otolith being much larger than the others in two species of Giraudia. Lavigeria, the only genus of which a female has been examined, is viviparous, and its radula most closely resembles that of the Melaniid genus Chiara, while the radula of Giraudia is clearly similar to that of the Melaniid genus Ancylotus.

Dr. G. A. Boulenger, in reviewing the evidence afforded by a study of the fishes, said that the Cichlid fishes, which form so large a proportion of the fishes of Tanganyika, are examples of an extraordinary modification of one type which has entered fresh water all over Africa, and that this lake seems to have served as a nursery for genera and species of this family. The Cichlids of Victoria Nyanza seem to have arisen, like those of Tanganyika, from a small number of generalised types. The fishes of Tanganyika indicate a long isolation of the lake, perhaps extending back to Miocene times.

The Nature of Fertilisation.

The discussion (conjointly with Section K) on the nature of fertilisation was initiated by Dr. V. H. Blackman, who gave a brief account of the recent work on which the present views of fertilisation are based, dealing specially with the *rôle* of the chromosomes, and taking as a starting point the theory put forward by Montgomery (1901), that in synapsis the maternal and paternal chromosomes unite in pairs and are later separated by the reduction division, which thus divides the somatic chromosomes into two groups. Fertilisation appears to be incapable of exact definition, for apogamy and parthenogenesis link it on to vegetative reproduction, and, indeed, nuclear fusions and reductions occur in plants apart from reproduction, *e.g.* in graft hybrids of Mespilus and Cratægus there is evidence that the fusing of vegetative cells has led to the mixing of characters.

Prof. Calkins described his experiments proving that it was possible to carry cultures of Paramœcium through a certain number of periods of depression, and to renew their vitality by means other than nuclear fusion (conjugation), he having been able to do this by treatment with beef extract and with extract of pancreas and brain. Prof. M. Hartog cited what he considered to be comparable cases of the orange, Funkia, &c., where cells of the nucellar tissue grow into the embryo-sac cavity, and, under the stimulus of the exceptional nutrition, grow into embryos which behave exactly like the normal embryos produced by the fertilised oosphere in the same favoured feeding place.

Mr. L. Doncaster gave a brief account of the maturation of parthenogenetic eggs, pointing out that many eggs which produce, not only one, but two polar bodies, may develop parthenogenetically. The fate of the polar nuclei varies considerably; in some cases they are cast out and lost, in others they remain in the egg, and (as in Artemia) one may conjugate with the egg nucleus, taking the place of the spermatozoon.

Dr. Rosenberg (Stockholm) described his experiments on the production of hybrids of *Drosera rotundifolia* and *D. longifolia*, the cells of the former having ten and of the latter twenty chromosomes. In certain of the daughter nuclei, ten, eleven, or twelve chromosomes move to one pole during division, the same number to the other pole, and between these lie a number of separate chromosomes, which are later taken into one or other of the division nuclei. In Hieracium, one polar nucleus returns to the embryo-sac cell and fuses with the egg-cell, producing a cell with unreduced number of chromosomes. Dr. Ostenfeld afterwards stated that Hieracium was able to produce fruits without ordinary fertilisation having taken place.

Prof. Hickson considered that the evidence that the chromosomes are the sole bearers of the hereditary characters had been much weakened during recent years by the results of such experiments as those on enucleated eggs fertilised by the sperms of another species, which gave rise to larvæ showing sometimes paternal and sometimes maternal and mixed characters.

Mr. H. Wager pointed out that in many of the lower organisms the nucleus does not seem to be concerned, as in higher organisms, in the blending, during fertilisation, of two distinct lines of descent, but presides over the nutritional activities of the cell, and fertilisation is replaced by various nutritional devices.

Spicule Formation in Sponges.

Prof. Minchin discussed a number of facts bearing on spicule formation in calcareous sponges, and concluded that the form of primary spicules is in no way dependent upon the physical properties of the material (calcite), but is regulated solely by biological conditions. When, however, primary spicules are joined together to form spicular systems, the physical properties of the material may exert an influence upon the form of the spicule as a whole by determining the angles at which the rays join together. Prof. Dendy dealt more particularly with the evolution of the various forms of siliceous spicules in the Tetraxonid sponges, showing that they are all derivable from a primitive tetraxon form. He showed that these spicules originated singly in mother-cells, and endeavoured to explain their great diversity of form as the result of the action of variation, heredity, and natural selection. Mr. W. Woodland contended that the forms of spicules are not inherited, for such an inheritance of forms of spicules adapted to the architecture of the organism implies that wandering cells (scleroblasts) are severally able to produce a part of the adult organism, an organ, in fact, related in form to the other parts. The collection of scleroblasts disposed about the spicule forming the protoplasmic mould in which the spicule is deposited is the organ assumed to be inherited. Such a theory seems to be contradicted by the facts of experimental embryology, which shows that a blastomere can only give rise to an integral part of the adult organism in virtue of its localised connection with other blastomeres. Mr. Woodland concluded, therefore, that the form of the deposited spicule determines the disposition of the scleroblasts, and not *vice versâ* (as held by the advocates of the inheritance of spicule form), and that spicular phenomena may be fully explained by reference to known physical facts. He suggested that many spicules are probably closely allied in their mode of origin to the curious structures (colloidomorphs) formed by mineral substances deposited in colloidal media.

Fishery Problems and Marine Investigations.

Dr. E. J. Allen opened a discussion on the relations of scientific marine investigations to practical fishery problems. He pointed out that the great growth of the fishing industry during the last thirty years has been accomplished by practical fishermen, and, in some directions at least, science could even now help little, *e.g.* in the case of drift-net fisheries any attempt to increase the supply would probably be futile. In the case of trawl fisheries a diminution in the source of supply has taken place, but there is hope of increasing the actual supply of fish in the grounds by (1) regulation and restriction of fishing; (2) re-stocking exhausted grounds by hatching or by transplantation; and (3) destruction of the enemies of food fishes. Before such measures can be carried out with much hope of success, a complete and exact knowledge is necessary of the habits and life-histories of the fishes, and of the conditions under which they live.

Dr. W. Garstang discussed the question of the diminution of the stock of plaice in the North Sea, and the methods suggested for increasing the supply. The diminution is supposed to be caused by the excessive fishing of young fish. In the southern part of the North Sea (Flemish Bight) most of the fish caught are less than 30 cm. in length, while on the Dogger Bank most are more than 30 cm. long. From January to June the small plaice are found chiefly inshore and out to the 11-fathom line; from June to December they travel out to the 20-fathom line. This gives a rough idea of the migration of the young plaice outward into deeper water during the summer and autumn months, and is confirmed by the results of marking experiments. The migration of fish to the Dogger Bank is, therefore, not a direct and simple one, but takes place in at least two stages. Much more information is still required concerning the normal distribution of fishes of various sizes, the migration of young fish, and the causes which determine rapidity of growth.

Mr. G. L. Alward expressed his belief in the value of fish hatcheries, and also advocated the exploration of the area between Norway and Iceland in the hope that new fishing ground may be found so as to relieve the present strain on the resources of the Dogger Bank. Dr. Masterman and others advocated the attacking of special problems, and thought that the more general questions might be for the present postponed.

Systematic Study of Oceanic Plankton.

Dr. G. H. Fowler put forward some suggestions for the more systematic study of oceanic plankton. Evidence that temperature appears to be the chief determinant in the distribution of plankton was cited, the highest depth of a species being the position of its maximum, the lowest depth that of its minimum, temperature at any given geographical position. It was urged that, for the solution of the problems demanding attention, oceanic expeditions should be confined to the systematic study of small areas instead of making long voyages, that the upper zones of water should be more carefully investigated than has hitherto been the case, and that standard tow-nets should be adopted internationally by all expeditions in order to afford means of comparison of the fauna in different seas and under different conditions.

Life Cycle of the Protozoa.

Prof. Calkins referred to some features in the life cycle of the Protozoa, and urged that the whole life cycle should be worked out before a new species could be regarded as safely established. This safeguard would prevent confusion and the undue multiplication of species. Prof. Calkins showed, for example, that two such well-known and apparently fixed species as *Paramoecium caudatum* and *aurelia* are no longer to be regarded as distinct. During the progress of a culture of *P. caudatum*, an individual appeared with all the characters of *P. aurelia* (including form of body and double micronuclei), but after forty-five generations, the organisms being watched daily, the *aurelia* characters were lost, and the entire race became *P. caudatum* again. In any such life cycle the organisms pass through phases of vitality comparable to the different age-periods of Metazoa. There are periods of (1) youth, characterised by great vigour of cell multiplication; (2) maturity, indicated by changes in the chemical and physical balance of the cell, accompanied by differences in size or protoplasmic structure, leading to the formation of conjugating individuals, with or without sexual differentiation; (3) in forms which do not conjugate, old age or senescence, ending in death. In many forms, especially where dimorphic gametes are produced, the period of sexual maturity leads directly to that of old age, and gametes which fail to conjugate soon die without further multiplication, as in the majority of Sporozoa and in many Rhizopods. In Ciliata, although failure to conjugate is finally fatal, many generations may be formed before death occurs, and in these may be studied the peculiar cytoplasmic changes which accompany protoplasmic senility. While working at the maturation phenomena in Paramœcium, Prof. Calkins and Miss Cull were able to show that the curious crescent form assumed by the micronucleus is the stage of synapsis, the chromosomes being double at this time, apparently by union side by side in typical parasynapsis. The two following maturation divisions have not yet, however, been completely followed. The speaker also dealt with the subjects of fertilisation and parthenogenesis, pointing out that the latter has only a limited success, acting merely to postpone or counteract physiological death (Hertwig). Physiological and germinal death in Protozoa are connected with exhaustion of vitality and of definite substances in the cell.

Infection of Monkeys with Guinea-worm.

Dr. R. T. Leiper described some results obtained by the infection of monkeys with guinea-worm. These confirm the view that *Filaria medinensis* gains access to the human host by introduction in the larval stage (while still contained within its intermediate host, Cyclops) into the stomach in drinking water. The larvæ are released and stimulated into activity by the gastric juice. A monkey which had been infected in this way was killed after six months, and five guinea-worms—three unfertilised females and two males (each of the latter 22 mm. long)—were found. No experimental evidence could be obtained in support of the theory which has, during recent years, been favourably received in this country, that the causal agent in the disease invades the body through the skin, nor was a repetition of Plehn's experiment of feeding monkeys with freshly discharged embryos attended with the slightest success.

Habits of Tube-building Worms.

Mr. Arnold T. Watson gave an account of the habits of tube-building worms. He showed how Sabella collects, by means of its branchial tentacles, particles which are applied by means of the collar lobes to the outside of a mucous tube secreted by the epidermis. As a safeguard against the intrusion of an enemy, the mouth of the tube usually collapses when the worm retracts, but in one of the rock-boring species the end of the tube rolls up like the frond of a fern. Terebella builds its tubes of sand, shells, or gravel, terminated by an arborescent arrangement composed of single grains of sand or other suitable material. Pectinaria produces the well-known conical sand-tubes, the material for which is selected with great care. Owenia constructs a flexible tube by attaching in an imbricating manner flat sand grains and fragments of shell to a membranous tube secreted by special epidermal glands. Panthalis weaves a massive tube composed of threads supplied by the parapodial glands. These tubes are open at both ends, but the worm is defended from attack by a series of internal valves at each end of the tube, which are automatically closed by the inrush of sea water immediately the inmate of the tube retracts itself.

Papers on Lepidoptera.

Prof. E. B. Poulton exhibited a series of forms of *Acraea johnstoni*, Godm., showing that each one of the protean series of varieties has been evolved in relation to a Danaine or Acræine model, the models and mimics occurring together on the slopes of Kilimanjaro.

Dr. F. A. Dixey exhibited butterflies, some possessing an epigamic scent, others an aposematic or warning scent, and others in which both kinds of scent existed independently. It is well known that the male of *Ganoris napi*, one of our common white butterflies, exhales a fragrant scent (compared to that of lemon verbena) which is probably epigamic in significance. Dr. Dixey has found similar, though weaker, scents in the males of other British Pierinæ, Satyrinæ, and Lycænidæ, and many of the native African species were also found to possess an agreeable odour suggestive of chocolate, vanilla, or the scents of various flowers. These scents are generally distributed by specialised scales (androconia), the distribution being, to some extent, under control, the perfume being economised when not needed in courtship. The offensive odours are more or less shared by both sexes, but are sometimes stronger in the female, and generally occur in forms which, on independent grounds, are believed to be protected. These aposematic odours are usually perceptible even in uninjured specimens, but are much more evident when the thorax is crushed.

Mr. G. T. Porritt read a paper, full of details, on melanism in Lepidoptera. He pointed out that melanism had increased with extraordinary rapidity in south-west Yorkshire and parts of Lancashire, and also occurred, to a less extent, in other parts of the United Kingdom. In some cases (*e.g. Amphidasys betularia, Odontoptera bidentata*) the change has been sudden, but in most cases there has been a gradual, though rapid, change from pale to black. More than thirty species are melanic in Yorkshire, most of which have become so during recent years, and there are other species which are tending in the same direction. Many of these melanic forms will probably, at no distant date, oust the ordinary pale forms. The variety *varleyata* of *Abraxas grossulariata* has, however, not increased, and, though known more than forty years ago, is as rare now as it was then, although melanism is so strongly impressed on the race that a brood reared this year, from a pair of moths from wild larvæ, were all of the extreme dark form, no single example showing any tendency towards the pale ordinary form. The reasons for and causes of the phenomenon were then discussed. The usually accepted theory is that the darker colour renders the insects less conspicuous as they rest upon the darkened (by soot, moisture, &c.) tree trunks, and, therefore, more likely to survive and to perpetuate dark forms. Mr. Porritt did not believe that birds fed to any great extent on moths, and when they did they took them on the wing at night, when their colour similarity to trees would be of no service. Moreover, many melanic species do not affect tree trunks, *e.g. Larentia multistrigaria*, in which melanism has rapidly developed for no apparent reason. The theory that smoke and humidity in the manufacturing districts have caused melanism, although offering in many cases a likely explanation, seems to be rendered untenable by numerous exceptions. Mr. Doncaster remarked that melanism could not be explained as due to natural selection or as the result of external conditions, as the black forms in some cases arose suddenly, and quickly became numerous. The black form is dominant, that is, the offspring of a pair, one black and one pale, have a tendency to be dark. Dr. Dixey pointed out that in Pierines dark pigment is often substituted for light, the female being usually darker. There may even be two grades of colour in the females, a darker in the individuals found in the wet season, and a lighter in those found in the dry season. He considered that locality, altitude, and other conditions may have an influence in darkening the pigment.

Pineal Eye of Geotria and Sphenodon.

Prof. Dendy described the structure of the pineal eye of the New Zealand lamprey (Geotria), which agrees in most respects with that of Petromyzon, but the former is more complex in histological structure, its pigment cells being divided into inner and outer segments. The pineal nerve is connected both with the right habenular ganglion and the posterior commissure, and in all probability with Reissner's fibre, whereby it would become linked with the optic reflex apparatus described by Sargent. Prof. Dendy also directed attention to some newly observed details of structure in the adult pineal eye of Sphenodon. The rods of the retina project into the cavity of the eye, and are connected with a network of fibres, which is also connected with the "lens." The lens contains a large central cell which resembles a unipolar ganglion cell. Prof. Dendy concluded that, in both Geotria and Sphenodon, the pineal eye is a functional organ.

Formation of Nucleoli.

Prof. Havet (Louvain) traced the formation of true nucleoli or plasmosomes in the nerve cells and blood cells of Rana and Alytes. The central part of each is formed from a small, clear area situated in the centre of the telophasic figure, while the peripheral part is derived from the internal extremities of the chromosomes which remain when the rest of the chromosomes form the nuclear network. Occasionally chromosomes also become included in the central area, giving rise there to one or two chromatic structures.

Milk Dentition of the Primitive Elephant.

Dr. C. W. Andrews, in the course of a paper on the milk dentition of the primitive elephant, pointed out that in recent elephants, owing to the large size of the molars and the shortening of the jaws, the teeth have an almost horizontal succession, their manner of replacement differing widely from the vertical succession found in other mammals. But as the earlier relatives of the elephant are followed back through the various Tertiary horizons a gradual approximation to the ordinary mammalian type of tooth replacement is observed, until in the recently discovered Eocene Palæomastodon a form is reached in which the milk molars are replaced in the normal way by premolars, which, along with the permanent molars, remain in use throughout the life of the animal.

A New Conception of Segregation.

Mr. A. D. Darbishire directed attention to some essential but usually unrecognised features of the Mendelian theory. He pointed out that although half the total number of children born to hybrids were unlike their parents, the hybrids, according to that theory, bore no single germ cell containing an element representing an animal like themselves, and that if a hybrid could be made to multiply parthenogenetically it would produce no offspring like itself. An experiment for testing this theory in an individual case was described.

Mr. J. T. Cunningham spoke on the evolution of the cock's comb; Mr. H. M. Bernard, on a periodic law in organic evolution, with a re-estimation of the cell; and Dr. H. J. Fleure and Miss Galloway gave a detailed paper on the habits of the Galatheidæ in relation to their structure; but these and a few other papers do not lend themselves to the purposes of a summary.

J. H. Ashworth.

THE ROYAL PHOTOGRAPHIC SOCIETY'S ANNUAL EXHIBITION.

This exhibition at the New Gallery in Regent Street will remain open until October 27. The three rooms, the central court, and the balcony, indicate its five main divisions. The last of these is devoted to scientific and technical photography and its application to processes of reproduction, and the exhibits here naturally fall into three sections, namely, the ordinary exhibits, those contributed by special invitation of the council of the society, and a small collection of photographs that have no other interest than that they are good technical work, and represent subjects of more or less interest, chiefly architectural. We hope to see this kind of work more fully represented in future exhibitions, for between the more strictly technical and the ultra-pictorial it has been almost squeezed out of existence.

A series of beautifully made models of light-pencils, which show the various effects of aberrations that particularly concern photographic lenses, is shown by Mr. C. Welborne Piper, and has been awarded a medal. The three dozen models illustrate very clearly a subject that must always be a somewhat difficult one. Immediately following this are a large number of photographs of living things, but chiefly birds, which appear to be receiving a very undue share of attention just now. Of these, we notice particularly a series of twenty-four photographs of the stone curlew in different stages of its existence, by Mr. W. Farren. Of the other subjects, "A Study of Wych Elms," by Mr. Alfred W. Dennis, is among the more novel. It is a series of seven photographs that show the same pair of trees, leafless and in leaf, and on larger scales the details of the trunk, blossom, fruit, leaves, and winter buds. Dr. Vaughan Cornish sends a further series of waves; Mr. J. C. Burrow two coal-mine subjects, excellently rendered as usual; and Mr. Bagot Molesworth a telephotograph of Vesuvius in eruption, taken from a distance of eight miles.

In the invitation section, Mr. Douglas English shows some examples of mimicry in British insects, and a particularly realistic effect is obtained in some of them by making the original carbon print with a green tissue, and staining the insects with dyes to represent their natural colours. The Royal Observatory, Greenwich, has contributed several of its recent results, including some of last year's solar eclipse. Mr. F. E. Baxandall (for Sir Norman Lockyer) also illustrates the eclipse, and sends photographs of two British stone circles that were erected some four thousand years ago as astronomical observatories. Series of cloud photographs are shown by Dr. W. J. S. Lockyer and Captain D. Wilson-Barker. Photographs illustrating the investigation of crimes, such as forgery and burglary, and the detection of the criminals, by Prof. R. A. Reiss, of Lausanne, will be of very general interest. Mr. K. J. Tarrant shows a series of thirty photographs of high-tension electrical discharges. Mr. Edgar Senior has continued his study of the Lippmann method of colour photography, and although the image generally shows no grain under the microscope, he has by special illumination got the surface to appear covered with discs of light, though what these indicate is not very clear.

There are a few photographs in "natural colours," but nothing better than, if quite so good as, has already been shown. Messrs. Sanger-Shepherd and Co., by preparing a more rapid and red-sensitive plate and special colour filters, have made it possible to take the three negatives necessary for their method of colour photography in three seconds, including the time required for changing the plates and light filters, when the light is only moderate and the lens aperture $f/16$. In the central court, besides a great deal of apparatus and several demonstrations of processes, the Adhesive Dry Mounting Co. shows its method of mounting by warm pressure. The Ozotype Co. shows in the north room several examples of "ozobrome" prints. These are quite a new departure, a carbon print being produced by means of a bromide print without exposure to light, the silver image in the bromide print reducing the bichromate in the carbon tissue by mere contact. The original bromide prints and the carbon copies are shown side by side. C. J.

GEODETIC OPERATIONS IN SOUTH AFRICA.[1]

It will be admitted that the Administration of Southern Rhodesia acted wisely in accepting the timely counsel which Sir David Gill brought under its consideration. Some ten years ago His Majesty's Astronomer at the Cape pointed out to Lord Grey, who then administered the government of the colony, the desirability of basing the land tenure on a properly established system of survey. The adoption of such a course would not only afford the means of supplying a sound and incontrovertible evidence of title to the possessor, but would protect the Government against the perpetration of fraud and tend to diminish future litigation. Sir David Gill does not hesitate to say that in Cape Colony large tracts of land have been stolen from the Government, either through the wilful shifting of beacon marks or from carelessness due to inadequate surveying. Sir David Gill did not lay any great stress upon the scientific value that necessarily attaches to accurate measurement conducted on a large scale; but this point was not neglected, and the work was planned so as to give the greatest assistance to economic requirements, and at the same time to forward scientific interests. The one purpose was effected by carrying a chain of triangles eastwards from Bulawayo, covering the most thickly populated and important parts of the country, the other by extending the chain north and south along the thirtieth meridian, so that it might form part of the great arc of meridian which it is proposed to extend from the south of Natal to the Mediterranean. The actual district surveyed extends from about 16° to 20° south latitude and from 28° to 31° east longitude.

Sir David Gill sketches the history of the work accomplished in successive years, from which can be gathered something of the difficulties which Mr. Simms and his assistants encountered and overcame. Abnormally wet seasons, illness among the staff, the necessary burning of the grass and the rising of the smoke preventing the measurement of horizontal angles, loss of cattle, and in one instance the destruction of the theodolite, are a few of the troubles that beset those who attempted geodetic operations in an unsettled country; but, notwithstanding these drawbacks, there remained only three stations south of the Zambezi which were not fully connected with the scheme of triangulation proposed. As the work is extended northwards these stations will be occupied, and thus form a useful link in the two systems.

A matter of great interest in the report from a scientific point of view consists in the critical examination of the Jäderin wires used in the measurement of the base lines. This apparently convenient form of measurement was, it is believed, adopted by the Russian geodesists in the work connected with the Spitsbergen base, but in this country the apparatus has not been submitted to any very thorough test, and figures for the first time on a large scale in the geodetic survey of South Africa. Two wires, one of steel and the other of brass, constitute a "pair," and, as a rule, were used in this form. Each wire is about 1·65 mm. in diameter, and is stretched by an accurate spring balance with a tension of 10 kilograms. The length of three pairs was each 80 feet, but two others of 160 feet and 320 feet respectively were used in crossing streams and gulleys. Another form of the same apparatus, occasionally used, consisted of a wire of "invar" nickel-steel and a wire of another alloy having a coefficient of expansion about the same as that of brass. The absolute length of each of these pairs was determined by repeated comparisons with a base line 80 feet in length, measured with a standard bar apparatus; but even the length of this base could not be assumed to be constant. The partially decomposed quartzose slate beneath the piers which carried the fiducial marks appeared to change slightly in position, especially after rain, and the length of this base as measured in the wet and dry seasons differed by half a millimetre. Constant measurement with the bars removed any source of error from this cause, since the change of length between the beginning and end of a set of wire comparisons was practically insensible.

But the real source of error in the use of the Jäderin wires lies in the fact that the ordinary steel and brass wires are liable to change of length, due to re-arrangement of the molecules of the constituent metals which takes place independent of temperature after these molecules have been violently disturbed. The tendency in all new drawn wires is to shorten, very markedly at first, and to diminish in amount as a more stable arrangement of the molecules is established. In a postscript, however, it is stated that, as the result of experiments conducted at the International Bureau of Weights and Measures, it is found possible by careful annealing and special mechanical treatment to render the arrangement of the constituent molecules of "invar" wires practically stable, and that such wires can be used as standards. Such wires, however, are not examined here. As an evidence of the change of length in the wires actually used, we may quote the following:—The length of a standard pair, at a temperature when both components were of equal length, was found to be in

April and May, 1898 ... ... 24382·07 mm.
October and November, 1898 ... 24381·84 ,,

Two base lines were measured in the course of the work, one of $11\frac{3}{4}$ miles and the other of $13\frac{1}{2}$ miles. The first, known as the Inseza base, was measured in three sections, the second in seven, each section being measured in opposite directions. As an indication of the accuracy attained we give the repeated measures in the shorter base:—

	Direct	Reverse	Discordance
	mm.	mm.	
Length of Section I.	4,509,571·88	4,509,554·47	1 in 259,000
,, ,, II.	6 200,765·86	6,200,732·18	1 ,, 184,000
,, ,, III.	8,196,927 19	8 196,928·28	1 ,, 4,746,000
TOTAL ...	18,907,264·93	18,907,214·93	1 in 378,000

We have not space to quote the results in the case of the Gwibi or longer base, but the results there are even more accordant, the average discrepancy amounting to only one in a million and a half. W. E. P.

[1] Report of the Geodetic Survey of part of Southern Rhodesia executed by Mr Alexander Simms, Government Surveyor, under the direction of Sir David Gill, K C B, F.R.S., His Majesty's Astronomer at the Cape. Pp. xiv+146. (Cape Town, 1905.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE celebration of the four hundredth anniversary of the foundation of the University of Aberdeen began on Tuesday, and will continue for several days. The commemoration has been planned on a magnificent scale, and the arrangements have been perfectly organised. The formal proceedings opened on Tuesday morning with a service at King's College in commemoration of the founding of the University by Bishop Elphinstone. In the afternoon, at a reception given by the Chancellor (Lord Strathcona) and other high officers of the University, the delegates of the British, colonial, and foreign universities were presented to the Chancellor and delivered their addresses. In the evening a banquet was given by the Lord Provost and the corporation. Among the distinguished foreigners who are taking part in the celebrations are:—Prof. H. Becquerel, Prof. Behring, Dr. C. De

Candolle, Prof. Deissmann, Prof. Yves Delage, Dr. Anton Dohrn, Prof. A. Giard, Prof. H. Höffding, Prof. F. Hueppe, Prof. Jensen, Prof. Lombroso, Prof. Matsumura, Prof. Mendeléeff, Prof. Menschutkin, Prof. Hugo Münsterberg, Prof. W. Ostwald, Prof. Giuseppe Veronese, Prof. Paul Vinogradoff, Prof. J. W. Wijhe, and Prof. Weichselbaum. The lecture-rooms, laboratories, and other buildings which will be opened by the King to-day have cost more than 200,000*l.* to erect and equip. The new block completes the quadrangle, and includes new class-rooms and laboratories for physiology, geology, and agriculture; new rooms for education, medicine, modern languages, and other subjects; a new library for scientific literature, and new offices. We hope to give in our next number a description of this extension of the University, and an account of the brilliant ceremonies with which it has been inaugurated.

THE next session of the South-Eastern Agricultural College, Wye, will commence on October 1, and the inaugural address will be delivered by Dr. H. E. Armstrong, F.R.S., on October 2. A conference of fruit growers will be held at the college on October 22, when discussions on methods of planting, fungus diseases, insect attacks, strawberry culture, will be opened by Messrs. S. U. Pickering, F.R.S., E. C. Salmon, F. V. Theobald, and W. P. Wright. The chair will be taken by Mr. Laurence Hardy, M.P. Those wishing to attend the conference should send their names to the principal of the college.

ON October 11 Sir William Anson will distribute the prizes awarded to students in the evening classes of the Royal Technical Institute, Salford. The calendar of the institute for the session 1906–7 contains the announcement that all intending students under sixteen years of age will, before admission to the evening classes, be required to pass an entrance examination in elementary mathematics and English, or to satisfy the principal that they possess the requisite preliminary knowledge. Those who do not possess the knowledge necessary to pass the entrance examination are recommended to join one of the evening schools which have been instituted in various parts of Salford, and at which the required preparation is provided. It is intended that next year all under seventeen years of age shall furnish evidence of the possession of the requisite preliminary knowledge.

IN the early days of the movement for the higher education of women, one of its most active workers was Mrs. William Grey, whose death on September 19 at the advanced age of ninety years was announced in the *Times* of September 21. Mrs. Grey's name was from the first well known among those who advocated and carried to a successful result the foundation of high schools for girls by combined private effort; and the Girls' Public Day School Company (Ltd.) was the outcome of this movement. Springing out of the needs presently revealed by the high schools came the establishment of a system of training for secondary teachers. The idea was then comparatively new in England, and public opinion on the subject had to be formed and fostered, as it was largely through the work of Mrs. Grey. In recognition of her labours the well-known Maria Grey Training College for Women, now situated at Brondesbury, was named after her.

AN inspiring address on educational methods and their relation to science and industry, with particular reference to pottery, was delivered by Prof. H. E. Armstrong in the Town Hall, Longton, on September 19. In the course of his remarks, he said that workers in science have evolved a method, the scientific method, involving the gradual and cautious passage from the known to the unknown. Workers in politics have no such method at their disposal. Too often they are more or less ignorant of the real nature and extent of the problems which they deal with and seek to solve; sentiment masters their actions. The application of scientific method to public affairs is, consequently, becoming a matter of paramount importance. In all manufacturing districts science and industry must be brought into an effective alliance. On no other basis are prosperity and happiness possible, for the simple reason that, in these days, an industry that does not repose on a scientific basis is one which has no proper knowledge of itself, science being nothing more than organised systematic knowledge. Scientific training, training in method, is required by all. Scientific knowledge, true knowledge, must be public possession. The feeling is becoming general that something must be done to make our schools more effective than they are. In a recent report of the Consultative Committee, the Board of Education is advised that the schools have failed, in the past, to develop both the moral and mental qualities which are desirable, and that we must now strive to make the teaching far more practical, manual training being openly and strongly advocated. We read, moreover, "It would seem clear to the committee that the thing needed is not only knowledge, but a right attitude of mind, a mind confident in its own power to observe and think, and in the habit of observing and thinking—a mind in which interest makes for intelligence and intelligence for interest." "The course," it is stated, "should consist of three threads or strands, roughly to be termed humanistic, scientific, and manual, and, in the case of girls, domestic; all higher elementary schools should give this threefold instruction." Though these views have been urged by many educational reformers for thirty years or more, the doctrine they involve is really quite revolutionary coming from such a quarter, especially as it is directed to the Board of Education, which treats manual training as a special subject for the select few.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 14, 1905.—"Observations on the Development of Ornithorhynchus." By Prof. J. T. **Wilson** and Dr. J. P. **Hill**. Communicated by Sir William Turner, K.C.B., F.R.S.

The paper treats of certain stages in the intra-uterine development of the egg of Ornithorhynchus. The following are points of more special interest among those set forth in the extended paper:—

(*a*) The very early differentiation of the layer of yolk-entoderm surrounding the yolk-mass of the monotreme egg.

(*b*) The original entire independence of the primitive streak from the primitive knot and its "gastrulation-cavity."

(*c*) The subsequent intimate approximation of these structures.

(*d*) The early appearance of an area of special differentiation in the vicinity of the primitive streak in the early blastoderm, and the later conversion of this "primitive-streak-area" into an "embryonic area" proper, by the annexation of the region surrounding the "primitive" or "archenteric" knot.

(*e*) The precise mode of disappearance of the ventral wall or floor of the archenteric- or invagination-cavity.

(*f*) The occurrence of peculiar segmental cell-masses in the substance of the "primitive knot," where that constitutes the parietes of an archenteric canal or its representative.

(*g*) The diagrammatically clear demonstration of various features of neural development, including the well-marked neuromeric segmentation of the cephalic region of the flattened medullary plate, the differentiation of early plate-like ganglionic expansions of the neural crest in the cephalic region, the presence of various cellular connections between the cephalic ganglionic plates and certain of the neuromeric segments of the medullary plate.

(*h*) The relative insignificance of the "archencephalic" subdivision of the cephalic portion of the medullary plate, from which the fore-brain and most, if not all, of the mid-brain are derived.

June 28.—"Note on the Production of Secondary Rays by α Rays from Polonium." By W. H. **Logeman**. Communicated by Prof. J. J. Thomson, F.R.S.

The author describes results which were obtained in the course of some experiments on the slowly-moving negative or δ rays emitted by polonium, and which indicate that negatively charged secondary rays are produced when an aluminium or copper plate is bombarded by a stream of α rays.

The method used may be briefly described as follows:—A polonium-coated copper disc was placed in a glass tube with its active side facing, and parallel to, a highly insulated metal disc of the same size, which could be connected to one pair of quadrants of a sensitive Dolezalek electrometer. The distance between the discs could be adjusted. The polonium disc could be raised to any required potential by connecting it to a battery of small secondary cells. The glass tube was evacuated by means of a mercury pump down to a pressure of about 0·001 mm. and then sealed off, and the vacuum was then rendered as high as possible by the use of Dewar's method. The apparatus was placed between the poles of an electromagnet in such a manner that a magnetic field could be applied in a direction at right angles to the straight line joining the centres of the discs. The charge acquired in a given time by the insulated disc, when different strengths of magnetic field were applied, and when the electric field between the discs had different values, was measured. Tables of results are given, and these are also plotted in the form of curves, showing the variation of the current between the discs with varying magnetic and electric fields. From the results obtained the author arrives at the following conclusions:—

(1) That under ordinary conditions, *i.e.* when not acted upon by an electric or magnetic field, the polonium gives off a larger amount of negative than of positive rays.

(2) Under the influence of a gradually increasing electric field more and more of the slowly-moving negative rays are stopped, and the charge carried by the α rays becomes more and more predominant.

(3) A potential difference of about 10 volts between the plates is sufficient to stop the last of the δ rays.

(4) The slowly-moving negative rays can also be prevented from striking the insulated plate by curling them up in a magnetic field. When they are stopped in this latter way, however, the quantity of positive electricity received by the insulated plate is only about one-fifth of that received when an electric field is used to stop the δ rays. The author explains this last fact as follows:—When the potential difference between the two plates is 10 volts or more (the polonium being positive), the positive current from the polonium to the other plate consists of two parts, viz. a stream of positive α particles in the direction of the current, and a stream of negative particles in the opposite direction given off by the insulated plate. A magnetic field curls up this latter stream of negative rays, as well as the δ rays given off by the polonium.

The author also points out that his results showing the magnetic and electric deflection of the δ rays are not in agreement with those obtained by Ewers with another sample of polonium.

PARIS.

Academy of Sciences, September 17.—M. Troost in the chair.—The International Congress for the Study of the Polar Regions: G. **Bigourdan.** The congress was held at Brussels on September 7, and was attended by delegates representing fifteen countries and eighty learned societies. Seven standing committees were formed, each concerning itself with a special group of sciences. The formation of an International Polar Commission was decided upon, and bye-laws drawn up.—The deviations from the vertical in the region of the Sahel, Algeria: R. **Bourgeois.** In the triangulation of Algeria, the summit of the Voirol column was taken as the junction of the network of triangles. The national observatory, founded some years later, is about 5 kilometres in a direct line from this column. If the astronomical latitude of the observatory is compared with the geodesic latitude of the same point, the calculation being made starting with the fundamental coordinates of Voirol, a relatively considerable discrepancy is found, indicating a strong deviation from the vertical at one or other of these two points. In the present paper it is shown that it is the Voirol station which is at fault, and hence all the data built on this as a starting point require re-calculation.—The action of fluorine on chlorine, and on a new method of formation of hypochlorous acid: Paul **Lebeau.** Attempts were made to combine fluorine with chlorine, under varying conditions, at temperatures ranging from 0° C. to −80° C. It was found that fluorine and chlorine do not combine directly. Liquid chlorine dissolves fluorine, but this fluorine is given off at the solidifying point of the chlorine. In presence of water, fluorine oxidises chlorine, the latter being completely converted into hypochlorous acid, thus giving a new method for the preparation of this acid.—Syntheses in the quinoline group: phenylnaphthoquinoline dicarboxylic acid and its derivatives: L. J. **Simon** and Ch. **Mauguin.**—The action of mixed organomagnesium compounds upon amides: Constantin **Béis.** To secure a reaction in all cases it is necessary to prepare the organomagnesium compound in the presence of the imide, the alkyl halide being added to a mixture of the imide, magnesium, and ether. Isoindolinones, isomeric with arylamidoketones, are obtained.—The hæmopoietic activity of the different organs in the course of the regeneration of the blood: Paul **Carnot** and Mlle. Cl. **Deflandre.**—The experimental infection of trypanosomiasis by naturally infected *Glossina palpalis*: L. **Cazalbou.** Two out of seven specimens of *Glossina palpalis*, captured on the banks of the river Bani, a large tributary of the Niger, have infected dogs with trypanosomiasis. A cat was similarly infected.—The movement of the pole at the surface of the earth: Marcel **Brillouin.** A discussion of the curves published by M. Albrecht since 1890.

CONTENTS.

PAGE

THURSDAY, OCTOBER 4, 1906.

THE EVOLUTION OF THE GLOBE.

Geology: Earth History. By Thomas C. Chamberlin and Rollin D. Salisbury. Vol. ii., Genesis, Paleozoic, pp. xxvi+692. Vol. iii., Mesozoic, Cenozoic, pp. xi+624. (London: John Murray, 1906.) Price 21*s.* net each.

THE first volume of this important work, noticed in NATURE of January 19, 1905, and already in its second edition, dealt with geological processes and their results. In the two volumes now before us, which complete the work, geology is treated from the historical side, and we have a comprehensive review of the history of the earth on systematic lines. The treatment of these two formally separable branches of the science is, however, such as to emphasise the essential unity of the whole. As geological processes were discussed with continual reference to the historical application of the principles laid down; so the evolution of the globe, which is the story of these latter volumes, is regarded consistently from the causal point of view. Indeed, some subjects already considered under the head of geological processes, such as the dynamics of deformation, the causes of glaciation, &c., are now more fully discussed in connection with the particular geological periods which most clearly exemplify the phenomena.

The part of the work which will be read with greatest interest is that which falls under the subtitle "Genesis." Considering geology as "the domestic chapter of astronomy," the authors devote much more space than is customary in geological treatises to the problem of the origin and primitive condition of the globe. This is, we think, amply justified by the fundamental place which cosmogony necessarily occupies in the construction of the science. It is evident that opinion concerning such questions as the causes of crust-movements, the essential mechanism of igneous action, the origin of the atmosphere and hydrosphere, the beginning of life, must be controlled by the view adopted, formally or tacitly, of the mode of origin of the earth as a planet. Less obviously, but not less surely, some theory of the earth's initial state is involved in numerous geological doctrines, the dependence of which on such considerations is liable to be overlooked; and the authors do good service in recalling this fact repeatedly in the historical record which follows. The clear recognition of cosmogony as the foundation of geology, by revealing an unsuspected element of hypothesis at various places in the superstructure, offers a warning which is perhaps in some quarters not wholly unnecessary.

The special interest of this part of the book, however, lies in the first complete exposition of the "planetesimal" theory, which the senior author has already propounded elsewhere. That our solar system has in some manner been evolved from a nebula of some kind is an assumption to which few will demur; but the particular theory associated with the name of Laplace, and generally known as the nebular hypothesis, starting from a gaseous nebula of extreme tenuity, has for some time been felt to involve difficulties, which become more serious upon a closer examination. These difficulties are cogently stated by the authors, especial stress being laid on the great discrepancy which Moulton has pointed out from a consideration of the actual distribution of moment of momentum in the solar system. The meteoritic hypothesis, whether in Lockyer's or in Darwin's form, is held by the authors to be open to the same objections as the theory of a gaseous nebula, with which, indeed, it is practically identical as regards its more important consequences. According to the planetesimal hypothesis, the constituents of the system might be molecules or small masses of any kind moving in orbits about a common centre, the essential point being that their behaviour depended, not on mutual collisions (as on the meteoritic hypothesis), but on revolution in independent orbits. On this supposition there was, after the initial nebula was once formed, no fundamental change in the dynamics of the system, but only a progressive aggregation of the infinitesimal planetoids ("planetesimals") to form the planets and their satellites as they now exist.

The original nebula postulated was not a gaseous one, but belonged to the type giving a continuous spectrum, and had, like most of these, the spiral form. There were also, as in such nebulæ in general, knots of denser aggregation which became the nuclei of the several planets, though the greater part of the material outside the central helioid was still widely scattered. The manner in which such a system may have been developed from an ancestral helioid by the near approach of another star is tentatively pictured; but this is no essential part of the hypothesis, which is concerned, not with the whole evolution of the solar system, but with the birth and subsequent history of the planets. Starting with the conception of an infinitude of small masses revolving in different elliptic orbits of considerable eccentricity, with a certain degree of clustering already pronounced, the authors discuss the manner in which these planetesimals became aggregated into planets, moving in orbits of only small eccentricity, and with rotation in the same direction as the orbital revolution.

It is for the mathematician rather than the geologist to pass judgment upon this new treatment of the dynamical problems involved, but the geologist must be vitally interested in the verdict. The earth as built up on the planetesimal hypothesis will be a very different body from the earth as condensed from a gaseous spheroid, and must have passed through very different stages of evolution since it acquired individuality. The first-formed solid nucleus was probably devoid of any atmospheric envelope, its attraction being insufficient to control the rapidly moving molecules of gases. An appreciable atmosphere had probably been gathered when the growing globe had attained one-tenth of its present mass (being then comparable with Mars). The atmosphere would at first be collected from outside, but there was already a large quantity of occluded gases in the material built into the solid globe, which might eventually be set free by extrusive agency, and continues to be a source of supply to the present time. The nature of the primitive atmosphere may be conjectured from the known occluded gases in crystalline rocks and meteorites, having regard also to a certain selective effect depending on molecular weights. Carbon dioxide was probably abundant and nitrogen only a minor constituent, the latter, in virtue of its chemical inertness, having accumulated progressively throughout subsequent time. It is supposed also that the oxygen in the present atmosphere has mainly been set free by the agency of vegetable life. The initiation of vulcanism is next considered, involving a discussion of the thermal conditions in the growing globe. The heat produced by the infall of the planetesimals was probably important only in the earlier stages of growth, and the chief source of the earth's internal heat is ascribed to the progressive compression of the central parts. It is estimated that this cause alone would suffice to reach the melting temperature of rock when the earth had acquired one-tenth of its present mass. On account of the originally heterogeneous composition of the globe, local spots of fusion would arise, the occluded gases presumably playing a part in the process, and, aided by the varying differential attractions of the sun and moon, the molten matter would gradually work its way outward. This action is supposed to be facilitated by "selective fusion," the more fusible materials encountered being taken up and the more refractory of the old materials deposited. In the general theory of igneous action developed by the authors there is evidently much that is debatable. In particular, the assumption that minerals have their melting points raised without limit by increased pressure, is one to which many physicists will demur. The maximum melting point found by Damien and others for various organic bodies, and considered by Tamman to be a general property, has led Arrhenius to very different conclusions concerning the actual condition of the earth's interior.

Another part of our authors' system which fails to carry complete conviction is the explanation offered for the initiation of the ocean-basins. The cardinal fact to be accounted for is the lower density of the crust in the continental areas as compared with that beneath the ocean floor. The difference is here attributed to the weathering and leaching action on the land, as contrasted with the relative protection of the rocks under the sea. It is supposed that the selective action of degradation and transportation sets up in time an appreciable difference in composition between the average material of the continental and that of the suboceanic tracts, the former becoming more acid and so lighter, and the latter more basic and therefore denser. The effect would be cumulative, and the difference of density established would be permanent, not being obliterated by subsequent metamorphism. In this way there might be evolved, from an originally fortuitous disposition of the growing hydrosphere, a distribution of land and water having a high degree of relative permanence.

We have dwelt on that part of the work which offers most of novelty, but the larger portion of the two volumes deals, on a more familiar model, with the several geological periods in order. The Archæan era is regarded as representing the climax of igneous action (or, as it is confusingly styled, volcanic action), and as being concurrently a time of intense crustal deformation. The Huronian and other pre-Cambrian formations which follow the Archæan are grouped as Proterozoic—an unfortunate choice, since the name has already been used by Lapworth for the Lower Palæozoic. The Lake Superior region is taken as the typical area, and three distinct systems are recognised —Huronian, Animikean, and Keweenawan. The great fossiliferous systems are then dealt with in turn, the chief innovations as regards systematic arrangement being the division of the Carboniferous into two, Mississippian and Pennsylvanian, and the separation of the Lower Cretaceous as a distinct system under the name Comanchean. Under each head the development of the stratified sequence in the North American continent is described and its interpretation discussed, the probable geographical conditions of the North American area at different periods being illustrated by maps. The corresponding strata of other parts of the world are dismissed more summarily. This plan is natural in a work designed primarily for American students, and its inconvenience is felt only in certain cases where the American record is incomplete or inadequate, especially in the Permian and Jurassic periods. We have, however, as a digression, a good account of the widespread glaciation in the southern hemisphere in Permian times, with excellent figures (after Schwarz) of glaciated rock-surfaces and boulder deposits in South Africa. We think that the authors have succeeded in giving a fairly complete and well-proportioned sketch of the earth's history in its successive chapters. The only serious defect which we find is the slight notice accorded to igneous action, and especially the failure (except in the earliest chapters) to recognise this as an essential part of geological history, closely bound up with the tectonic development of the globe.

For reasons connected with the curriculum of American universities, the history of life is treated in great measure apart from the physical history of the earth, a plan not without practical disadvantages. No attempt is made to give a complete "roll-call" of the flora and fauna of each period, but attention is directed especially to the main lines of biological development from the evolutionary standpoint. As regards the evolution of life in general, it is supposed that more than half of the complete history antedates the first fair record, offered by the Cambrian strata, in which we have abundant evidence of a development already far advanced. For this reason the Cambrian faunas are dealt with at some length. Similarly, in the Carboniferous we have for the first time a large mass of material bearing on the evolution of plant life, and this receives due notice, with a digression discussing the origin of coal and the climatic conditions implied in the profusion of vegetable life at that epoch.

The arrangement of the book is in most respects well adapted to the requirements of students, and the presentation of the subject-matter is always clear. In the biological sections Transatlantic freedom of style is sometimes carried so far as to savour of the evening Press, paragraphs being headed, for example, "New Devices of the Bryozoans" and "The Protozoans make a Record." The abundant figures are well chosen, and, within the limitations of black and white, usually well executed, but the glazed paper, on which the whole is printed, is an offence to the sensitive eye. The work as a whole is one which will find a welcome in England as well as in America. The planetesimal theory, too, whatever its ultimate fate, is at least a spirited protest against any narrow limitation of geological time, and may serve to fortify timid geologists against the thunders of certain mathematicians, too apt to forget the precarious basis upon which their calculations are built. A. H.

THE GENESIS OF THE INVENTOR.

Erfindung und Erfinder. By A. du Bois-Reymond. Pp. vi+284. (Berlin: J. Springer, 1906.) Price 5 marks.

In his opening chapter, Herr du Bois-Reymond gives an historical survey of the development of the Patent Laws in civilised countries. They date from the Act of Parliament passed in the year 1623, which in its first clause abolished the long-standing grievance known as monopolies, by which favoured individuals had the exclusive right to sell such things as salt and coal; the second clause established a new variety of monopoly, out of which patent rights had their origin. Little has been altered in principle since that date. Even down to the term of fourteen years the system still holds good, rights being granted to "any new manufactures." Other countries, adopting the idea at much later dates, attempted a more formal definition of invention, and legal logic has constantly tried to define the admissible and the inadmissible. Herr du Bois-Reymond shows that in Germany, since the year 1889, the number of patents granted has varied between 29 per cent. and 45 per cent. of the number of applications filed, and, therefore, assuming the quality of the inventions to be on an average the same from year to year, it would seem that the official mind is not yet certain in its workings.

The author's analysis of the nature of invention and inventors leads to the conclusion that neither need, nor chance, nor the lack of necessaries in surrounding life suffices to draw out the inventor. Instead of solving the problem by philosophic deductions from generalities, he descends to the particulars of the Patent Office, and concludes that inventors can be subdivided into three classes:—first, the intuitive genius, or, as Herbert Spencer would have said, the man who can do with little trouble that which cannot be done by the ordinary man with any amount of trouble; secondly, the technical man, well acquainted with his work, who follows in the wake of the intuitive genius, and is largely inspired by him; thirdly, the layman, whose special province seems to be feeding-bottles. We are inclined to think that too much stress can be laid on the existence and qualifications of the first class. A long series of inductive reasonings, followed generally by equally laborious experiment, is the usual course of a successful invention. Helmholtz and Darwin were not inventors, but their methods were the same. Helmholtz said that in his work he could only liken himself to the mountaineer, painfully and slowly climbing, often obliged to turn backwards, lighting later on new traces leading forward, and finally reaching the goal, only to find to his confusion that a plain road led thither, if he had only had the eyes to see. Darwin said he thought he was superior to the common run of men in noticing things which easily escape attention, and in observing them carefully. "My industry has been nearly as great as it could have been in the observation and collection of facts." Herein lies the real spirit of the pioneer. Nothing is more useful than the quality on which Darwin naïvely lays stress, viz. that of noticing things which escape attention; and those who hope to reach the promised land without wandering in the wilderness are probably doomed to disappointment.

Superficially, chance seems to play a large part; but Herr du Bois-Reymond maintains that chance only determines whether this or that individual shall do the deed, and has nothing to do with whether or not the deed shall be done. This is probably true in those cases in which attention is directed to a problem from various sides owing to a main directing cause. Such was the result of Moissan's discovery of the production of calcium carbide in the electric furnace. The acetylene generator seems to follow as a matter of course. Moissan had no heed for the commercial exploitation of such things, and many others, becoming aware of the existence of an obvious need, which appeared to be capable of being dealt with without the aid of the calculus, rushed in, left the relics of their labours in the files of the Patent Office, and discovered later that they were wholly unacquainted with the conditions of the problem. In this case mere inspiration leads nowhere; laborious experiment is much more to the point, and chance only comes in, having regard to the number of men at work on the task, in determining who shall lodge his application first. That cannot properly be called chance which is merely the outcome of some unlooked-for combination or slight variation of procedure; it is precisely for these things that the inventor toils, and when they come within his sight he merely recognises that for which he has patiently hoped.

Herr du Bois-Reymond concludes by considering the reaction on civilised life which is due to the existence of the inventor. The idea of protecting the inventor was only an indirect cause of the Patent Laws in most countries. A more direct impulse was probably given by the view that the prosperity of the State was likely to be increased by such encouragement as could be given to the creation of industries. Still, Faraday's commercial value has been incalculable, but he received little encouragement from Patent Laws, while

Watt was obliged to circumvent them in order to carry on his business. Moreover, the State undoubtedly profits directly. It is asserted by men competent to judge that the amount received in patent fees is greater than all the profits made by inventors. In other words, the average profit made on an invention is not sufficient to cover the charges made by the State. Herr du Bois-Reymond's book may be recommended to those who take an interest in the philosophic analysis of these questions, and they may also hope to find much worldly wisdom scattered throughout its pages, and a wealth of illustration, drawn from the experience of a busy life.

W. H. S.

BIOLOGICAL PHILOSOPHY.

Psychology (pp. 124); *Sociology* (pp. 124); *Ethics* (pp. 118). By Dr. C. W. Saleeby. Three vols. Scientific Series. (Edinburgh and London: T. C. and E. C. Jack.) Price 1*s.* net each.

DR. SALEEBY discusses the problems of philosophy from the Spencerian standpoint in an interesting fashion. Of the three volumes, that on Psychology appears much the best; it is the most serious, and though the author has there one *bête noire* in the person of Dr. Ward, who suffers vicariously for all the sins of "academic psychology," the reader is not wearied, as in the Ethics volume, by incessant declamation against Nietzscheanism, on the one hand, and what is politely called "hell-fire morality" on the other.

On psychology our author has nothing very startling to say. He defines his subject as the science, not of consciousness, but of mind. He favours the Wundtian theory of psychophysical parallelism. He regards mind as a product and phenomenon of evolution; or rather, having boldly stated that life is prior to mind, he closes one of two chapters on the evolution of mind by maintaining that the responsiveness of the leucocyte to irritation points to sentiency on its part, and by withdrawing his bold statement in favour of a bolder, that life and mind are co-equal, co-extensive, and of common origin. That is to say, he levels up the leucocyte to man. In the latter part of his book he dwells much more on the will than on the intellectual functions, as he wishes, not to lead up to a text-book on logic, but to the consideration of conduct. The result is that many questions which one finds discussed in the ordinary handbooks are not even mentioned in this; but, of course, amid the multiplicity of cheap introductory works there is no reason why all should go in the same ruts.

In the volume on Sociology one notes that our author follows the Spencerian line that the State has no consciousness of its own, and therefore the welfare of the State never means anything more or other than the welfare of the citizens. He follows his master, too, very closely in his opposition to free education, which he thinks as bad as free breakfasts for the children. A later chapter is occupied with an indictment of the modern city, and others with a discussion of socialism, conservatism, and liberalism.

The volume on Ethics has some excellences—the discussion of the origin of morality, for example, with what the author regards as the most important proposition he has to offer, viz. that organic evolution, reproductive evolution, and moral evolution are interdependent. Some other things are not quite so convincing—the statement that there has been far more vicious than virtuous obedience in human history, or another that morality is æons of æons older than the oldest creed, the proof offered being that a cat cares for its kittens. Apparently morality began ages before man was ever heard of, though, in a different context, Dr. Saleeby describes a baby as "non-moral, premoral, or if you like, immoral."

There is a hard saying on one page to the effect that historians of the (inaccurate and picturesque) school of Carlyle and Froude are no longer in request. This comes with rather a bad grace from one whose merits are probably—*quanto intervallo!*—much like those of the writers named; while his defects include an inadequate apprehension of the real issues involved and a stumbling knowledge of Greek. For *logos* does not mean science, nor is teleology derived from the word meaning "at a distance."

BIOLOGY OF THE FROG.

The Biology of the Frog. By Samuel J. Holmes, Ph.D. Pp. vii+370. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1906.) Price 6*s.* 6*d.* net.

IN the vast literature that treats of the frog there is no comprehensive summary of its biology. Every natural history teacher has realised this want, which has increased in proportion with the great recent extension of instruction in elementary natural phenomena. No animal is more thoroughly known from the anatomical, histological, and embryological aspects, but on the side that appeals to teachers and commencing students, the study of habit and function, existing knowledge of the frog is scattered and often untrustworthy. This gap the author strives to fill, writing primarily for the student. His book is a compilation of what is known of the behaviour of the frog and of its several organs. Unfortunately it is not only this. Dr. Holmes has not freed himself sufficiently from formal and dogmatic zoology. He must have all the nomenclature and the anatomy of the medical school, as though we could never learn or teach zoology without a load of descriptive structural details. The new wine of comparative physiology has been poured into the old vessel and has burst it, leaking out now here now there, so that no good draught is obtainable. The wine, however, is good, and the more pity the framework was not better adapted to hold it and yield it to the thirsty soul.

The frog enters on p. 62, chapter ii. Here "we begin our study." Unfortunately there are two earlier chapters, with which most readers will begin. The first deals with the classification of Amphibia, and ought to have been simplified or postponed. The second is the main ecological chapter, and involves the use of many anatomical expressions that a young student will not understand until later. The mode of protrusion of the tongue by lymph pressure; the changes in the liver, fat-body, and gonads; the formation of new blood corpuscles and other difficult topics, are referred to before so much as a brief reference to the chief features of the frog itself.

The succeeding chapters are arranged on the stereotyped anatomical plan. In reference to the external features, no remark is made of the prevalence or significance of the dark upper sides and light under sides of animals, or of the meaning of gradational shading. A green pigment is attributed to the frog at the close of the third chapter and denied on p. 192. Descriptions of the internal organs, of development, and of the histology of the different organic systems occupy the rest of the book. We have, however, admirable summaries of physiological action under each histological section, and for these teachers will be thankful. The treatment of the skin and of the blood, of digestion and respiration calls for praise. The seasonal metabolic changes in the tissues of the frog are well described under the various organs that are affected, and the references will enable one to find the original papers with ease.

The book is one that will prove useful to every teacher of elementary biology, and its usefulness would have been enhanced by a thorough-going biological treatment and simplification of the anatomical details. Few biological writers realise what a stimulus to teachers and to taught lies in a new mode of presentation of a well-worn subject. In the writing of a biology of the frog a superb opportunity has presented itself of boldly embarking on the physiological method and of subordinating anatomy to the working out of function and response. Moreover, the biology of the frog is not well worn. It is, in contrast with anatomical knowledge, inaccessible and scattered, and with much labour it has been brought together for the first time. With so much novelty at his disposal one cannot help regretting that the author has adopted an arrangement for his work that puts biology into a subordinate place, with the result that he has made a useful but not an illuminating work.

It is in no carping spirit that we point out a few suggestions and corrections for a second edition. Chiefly we should advise the deletion of the experiments and experimental results dealing with severe lesions. The chapter on the nervous system is one that no sensitive student could read without shuddering, and a recapitulation of the revolting experiments made by certain writers was wholly unnecessary in such a work as this. It is with regret that we notice this serious drawback.

The description of the tadpole, and, indeed, of the life-history generally, while fairly careful in cellular detail, is lacking in any broad suggestiveness that will remain after the anatomical detail has faded from the mind. The mode of hatching, the meaning of food-yolk, the fish-like character of the larva are not touched upon, nor is there given in this or any other chapter of the book an idea of the process of evolution.

Few misprints occur, but "Wiederscheim" for the distinguished anatomist of Freiburg is of irritating frequency.

F. W. G.

OUR BOOK SHELF.

Morphologie und Biologie der Algen. By Dr. Friedrich Oltmanns. Zweiter Band, Allgemeiner Theil. Pp. vi+443. (Jena: Gustav Fischer, 1905.) Price 12 marks.

It is difficult to say of this much-wished-for and long-expected fruit of Dr. Oltmanns's industry more than that it meets all these wishes and hopes. There is one respect in which a fault may be found, the last to be thought of, viz. the arrangement, but it is cured by the provision of an excellent index. Detailed criticism of a work of this size in the pages of Nature is out of the question, and the present writer confesses that he has attempted such a task several times, but always with the result that his effort not only left no satisfaction to himself, but kept a fear before him that his judgment might easily be misunderstood.

In a word, the book is invaluable to all workers at this subject, and well worthy of the great reputation of Dr. Oltmanns as a researcher and teacher. If any faults were to be found in a detailed criticism they would be, not with Dr. Oltmanns, but with the fate that has prevented his access to our great collections. This short notice of so great a work must not, from its brevity, seem to lack in the heartiness the reviewer wishes to express in his welcome to it. The volume has been long needed by those who are earnestly at work, and no one values it more than the writer of this brief note of thanks for it, and for the industry of the author of it.

George Murray.

Atlas colorié de la Flore alpine. By J. Beauverie and L. Faucheron. Pp. 98. (Paris: J. B. Baillière and Son, 1906.) Price 7.50 francs.

The recollections of botanising expeditions in the High Alps must ever remain a source of pleasure to those who have had such enjoyable experiences. Not only the botanist, but anyone endowed with a spark of latent appreciation for the beauties of nature cannot fail to be aroused to enthusiasm when for the first time he has the good fortune to behold patches of *Anemone vernalis* in the spring, or to discover clumps of *Ranunculus glacialis* on the snow-line. It is natural, therefore, that there should be a demand for floras of the Alpine regions adapted to amateurs, and also worthy of professed botanists. Such is the nature of this volume, which contains excellent illustrations combined with simple descriptions of the flowers and references to localities where they may be found. To confine the book to reasonable compass, only fairly common Alpine plants are included, and preference is given to the denizens of the higher Alps. So far as the selection is concerned, there is little to note except that the orchids have received rather scant measure, and the thistles are entirely omitted. Some of the plants, *e.g.* *Douglasia vitaliana* and *Androsace villosa*, are interesting for their association with the French Alps, while, on the other hand, several species are included that are absent from French territory. The compilation reflects credit on the authors for their clear and pithy descriptions, and on the publishers for the manner in which the plates are produced.

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.]*

Measurement of Resemblance.

At the distance of a few scores of paces the human face appears to be a uniform reddish blur, with no separate features. On a nearer approach specks begin to be seen, corresponding to the eyes and mouth. These gradually increase in distinctness, until at about thirty paces the features become so clear that a hitherto unknown person could thereafter be recognised with some assurance. There is no better opportunity of observing the effects of distance in confounding human faces than by watching soldiers at a review. Their dress is alike, their pose is the same, the light falls upon them from the same direction, and they are often immovable for a considerable time. It is then noticeable how some faces appear indistinguishable at distances where great diversity is apparent in others, and the rudely-defined idea will be justified that the distance at which two faces are just mistakable for one another might serve as a trustworthy basis for the measurement of resemblance. The same may be said of obscurity, of confused refractions, and of turbid media; but in this letter I shall confine myself almost wholly to the effects of distance under the conditions of ample light and a transparent atmosphere. Beyond this I shall say nothing, except in one paragraph almost at the end.

The scale of the features has, of course, to be taken into account. This is of much less importance in living persons than in portraits, because the differences in scale of the adult human face are not very great, whereas those in photographs and paintings—ranging as they do between miniatures and life-sized portraits—are so. It is necessary to adopt a *facial unit*, based on some specified dimension. That which I use is the vertical distance between the middle of the line that joins the pupils and the parting of the lips. It is unaffected by head-dress or by the thickness of the hair on the top of the head, while its lower termination can be located in a bearded face more accurately than the chin. I call this u. If the portraits have different units, they are distinguishable as u and u'. If d and d' be the critical distances at which mistakability first occurs, then u/d and u'/d' are necessarily equal, and either of them would serve as a measure of mistakability; but as u is very much smaller than d, this fraction would always be a decimal preceded by one or two zeros. Therefore I take the index of mistakability, which I will call N, as $=1000\,u/d$. It is, however, convenient to measure u and d by different scales; u in millimetres, distinguishing it as u_m; d in centimetres, distinguishing it as d_c. Then $\text{N}=100\,u_m/d_c$.

Of course, N could be expressed by the arc or angle of which u/d is the chord, but it would be a roundabout method, as angles could not be measured directly without special and troublesome apparatus. I find it very convenient for my purposes to employ a nomenclature for chords based on that of the metrical system, d, the distance, being the radius or "rad." So a chord $=1/100$ becomes a "centirad," and that $=1/1000$ a "millerad." A centirad is the chord of 34·4 minutes of a degree, and, therefore, a trifle larger than the apparent diameter of the sun or moon. It is equal to the apparent size of one-tenth of an inch at 10 inches distance from the eye, which is a convenient distance for reading small type. A millerad which subtends between three and four minutes of a degree, and is equivalent to 1/100 of an inch seen at 10 inches, is as small an interval as can usually be detected in photographs without scrutiny, though a normal eye is able to distinguish one-third or even one-fourth of that interval between sharply defined objects.

Mistakability is only an approximate measure of resemblance, for it depends more on the scale of the distinguishing features than on the amount of difference of those features. This peculiarity is well exemplified, though greatly exaggerated, by what is seen in the time-tables hung up by railway stations. From across the road, say, they all appear alike as a shade of uniform grey. On approaching nearer, differences are observed in the headlines; nearer still, varieties in paragraphing come into sight, and at a reading distance the figures are all simultaneously distinguishable. This experience is partly, but only partly, applicable to human faces. Those that are alike are certainly distinguishable at shorter distances than unlike ones, and I notice no excessive clustering of values closely round particular values of N in my results, which there would be if mistakability always occurred near a particular stage, such as that at which the whites of the eyes cease to be visible, or at twice or three times that distance.

A strong likeness in small details may so dominate the perception that a want of likeness in larger features is overlooked. Here the distance of maximum mistakability will be small, the portraits appearing more unlike when removed further off, and the small details cease to be visible. Extreme cases of partial likeness, whether in contour or in detail, would, of course, be noted and allowed for. With these exceptions the index of mistakability appears to be a fair, even, as I think, a close, approximation to an index of resemblance when the quality of the observed likeness is recorded by appropriate letters, as will be described later on.

The observational value of mistakability lies in its asking a simple question which different persons would answer in the same way, when they had become familiar with the method. On the other hand, *likeness* includes mutual *suggestibility*, a highly complex perception dependent on the mind of the observer, and consequently appreciated differently by different observers, as is notoriously the case.

The apparatus I now use with ordinary photographs acts very well, but I wasted much time before I contrived it, and more before sending it to be made in a workmanlike manner. I think it could still be improved, so I will describe, not my own, which was made for me by Baker, 240 High Holborn, but such as I should order if I required another one.

It is a long, thin, light box or framework $6\frac{1}{2}$ feet (2 metres) long, 10 inches (25 centimetres) wide, and 2 inches (5 centimetres) deep, which admits of being divided for sake of portability. It stands on two folding supports $2\frac{1}{2}$ feet apart, which fold back when out of use; when in use they can be clamped to any ordinary table. These raise the long box in a sloping position, the end towards the eye being at the most convenient height for a person seated on a chair, but the further end being lower, because it is easiest to look somewhat downwards. Two rollers, A and B (Figs. 1 and 2), run independently on a horizontal axis at one end of the box, and two corresponding ones, a and b (Fig. 2) at the other end. A light sledge that slides on the top of the box is harnessed in front to a tape graduated in centimetres, which passes over and round A, back to and around a, and thence forwards to the back of the sledge. (By inadvertence the path of the tape between the lower margins of A and a has been omitted in Fig. 1. The reader might dot it in pencil.) A similar sledge and tape is adapted to B and b. The tapes lie half an inch above the box (Fig. 1), and can be manipulated by the hands severally, so either or both sledges can be easily pulled either backwards or forwards while sitting in the chair, and their distances from the rollers at any moment be read off on the graduated tapes. (A winch and handle are superfluous.) The photos are mounted on two easily detachable standards (Figs. 1, 2), with clips at the bottom to hold them (not shown in the diagram), and standing on circular bases. These fit quite loosely into shallow hollows in the tops of the sledges. The standards can be lifted out, the photographs inserted, and the whole replaced with perfect ease. The circularity of the bases of the standards enables either of them to be set a little askew, which is convenient when the broad, full face of one portrait has to be compared with the narrowed, three-quarter face of another. A board stands vertically across A and B, and above them as a bridge. An eye-slit of half an inch width runs below its upper edge (Figs. 1, 3, 4), through which the photos are viewed, and from which the distances of the sledges are reckoned. A ledge 1 inch below the eye-slit (Fig. 1), with a parapet a little less than 1 inch high, forms a long, narrow groove into which light rectangular frames of wood, each with a spectacle lens in it, can be slipped and will stand upright (Figs. 1, 4). I chiefly use lenses of 12, 24, and 48 inches; my eye can accommodate its focus to intermediate distances, but I possess others which are sometimes serviceable. Younger persons with normal eyesight would want no lenses at all. The length of the box suffices for cabinet-size photos. An opera-glass reversed enables it to be used with larger ones, the minifying power of the opera-glasses at various short distances having been ascertained.

Mutual mistakability may occur under any one or more of the following conditions, which are to be noted, together with further remarks:—

a a. The portraits are apparently exact copies or reductions on different scales.

a. They appear to be portraits of the same person at about the same age, though differing in pose and dress.

b. They would be mistaken for portraits of the same person, even though they differ in sex and considerably in age, if the hair had been cut and dyed alike, and the dress arranged in the same way.

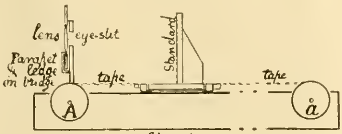


fig. 1

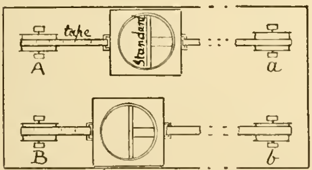


fig. 2

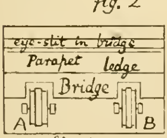


fig. 3

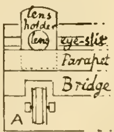


fig. 4

c. As above, if much disguised, as for theatrical personations.

b–c. Applies to cases intermediate between *b* and *c*.

P. Their resemblance is partial only, being confined to specified features.

The following little table saves trouble in operating; my own is more extended:—

Values of d_c in terms of N and of u_m $\left(d_c = \frac{100\,u_m}{N}\right)$

N	u_m 1	2	3	4	5	6	7	8	9	10
5	20	40	60	80	100	120	140	160	180	200
7·5	15	30	45	60	75	90	105	120	135	150
10	10	20	30	40	50	60	70	80	90	100
15	7	15	22	30	37	45	52	60	67	75
20	5	10	15	20	25	30	35	40	45	50
25	4	8	12	16	20	24	28	32	36	40

The procedure adopted after many trials was to measure the u_m of each portrait to the nearest half-millimetre and to write it below. Then to mount the two portraits, each on a separate sledge if their facial units differed, otherwise on the same. When they differed, the facial unit of the one about to be used for d_c was distinguished as u_m, the other was in brackets as (u'_m). Next, after referring to the above table, to send them to their respective d_c for $N=5$, to consider them carefully, and to note the result. Then to do the same for $N=10$, and so on, until the eye became familiarised with the differences between the portraits. Finally, guided by these provisional attempts, to fix on the suitable index and letter, adding such remarks as may seem wanted.

I became gradually more consistent in judgment, as ascertained by comparing the results on different days, but have felt all along that it would conduce to trustworthiness if two or more companions worked together and criticised one another, and recorded their common verdict.

A very brief example will suffice. Usually an entry consists of more lines followed by general remarks.

Two Sisters, Registers (so and so).
$u_m = 8{\cdot}5$; $(u'_m = 9{\cdot}0)$

N	d_c	Character of likeness
5	170	*b*
10	85	Nearly *b*
After trials	115	Just *b*

$$\text{Accept } N(b) = \frac{850}{115} = 7{\cdot}4$$

I will add a few words on dealing with mistakability caused through obscurity or other hindrances to clear vision. I prepared test cards, each containing numerals printed in different types, and, having ascertained by experiment the value of d_c for each kind of type when just able to read it in a clear light, wrote that value boldly by its side. An appropriate test card was put by the side of the portraits, and at the time when the portraits themselves were just mistakable, the written d_c of that row of figures which were just unreadable, was noted. The value of d_c remains constant whatever be the character or amount of the optical hindrance. If the hindrance increases, the portraits and the accompanying test card must be brought nearer to the eye. They will increase simultaneously in legibility. The written d_c will always show what the d_c would be in a clear light.

The applications of the process are numerous, as must always be the case when a hitherto vague perception is brought within the grip of numerical precision. To myself it has the especial interest of enabling the departure of individual features from a standard type to be expressed numerically. The departure may be from a composite of their race, or from a particular individual. The shortcomings of a pedigree animal from a highly distinguished ancestor could be measured in this way. Many other examples might be given.

I must not conclude without expressing gratitude for answers to a request, published by me some time ago in NATURE, for waste photographs from amateurs and professionals. If I be allowed to mention a single name, it would be that of Mr. Norman Campbell, whose photographs have been eminently serviceable.

FRANCIS GALTON.

Models of Atoms.

AN interesting and instructive variant of Prof. Mayer's experiment with floating magnets, which has been used so much to illustrate the structure of atoms, is to do away with the *centripetal* magnetic force and to arrange that its place be taken by forces arising from capillarity. This is managed as follows:—

A small circular dish is filled almost to overflowing with water the surface of which will be convex. A single floating magnet (with its axis vertical) placed on this moves at once to the centre; two or more such magnets placed on it form regular equilibrium figures, as in the usual form of the experiment. The chief interest of the modification arises, however, from the fact that *the figures are not in general the same as in the ordinary arrangement.* This is instructive, because it brings out clearly the necessity of knowing the exact law of force between the parts of an atom before it can be possible to predict its structure.

The experiment is so easily tried by anyone that there is no need to go into great detail here; but it may be mentioned that with the particular dish and magnets used by me it is possible to arrange ten in a single ring without any central nucleus, and that in a larger dish more can, of course, be so arranged. These ten also form stable groups as a ring of nine with one in the middle, or a ring of eight with two in the middle. But a ring of seven with three in the middle is not possible; if temporarily so placed one of the three gradually moves out and joins the seven. The first arrangement in three groups occurs for eighteen magnets in all; these are stable when placed with twelve in an outer ring, five in an intermediate ring, and a single one in the centre. ALFRED W. PORTER.

University College, London, September 17.

Chemical and Electrical Changes induced by Light.

THE issue of NATURE for August 30 (p. 455) contains an abstract of a paper read before Section A of the British Association by Sir Wm. Ramsay and Dr. J. F. Spencer on the chemical and electrical changes induced by ultraviolet light, in which the "fatigue" shown by certain surfaces is discussed. I have for some time been engaged in an investigation of the fatigue shown by metals for the photoelectric effect, and have made a careful examination of the rate at which the photoelectric current decays in the case of a zinc plate, polished or amalgamated. A large Nernst lamp supplied with current from storage cells was used to give a steady source of light. The decay immediately after exposure to the light was very rapid, but after about twenty minutes became much slower. For a change taking place according to the "compound interest law," as in the case of a monomolecular chemical reaction or a single purely surface effect, we know that the curve can be represented by an exponential term involving the time. In the case of zinc, I find that the activity at any instant can be represented with considerable accuracy by the sum of two exponential terms. It is possible to interpret this result somewhat on the lines followed by Rutherford in explaining the decay of the excited activity of radium or thorium, by supposing that a succession of changes takes place.

Similar results have been obtained in the case of aluminium, and also with specimens of coloured fluorspar. In the latter case the colour is attributed to the presence of particles of reduced metal.

It is interesting to note that the longer waves of light tend to produce a change in the opposite sense, so that the rapid decay at first observed on exposure to light may be followed by a small increase in activity unless the long waves are absorbed by a solution of alum.

These experiments were carried out partly in the laboratory of Lord Blythswood, to whom my thanks are due, and partly in the Wheatstone Laboratory of King's College.

H. S. ALLEN.

King's College, London, September 21.

The Rusting of Iron

THE experiments made by Mr. J. Newton Friend, and described by him in NATURE of September 27, confirm similar experiments previously made by me, and furnish further evidence that the rusting of iron is primarily a result of acid attack. That cast iron, a very complex material frequently containing a high percentage of sulphur and phosphorus, decomposes hydrogen peroxide "with astonishing rapidity," and that the metal becomes covered with rust in a few minutes, is not, however, to be referred to catalytic action, as Mr. Friend suggests, but is a consequence of the formation of acids by the oxidation of some of the impurities present in the iron, and of the subsequent electrolytic action. As Mr. Friend says, "the purer the iron the less is the action of the peroxide upon it," which is another way of stating that the intensity of action will be determined by the amount of acid formed on the surface of each particular sample of metal when in contact with the peroxide.

Cast iron is known to oxidise in air more readily than wrought iron, and this is probably due to the former containing impurities which on oxidation yield acids. The rust formed on cast iron exposed to air often contains appreciable quantities of combined sulphur.

The fact that cast iron is attacked by water in absence of air, becoming darker in colour, whilst pure iron under identical conditions remains unchanged, may also be referred to the production of a minute quantity of acid. In this case the acid is not formed by oxidation, but it is probably hydrogen sulphide resulting from the interaction of sulphides, such as silicon sulphide, contained in the crude iron, with water. GERALD T. MOODY.

Central Technical College, October 1.

Remarkable Rainbow Phenomena.

MAY I be permitted, with reference to Mr. Spence's observation of a remarkable rainbow, described in your issue of September 20, to direct attention to a number of phenomena of the same kind observed in Holland during the last ten years, and published by the Dutch Meteorological Institute in *Onweders, Optische Verschijnselen enz.* At Fort William, also, on August 16, 1887, a phenomenon of this sort was seen, a drawing of which is to be found in Trans. Roy. Soc. Edin. (vol. xxxiv., p. xvii, Fig. 17). Readers of NATURE will find an observation of a double rainbow, with drawing, similar to the oval described by Mr. Spence, made by Prof. Tait on September 11, 1874, in the issue of October 1, 1874, with a comment by Maxwell upon it.

The explanation of the phenomenon is simple, and seems to have been first given by Rubenson. The upper of the two ordinary and the two secondary bows is generated by rays which enter the raindrops after reflection from a level of water situated behind the observer. It is obvious that the altitude of the ordinary rainbow being $42^\circ - h$, the altitude of the one generated by reflection will be $42^\circ + h$, h being the sun's altitude; the same holds good for the secondary rainbow. The centres of all the bows lying in the same vertical, it is clear that the two ordinary bows and the two secondaries touch each other at the horizon. For further information see my "Meteorologische Optik" (pp. 491 and 555). J. M. PERNTER.

Vienna, September 28.

Fugitive Coloration of Sodalite.

WITH reference to the properties of Indian sodalite shown by Mr. T. H. Holland at the York meeting of the British Association (September 27, p. 550), will you permit me to point out that, although not generally noticed in the textbooks, the change of colour referred to is not peculiar to the Rajputana mineral. The first sodalite discovered had the same property, and Giesecké, under date August 28, 1806, records the occurrence of "pfirsichblüthenrothfarbene" sodalite from Kangerdluarsuk, in Greenland, "welche die hohe Farbe auf frischem Bruche sogleich beinahe ganz verliert." The same observation was made independently by Allan (Thomson's "Annals of Philosophy," 1813, vol. i., p. 104); but I am not aware that there is any record of a recovery of the lost colour, which Mr. Holland appears to have observed.

JAS. CURRIE.

Edinburgh, October 1.

THE QUATERCENTENARY CELEBRATIONS OF THE UNIVERSITY OF ABERDEEN.

THE quatercentenary celebrations of the University of Aberdeen, which included the opening of the new buildings at Marischal College by their Majesties the King and Queen, were favoured by a week of uninterrupted sunshine, which quickened everyone's pulse and gave splendour to the proceedings. There were many remarks on the forethought of the University in conferring the honorary degree of Doctor of Laws on the director of the Meteorological Office.

On the morning of Tuesday, September 25, there was a solemn service of commemoration in the chapel at King's College—that priceless heritage founded by Bishop Elphinstone in 1500. In the afternoon there was a remarkable procession through a mile of crowded streets, by a circuitous route from Marischal College to the temporary Strathcona Hall, built for the celebrations by the generous Chancellor. This pageant, almost iridescent with robes of many colours, included the University authorities and staff, the Town Council, the delegates and guests, the honorary graduates, the general council, and students. It was a striking spectacle, greatly appreciated by the keenly interested and courteous crowds, a quaint intertwining of town and gown.

In the Strathcona Hall, the delegates from sister universities and learned institutions all over the world presented congratulatory addresses, and representative men made brief speeches. Thus the Vice-Chancellor of Oxford spoke for Britain, Principal Peterson for dominions beyond the seas, Prof. J. William White for the United States, Prof. Becquerel for France, Prof. Deissmann for Germany, Prof. Höffding for Denmark, Prof. Einthoven for Holland, Prof. Lanciani for Italy, Prof. Scheviakoff—a zoologist for Russia, and Prof. Matsumura—a botanist—for Japan, and there were many others. The huge audience of 4000 showed enthusiastic interest in the famous men who filed past, especially in those who are familiar to all, such as Sir Oliver Lodge, Sir William Turner, and Sir Archibald Geikie.

The great event of Wednesday was the conferring of honorary degrees on a phalanx of intellectual giants, who came from all quarters of the world to do honour to, and be honoured by, the ancient University of Aberdeen. They included, as the Dean of the Faculty of Laws felicitously expressed it,

"explorers, discoverers, inventors; some who have all but solved the mysteries of the natural universe or of the animal frame, others who have illuminated the even greater depth of mind, others who have successfully grappled with controversies of history or the not less complex problems of national institutions and international relations; men of thought and action, poets, musicians, and philosophers, great administrators, great rulers, and judges."

The list is too long to be quoted *in extenso*, but we may note some of those who are especially concerned with science in the wide sense. It may be noted that a few who were expected were unavoidably absent, such as Signor Marconi, who was referred to by the promoter as "the annihilator of time"; Dr. Dohrn, of the Naples Zoological Station; and Prof. Lombroso. Among those upon whom the degree was conferred were the following:—

Richard Anschutz, professor of chemistry, Bonn; Henri Becquerel, professor of physics, Paris; Sir James Crichton-Browne, Kt., Lord Chancellor's Visitor in Lunacy; Casimir de Candolle, Geneva; Frank Wigglesworth Clarke, chief chemist, U.S. Geological Survey, Washington; Yves Delage, professor of zoology and comparative anatomy, Paris; J. Deniker, librarian of the Museum of Natural History, Paris; W. Einthoven, professor of physiology, Leyden; Herbert Mackay Ellis, Director-General, Naval Medical Service, London; Arthur J. Evans, keeper of the Ashmolean Museum, Oxford; Andrew Russell Forsyth, Sadlerian professor of pure mathematics, Cambridge; Sir Archibald Geikie, secretary to Royal Society; Arnold Hague, U.S. Geological Survey, Washington; H. J. Hamburger, professor of physiology, Groningen; Edward Hjelt, professor of chemistry, Helsingfors; Harald Höffding, professor of philosophy, Copenhagen; Ferdinand Hueppe, professor of hygiene, Prague; Howard A. Kelly, professor of gynæcology, Johns Hopkins University, Baltimore; Surgeon-General Sir Alfred Keogh, K.C.B., Director-General, Army Medical Service; Rudolf E. Kobert, professor of pharmacology, Rostock; Casimir Kostanecki, professor of anatomy, Cracow; Hugo Kronecker, professor of physiology, Bern; Sir Francis H. Laking, Bart., G.C.V.O., physician in ordinary to His Majesty the King and the Prince of Wales; Commandatore Rodolfo Lanciani, professor of ancient topography, University of Rome; Charles Rockwell Lanman, professor of Sanskrit, Harvard University; Gustavus Mittag-Leffler, professor of mathematics, Stockholm; Oscar Liebreich, professor of pharmacology, Berlin; Sir Norman Lockyer, K.C.B., director of Solar Physics Laboratory, South Kensington; Sir Oliver Lodge, Kt., Principal of Birmingham University; Friedrich Loffler, professor of hygiene, Greifswald; Donald Macalister, president, General Medical Council; A. B. Macallum, professor of physiology, Toronto; Sir John Macfadyean, Principal of the Royal Veterinary College, Camden Town, London, N.W.; Lord M'Laren, vice-president, Royal Society of Edinburgh; Jinzo Matsumura, professor of botany, University of Tokyo, Japan; His Serene Highness Albert Honore Charles, Prince of Monaco; Wilhelm Ostwald, professor of chemistry, Leipzig; Edmund Owen, vice-president, Royal College of Surgeons of London; W. M. Flinders Petrie, professor of Egyptology, University College, London; Rev. George E. Post, professor of surgery in Johanite Hospital, Beirut; Sir Richard Douglas Powell, Bart., K.C.V.O., president of the Royal College of Physicians, London; Salomon Reinach, professor of archæology, Paris; Guglielmo Romiti, professor of anatomy, Pisa; Sir Henry E. Roscoe, late professor of chemistry, Owens College, Victoria University; Major Ronald Ross, C.B., Liverpool School of Tropical Medicine; Vladimir Scheviakoff, professor of zoology, St. Petersburg; Jakob Schipper, professor of English philology, Vienna; Dukinfield Henry Scott, hon. keeper, Jodrell Laboratory, Kew Gardens; William Napier Shaw, director of the Meteorological Office, London; Joseph J. Thomson, Cavendish professor of experimental physics, University of Cambridge; Frederick Trendelenburg, professor of surgery, University of Leipzig; Sir William Turner, K.C.B., principal of University of Edinburgh; Giuseppe Veronese, professor of analytical geometry, Padua; Hugo de Vries, professor of physiological botany, Amsterdam; J. William White, professor of surgery, Pennsylvania University; J. W. van Wijhe, professor of anatomy, Groningen, Holland; Sir John Williams, Bart., K.C.V.O., late professor of midwifery, University College, London.

The proceedings concluded with a speech by the Chancellor, who in the course of his address is reported by the *Times* to have said:—

"The presence of so many distinguished men representing universities and learned societies from all parts of the world might suggest, if this were the occasion to deal with it at length, a comparison of the aims and objects which we cherish here and the methods by which we seek their accomplishment with those of similar institutions in other countries. Let me say, to begin with, that Scotland is proud of her universities, their close connection with the national life, their free and open constitution, their services to science and letters, their stimulating influence—especially of late years—on the schools of the country, and the manner in which, in spite of great difficulties, they have kept before them lofty and high standards. All the countries of the world have each their own type of national university. There are, among many others, the

English type, the German type, and the American type. We have no reason to be ashamed of the Scottish type. But while it is legitimate for us, especially at the celebration of our 400th birthday, to plume ourselves on work done and service rendered, we must not forget that others also have been making progress, and are even now passing us in the race of efficiency. Scotland is no longer the only country in the world that can justly boast that its main industry is education; and our universities have still, perhaps, something to learn in the way of relegating a greater proportion of their work to the practical activities of life. I do not speak from a merely utilitarian point of view, and I know that it is the proper function of a university to foster even those studies which may be described as ends in themselves. If it were not for what universities do in cherishing abstract and theoretical learning, some of the practical applications of that learning resulting in the great triumphs of modern scientific activity would never have been made. I know also that the universities, for example, of the New World have something to learn from those of Europe in the direction of more solid attainment and a higher standard, at least in certain departments of study. But speaking for the moment as one who has lived for many years on the American continent and has watched with close attention the growth of one of our greatest universities in Canada, I may be allowed to record my conviction that universities on the other side of the Atlantic enjoy a considerable advantage in the ease and readiness with which, unhampered as they are by any venerable traditions, they can adapt themselves to the practical needs of the various constituencies which they seek to serve. They found out long ago that law and medicine and theology are not the only legitimate points of academic study; and in their faculties of applied science they are training their young men to do work that is most loudly called for. They have never accepted the view that universities must necessarily be institutions cloistered and apart from the main current of public life and service. On the contrary, they make a training for citizenship and for public usefulness the basis and foundation of much of their educational activity. The reward they have is that—fully as much as we do here—they find their *alumni* in every walk of life, not in the 'learned professions' only; and some of the most notable benefactions which the American universities have lately received come from men whose desire it is to connect them still more closely with practical work. As a recent illustration of this spirit, let me refer to the great gift that was made the other day by my friend Sir William Macdonald to McGill University, Montreal. It consists of a college of agriculture situated about ten miles outside the city, and comprises, besides all the necessary buildings erected in palatial style, some six hundred acres of ground. The whole benefaction amounts to some 600,000*l.*, and secures to the agricultural interests of the country that they shall be developed hand in hand with those of a university which has already done so much for engineering and other practical sciences."

At the various festive meetings of the crowded four days—the receptions at the two colleges and at the Art Gallery, the Town Council banquet, and Lord Strathcona's gigantic dinner-party of two thousand four hundred guests—there was renewed opportunity to realise the cosmopolitan nature of the concourse and the generosity of the response made to the University's invitation. Among the famous men who were present as delegates we may note the following, taking them in order of the institutions represented:—

(1) Great Britain and Ireland:—Universities: Oxford, Prof. Henry Goudy, Prof. Arthur Thomson; Cambridge, Prof. Henry Jackson, Dr. James Adam, Dr. William L. Mollison; Durham, Rev. Dr. Henry Gee (Master of University College, Durham); Edinburgh, Prof. Alex. Crum Brown, Prof. George Chrystal, Prof. James Cossar Ewart, Sir Thomas Richard Fraser, Dr. Thomas Smith Clouston; Glasgow, Sir T. McCall Anderson, Prof. Archd. Barr, Prof. John Cleland, Prof. John Ferguson, Prof. Samson

Fig. 1.—View of Marischal College. (From over the top of the houses in front.)

Gemmell, Emeritus Prof. John G. McKendrick; Leeds, Dr. Nathan Bodington (Vice-Chancellor); Liverpool, Mr. Alfred W. Winterslow Dale (Vice-Chancellor); London, Dr. Augustus Desiré Waller; Manchester, the Victoria University, Dr. Alfred Hopkinson (Vice-Chancellor); St. Andrews, Lord Balfour of Burleigh (Chancellor), Dr. Andrew Carnegie (Rector), Principal James Donaldson, Very Rev. Principal Alexander Stewart, Principal John Yule Mackay (Dundee), Prof. James Musgrove, Prof. John E. A. Steggall (Dundee); Wales, Mr. Henry Rudolf Reichel (Vice-Chancellor). Colleges and Learned Societies:—Bangor, University College of North Wales, Prof. Philip J. White; Bristol, University College, Principal C. Lloyd Morgan; Dublin, Royal College of Physicians, President Sir William J. Smyly; Royal College of Surgeons, President Henry Rosborough Swanzy; Edinburgh, Royal College of Surgeons, President Charles Watson MacGillivray; Glasgow, West of Scotland Agricultural College, Principal Robert Patrick Wright; London, British Academy, Prof. Henry Francis Pelham, President of Trinity College, Oxford; British Medical Association, Mr. George Cooper Franklin (President); Charing Cross Hospital Medical College, Dr. William Hunter; Guy's Hospital Medical College, Dr. Frederick Taylor; Inner Temple, Hon. Mr. Justice Grantham; King's College, Rev. Principal Arthur Cayley Headlam; London Hospital Medical College, Dr. Wm. Bulloch; Middlesex Hospital Medical College, Mr. Andrew Clark; Pharmaceutical Society of Great Britain, Mr. Alderman R. A. Robinson (President); Royal Academy of Arts, Mr. John Macallan Swan, R.A.; Royal College of Physicians, Sir Richard Douglas Powell, Bart. (President); Royal College of Science, Prof. W. Gowland; Royal College of Surgeons, Mr. Edmund Owen (Vice-President); St. Bartholomew's Hospital Medical College, Sir Dyce Duckworth; University College, Principal T. Gregory Foster.

(2) British Dominions beyond the Seas:—Canada: Dalhousie University, Halifax, N.S., Prof. Jas. G. MacGregor; University of Toronto, Prof. A. B. Macallum. Africa: South African College, Prof. P. Daniel Hahn. Australia and New Zealand: University of Tasmania, Prof. John Walter Gregory. India: Calcutta, Asiatic Society of Bengal, Colonel Alf. Wm. Alcock.

(3) Other countries:—America (South): University of Ecuador, General Don Emilio M. Teran. Austria-Hungary: University of Vienna and Imperial Academy of Sciences, Vienna, Prof. Jakob Schipper; University of Buda Pesth, Prof. Ignacz Goldziher; Bohemian University of Prague, Prof. Vaclav E. Mourek; German University of Prague, Prof. Ferdinand Hueppe. Belgium: University of Brussels, Prof. Count Eugene Goblet D'Alviella. France: Institut de France, Prof. Émile Boutroux, Prof. Salomon Reinach. Germany: University of Berlin, Prof. Hans Dellbrück; University of Greifswald, Prof. Friedrich Löffler. Italy: University of Padua, Prof. Giuseppe Veronese. Norway: University of Christiania, Prof. A. Taranger. Russia: St. Petersburg, Imperial Academy of Military Medicine, Prof. Henry Turner. Sweden: University of Upsala, Prof. Henrick Schück (Rector); Stockholm, Royal Swedish Academy of Sciences, Prof. Einar Lönnberg. Switzerland: University of Geneva, Prof. Charles Borgeaud; University of Bern, Prof. Hugo Kronecker; University of Zürich, Prof. Theodor Vetter.

Among the guests of the University other than delegates there were many illustrious men of science, such as

(1) England:—Dr. T. Clifford Allbutt, regius professor of physic, University of Cambridge; Dr. Henry E. Armstrong, professor of chemistry, Central Technical College, London; the Right Hon. Lord Avebury, F.R.S.; Sir Robert S. Ball, professor of astronomy and geometry, Observatory, Cambridge; Colonel David Bruce, C.B.; Dr. Wm. Burnside, professor of mathematics, Royal Naval College, Greenwich; the Lord Archbishop of Canterbury; Prof. W. Watson Cheyne, professor of surgery, King's College, London; Sir William Crookes; Sir Edward Elgar; Dr. Herbert MacKay Ellis, Director-General, Naval Medical Service; Dr. Arthur J. Evans, keeper of the Ashmolean Museum, Oxford; Sir John Evans, K.C.B.; Prof. A. R. Forsyth, Sadlerian professor of pure mathematics, Trinity College, Cambridge; Right Hon. Sir Edward Fry, F.R.S.; Dr. Richard Tetley Glazebrook, director of the National Physical Laboratory, Bushy House, Teddington; Dr. A. S. F. Grünbaum, professor of pathology, University of Leeds; A. D. Hall, director, Rothamsted Agricultural Experiment Station, Harpenden, Herts; Prof. Joseph Larmor, secretary of the Royal Society; Sir Norman Lockyer, K.C.B.; Dr. Alexander Macalister, professor of anatomy, University of Cambridge; Dr. Donald Macalister, president, General Medical Council; Major Percy Alex. MacMahon, secretary, British Association; Prof. Raphael Meldola, president of the Chemical Society; J. E. Quibell, Bedrashein, Egypt; Sir Wm. Ramsay, K.C.B., professor

FIG. 2.—Front of Marischal College Buildings, looking southward.

of chemistry, University College, London; Sir Henry E. Roscoe, late professor of chemistry, Victoria University; Major Ronald Ross, C.B., Liverpool School of Tropical Medicine; Rev. Archibald H. Sayce, professor of Assyriology, University of Oxford; Dr. George D. Thane, professor of anatomy, University College, London; Dr. Thomas E. Thorpe, C.B., director of Government Laboratories, London; Dr. J. A. Voelcker, chemist to Royal Agricultural Society of England.

(2) Scotland:—William S. Bruce, leader of the Scottish Antarctic Expedition (1902–4), Edinburgh; Sir Henry Craik, K.C.B.; the Right Hon. the Earl of Elgin, K.G., G.C.S.I., LL.D., D.C.L.; Right Hon. Richard Burdon

Haldane, M.P., Secretary of State for War; Sir John Murray, K.C.B.; Sir J. A. Russell, inspector of anatomy for Scotland.

(3) Ireland:—Dr. Jas. Little, professor of physic, University of Dublin; Prof. John Pentland Mahaffy, senior fellow, Trinity College, Dublin, late professor of ancient history.

(4) Other Countries:—Yacoub Artin Pasha, Under-Secretary of State for Education, and president of the Institute of Egypt, Cairo; Dr. G. Stanley Hall, professor of psychology, Clark University, Worcester, Mass., America; Prof. H. J. Hamburger, professor of physiology, Groningen; Prof. O. Kellner, K. S. Landwirthschaftliche Versuchsstation, Möckern, Leipzig; Prof. Oscar Liebreich, professor of pharmacology, University of Berlin; Prof. Friedrich Trendelenburg, professor of surgery, University of Leipzig.

The great event of Thursday was the opening of the new buildings at Marischal College by the King and Queen. The whole of the large quadrangle was filled with a sea of faces, and Dr. Marshall Mackenzie's "granite miracle" was the subject of universal admiration. The Principal read an address from the University, and His Majesty in a strong voice declared the buildings open. The Rector asked leave to present the following gentlemen:—

Mr. Alexander M. Gordon, Mr. Alexander Wilson, Dr. William Dey, Dr. Angus Fraser, Dr. David Littlejohn, Dr. Albert Westland, Prof. Matthew Hay, Prof. John Harrower, Prof. Neil J. D. Kennedy, Prof. Robert W. Reid, Prof. James W. H. Trail, Prof. Henry Cowan, Prof. James B. Baillie, Prof. Stephenson, Prof. Charles Niven, Prof. David J. Hamilton, Prof. Alexander Ogston, Prof. William M. Ramsay, Mr. Patrick Cooper, Mr. Theodore Crombie, Dr. John Fleming, Mr. Alexander O. Gill, Mr. David M. M. Milligan, Mr. James Murray, M.P., Mr. Andrew R. Williamson, Mr. A. Marshall Mackenzie, A.R.S.A., the architect, and Mr. W. Wilfred Campbell.

Their Majesties afterwards visited the parts of the new buildings devoted to agriculture and modern languages, and showed great interest in their equipment.

The success of the University celebrations surpassed even the most sanguine expectations, and was attributable to a combination of factors. The weather, though technically autumnal, was better than the best Aberdonian summer. The solemn commemoration of a past four hundred years happily coincided with entering into the possession of a new legacy which makes the University's outlook on the future hopeful. The response to the University's invitation on the part of sister institutions and her own sons and daughters was exceedingly hearty. What began as a primarily academic ceremony broadened out into a civic festival, partly through the kindness of their Majesties, partly through Lord Strathcona's princely generosity, and partly because of the cordiality of the relations between town and gown. But there can be no overlooking the fact that the success of the celebrations was the natural reward of most thoughtful and detailed organisation, of putting brains as well as goodwill into an arduous task. *Vivat, crescat, floreat Universitas Aberdonensis.*

TWO BOOKS ON ANGLING.[1]

IN "Salmon Fishing" Mr. Hodgson deals with the spirit, rather than the technique, of the sport. The first half-dozen chapters of the book are a series of essays on different aspects of fishing, and they are written in a most attractive manner and provide excellent reading. In the chapter on the "Elusive quarry," for instance, the instincts, or rather whims, of the salmon are written about very pleasantly. Mr. Hodgson discusses the old question as to whether or not the salmon feeds in fresh water, and is inclined to think that when the fish rises to a fly it does so with the intention of eating. Evidence against this contention was collected a few years ago by the Scottish Fishery Board, and it was shown that the epithelium of the stomachs of salmon in fresh water was in a catarrhal condition that made digestion impossible. It is, on the whole, the simplest solution of this question that the salmon, when it rises to a fly, does so urged by some kind of sporting instinct.

Non-migratory Danube salmon, and British fish, in the Thames. The small fish, natives in British waters, are four times the age of the less small—an alien from the Danube. From "Salmon Fishing," by W. Earl Hodgson.

Mr. Hodgson's book is, however, very practical as well as entertaining. Three chapters are devoted to an account of the salmon rivers of the United Kingdom, and in one very useful chapter there is an excellent account of salmon passes and some useful

[1] "Salmon Fishing." By W. Earl Hodgson. Pp. xi+314. (London: A. and C. Black, 1906.) Price 7s. 6d. net.

"The Science of Dry Fly Fishing." By Fred. G. Shaw. Pp. xii+142. (London: Bradbury, Agnew and Co., Ltd., 1906.) Price 3s. 6d. net.

suggestions as to their improvement. The account of the British and Irish rivers is rather depressing reading. Almost everywhere, save in a few favoured counties, there is the tale of pollution. We agree with Mr. Hodgson that this is preventable. The crude by-products of various manufactures need never be turned into fishing rivers such a thing, for instance, as the reckless discharge of sawdust into a stream, and the consequent destruction of hosts of trout, ought certainly not to be permitted. With modern methods of septic purification it is a scandal that salmon rivers and streams should still be the repositories of crude sewage; but local sanitary authorities are difficult to move, and so far as the prevention of the pollution of rivers is concerned the law "is a hass."

The book is excellently printed and illustrated. Particular praise should be given to the series of seven plates at the beginning of the volume illustrating eighty typical salmon flies. The colouring and printing of these plates leave nothing to be desired. Altogether Mr. Hodgson's book should be a very welcome addition to the sportsman's library.

In "Dry Fly Fishing" Mr. F. G. Shaw makes a creditable attempt to make clear that which he terms the "science" of trout fishing. Chapters i. and ii. give directions how, when, and where to cast a trout fly. Chapter iii. deals with the selection of the fly, and includes a discussion of the range of vision of the fish. Chapter iv. gives a useful account of some aspects of pisciculture, and chapter v., "The necessities of the trout fisherman," is devoted to a consideration of the "gear" necessary for the craft. The book is abundantly illustrated. If the niceties of trout fishing can be taught by means of diagrams and practical directions, then Mr. Shaw's book ought to be very useful; but, as he says himself, "It is of no use to read books in order to determine your actions when actually fishing. Common sense is the most valuable guide." Nevertheless, the experience of others is always interesting, and no doubt the tyro, and even those of greater knowledge, will learn much from this work.

J. J.

PROF. LUDWIG BOLTZMANN.

ONLY two years ago Dr. Ludwig Boltzmann, professor of physics in the University of Vienna, celebrated his sixtieth birthday. On that occasion a "Festschrift" was presented to him containing papers by about 125 physicists from all parts of the world. The announcement of Prof. Boltzmann's death, which was reported in the London papers of September 8, will be received with regret, not only by physicists of repute, but by every student who has attempted to gain an insight into the mysteries of molecular physics.

Ludwig Boltzmann was born on February 20, 1844. Before he was twenty-two years old, on February 8, 1866, he read a paper before the Academy of Sciences of Vienna entitled "Ueber die mechanische Bedeutung des zweiten Hauptsatzes der Wärmetheorie." The opening sentences of the paper may be freely translated as follows:—

"The identity of the First Law of Thermodynamics with the principle of *vis viva* has long been known, on the other hand the Second Law occupies a peculiarly exceptional position, and its proof is based on methods which are not only uncertain here and there, but are in no case obvious. The object of this paper is to furnish a purely analytical and perfectly general proof of the Second Law of Thermodynamics, as well as to investigate the corresponding principle in Mechanics."

Little did the young Boltzmann imagine that the task he had thus set before himself would occupy his whole lifetime.

A year later, after having obtained the doctorate, and having been appointed assistant in the physical institute at Vienna, we find him writing on the number of atoms in a gas molecule and the internal work of gases.

In 1868 he published his first important paper on the law of partition of energy under the title of "Studien über das Gleichgewicht der lebendigen Kraft zwischen bewegten materiellen Punkte." The problem had been previously attacked by Maxwell, but Boltzmann soon found difficulties and objections arising out of Maxwell's treatment, and it was one of the objects of the paper to place the theory on a more satisfactory basis. A second paper on the same subject ("Weitere Studien") was published in 1872, and in it the important theorem now known as Boltzmann's "minimum theorem" or the "H-theorem" first saw the light. That this theorem is not independent of assumed hypotheses has been amply shown by discussions in NATURE and elsewhere in which Watson, Burbury, and other physicists took part early in the 'nineties; but, granting these premises, it is proved that in a system of molecules a tendency exists to assume an equilibrium distribution of energy analogous to the tendency to heat equilibrium in a material gas. It was not until 1892 that Boltzmann published a third part to his "Studien." In it he deals with difficulties that had been raised in the discussion referred to in connection with the assumption that the kinetic energy of the system could be reduced to a sum of squares, and he also examines certain test cases of the kinetic theory proposed by Lord Kelvin.

In 1875 Boltzmann, then a corresponding member of the Vienna Academy of Sciences, treated the problem for the case of a system of molecules in a field of external force.

From Vienna Boltzmann went to Graz, where he was appointed professor in the university. After going there he wrote, in 1876, a paper on the integration of the equations of molecular motion, and several other minor papers on the kinetic theory. A fresh line was started in 1877, although the underlying idea had been suggested by Boltzmann in 1871, and employed by Dr. Oskar Emil Meyer in his book of 1877. This was the application of the theory of probability to the problem of energy-partition. The method of treatment adopted is highly instructive; Boltzmann starts with considering a system of molecules the energy of each of which can only have one or other of a series of discrete values—a series of counters marked 1, 2, 3 . . . might be used in illustration—and he investigates the most probable distribution of energy for a number of them drawn at random. From this simple case he is led by gradual stages to the more complicated case of a gas the molecular state of which is specified by generalised coordinates.

In 1880 to 1882 Boltzmann published long and important papers on viscosity and diffusion of gases, in which the consequences of Maxwell's assumption of the "inverse fifth" law of intermolecular force were fully discussed. In 1884 he was evidently attracted by Helmholtz's work on monocyclic systems, and lost no time in applying the method to the kinetic theory. In this connection the possibility of building up statistically monocyclic systems was considered. But a further application suggested itself in the possibility of representing thermodynamic and other phenomena by means of mechanical models. In his "Vorlesungen über Maxwell's Theorie," published in 1891, Boltzmann makes use, not only of monocycles, but also of what he calls "bicycles," illustrating the phenomena of mutual induction of electric currents.

In 1885 Boltzmann was raised from "corresponding" to ordinary member of the Vienna Academy. He remained at Graz until about 1891, when he was called to Munich. A year or two later he visited England and called on the present writer at Cambridge, and thus a personal friendship sprang up. In 1894 the British Association meeting at Oxford, with its memorable field-day on the kinetic theory, came simultaneously with Lord Rayleigh and Sir William Ramsay's announcement of the discovery of argon. The part which Prof. Boltzmann took in these discussions will long be remembered. He received an honorary degree, and expressed some amusement at being made a Doctor of Laws. "It were better they made me Doctor of Science," he remarked. It was, however, pointed out that as an authority on the laws of thermodynamics the title was a fitting one.

In 1895 Boltzmann was transferred from Munich to Vienna, where he resided until his death, with one exception. In 1904 he was called to the University of Leipzig, and actually went there for a short time, but the change did not suit him, and he was back again in Vienna almost immediately.

In 1899 he was elected corresponding fellow of our Royal Society, and allusion has already been made to the universal and widespread enthusiasm shown over his diamond jubilee five years later.

Those who knew Boltzmann will remember the pair of heavy, highly-powerful spectacles resting on a deep groove in his nose. For many years his eyesight had been failing, and he found it increasingly difficult to complete the many researches which were on his mind. He appears to have ended his life during a summer holiday at or near Abbazia, a neighbourhood which he frequently visited with his wife and family.

We have alluded to some of Boltzmann's earlier writings more or less in chronological order. One of his most important later works is his book "Vorlesungen über Gastheorie" (Leipzig: Barth), the first volume of which bears the date 1895 and the second 1898. It fills an important gap in the literature of the kinetic theory, and renders much of Boltzmann's own work more accessible to general readers than it would be if his separate papers had to be consulted. While Boltzmann's chief energies were concentrated on the difficult problems of the kinetic theory, other branches of physics were by no means neglected. In evidence we have his book of lectures on Maxwell's theory, papers on Hertz's experiments, and an address on the methods of theoretical physics. Artificial flight also interested the Vienna physicist, who some years back gave a discourse on the subject, illustrated by models. Among his recreations allusion may be made to music. His thick fingers descending on the keys of the piano well knew how to produce those variations in timbre which are understood in Germany, but the want of which makes English people often say that the piano is devoid of soul. He would often play in trios with his son and eldest daughter.

It may be that the kinetic theory of gases is even now regarded as being less complete and perfect in itself than many other physical theories, such as the electromagnetic theory of light. But the study of irreversible phenomena stands on a far higher order of difficulty than that of purely reversible effects. If it has been impossible to build up a statistically irreversible system out of reversible elements without making *some* assumptions, we are, at all events, in possession of theories of molecular phenomena in which the assumption in question is of the simplest and most self-evident character, and the agreement with experiment as close as could be expected. These theories are in a very large measure results of the labours of Ludwig Boltzmann.

G. H. BRYAN.

NOTES.

THE results of the Gordon-Bennett balloon race, as announced in the daily papers, show that the sixteen competitors who started from Paris on Sunday afternoon all landed within a belt comprised between the meridians of 1° east and 1° west of Greenwich. The longest and most northerly journeys were those of Lieut. Lahm (U.S.A.), who landed near Whitby—about 400 miles from Paris—after a journey of $23\frac{1}{2}$ hours; Signor Vonwiller (Italy), near Hull; Comte de la Vaulx (France), near Walsingham, four miles from the Norfolk coast; and the Hon. C. S. Rolls, near Sandringham. A second group landed in the south of England, this group comprising M. J. Balsan (France), at Singleton, near Chichester; Prof. Huntington (Great Britain), at Sittingbourne, Kent; and Captain Kindelan (Spain), near Chichester. The next group were carried from Paris in directions between west and north-west, and landed on or near a strip of the French coast extending from Dieppe to near Caen. These were Herr Scherle (Germany), near Dieppe; Mr. F. H. Butler (England), Comte de Castillon (France), and Señor Salamanca (Spain), all three at Blonville, near Trouville; Baron von Hewald (Germany), at Coudé, near the mouth of the Seine; Captain von Abercron (Germany), at Villers-sur-Mer; and Lieut. Herrera (Spain), at Cabourg. A little south of this group, M. Santos Dumont landed at Broglie, after having met with an accident to his arm. A different course was followed by the Belgian competitor, M. van den Driesche, who landed at Bretigny, a place $19\frac{1}{2}$ miles south of Paris, soon after midnight.

SIMULTANEOUSLY with this competition, another of the same character, in which seven balloons took part, started from Milan. This was one of a number of aëronautical competitions organised during the month of September in connection with the exhibitions, other contests being arranged for aëroplanes, machines, and models, both with and without motive power. Whether owing to this clashing or to other causes, the aëronautical pavilion at the Milan Exhibition shows a remarkable dearth of exhibits, the only really successful attempt at a complete and well-organised exhibit being that of the Prussian Aëronautical Observatory in Lindenburg. These exhibits mostly illustrated apparatus for the meteorological study of the upper layers of the atmosphere, and their systematic display under the charge of Prussian officials in their smart military uniforms only made the absence of other important exhibits the more conspicuous.

THE second International Conference on Wireless Telegraphy, which is now sitting in Berlin, is likely to prove of great interest and importance from both the national and commercial points of view. Delegates from nearly all countries have accepted the German Government's invitation, and are now in Berlin. The preliminary conference of 1903, which was also convoked by the German Government with the hope of securing general support for its contention—that intercommunication between ships fitted with wireless telegraphy apparatus and where stations should be made compulsory without regard to the system employed—ended in a protocol embodying the German view being signed by all the delegates attending the conference except those of Great Britain and Italy. The basis of the discussions at the present conference will be the protocol above mentioned, though further proposals arising out of the recommendations contained therein have been put forward. At first sight the proposition of universal intercommunication seems to have considerable attractions, but many difficulties will have to be overcome before it can be carried out. The present conference may, therefore, have greater issues and unforeseen results than are expected, and the scientific world will be especially interested, as should the proposed treaty be entered into by our delegates—who are drawn from the Post Office officials, the Army, and the Navy—future improvements in wireless telegraphy would be more or less confined to a specified basis. As to which is the best system of wireless telegraphy of the many now at work, the question is one that may well puzzle the delegates, and may take many years of practical working of wireless telegraphy before it can be satisfactorily answered.

A short description of a new method of colour photography, described by Prof. Lippmann before the Paris Academy on July 30, was given in Nature of August 30 (p. 459). Mr. F. Cheshire, writing from the Birkbeck College, London, states that Mr. Julius Rheinberg suggested in the *British Journal of Photography* of January 1, 1904, "a method which is, I think, identical for all practical purposes with that now proposed by M. Lippmann." We have referred Mr. Cheshire's letter to Prof. Lippmann, who, in the reply with which he has favoured us, expresses regret that he overlooked Mr. Rheinberg's article, and agrees that the method proposed in it is the same in principle as that described by him. Prof. Lippmann adds that about three years ago he obtained successful results by this method, using very imperfect apparatus, still in his laboratory, and a grating roughly made by hand. In July last he obtained a more suitable grating, and the results of his experiments with it were described in his recent paper.

The fifteenth International Geodetic Congress was held at Budapest last week. Sir George Darwin invited the congress to meet at Cambridge in 1909.

On September 27 a series of severe earthquakes was felt at San Juan de Puertorico, and a sharp and prolonged earthquake shock occurred at St. Thomas, Danish West Indies.

The Vienna correspondent of the *Daily Chronicle* announces that Herculaneum is to be excavated by the united action of England, France, Germany, Italy, the United States, and other countries.

To honour Prof. Ronald Ross, Prof. Boyce, and Dr. J. L. Todd, and in recognition of the decoration recently conferred on them by the King of the Belgians for services in research into tropical diseases at the Liverpool School of Tropical Medicine, the Lord Mayor of Liverpool gave a luncheon at the Town Hall on Monday. Sir Alfred Jones announced that the King of the Belgians has just subscribed the sum of 1000*l.* to the Liverpool School.

The first International Congress for Cancer Research met last week at Frankfurt-on-Main under the presidency of Profs. von Leyden, Czerny, and Ehrlich. All those invited to take part in the work of the congress are actively engaged in cancer research, and a number of important papers were contributed, so many, in fact, that discussion had to be restricted; and the clinical, experimental, and statistical branches of the cancer problem were fully represented. Their Royal Highnesses the Grand Duke and Grand Duchess of Baden were present at the opening ceremony.

The council of the Institution of Civil Engineers has, in addition to the medals and prizes given for communications discussed at the meetings of the institution in the last session, made the following awards in respect of other papers dealt with in 1905–6:—a Telford gold medal to Mr. G. A. Denny; a George Stephenson gold medal to Prof. W. E. Dalby; Telford premiums to Messrs. W. R. Baldwin-Wiseman, G. N. Abernethy, H. R. C. Blagden, M. R. Collins, and James Kelly; a Crampton prize to Mr. P. T. Gask. For students' papers the awards are:—Miller prizes to Messrs. Ralph Freeman, A. F. Harrison, A. J. Grindling, T. R. Grigson, J. W. D. Ball, and A. Morris. Mr. A. F. Harrison also gained the James Prescott Joule medal. The awards will be presented on Tuesday, November 6, when an inaugural address will be delivered by the president, Sir Alexander B. W. Kennedy, F.R.S.

The authorities of the Clifton Zoological Gardens, Bristol, have recently made considerable improvements designed for the increased comfort and display of their collections. Two years ago a new lion house was built, having the cages within communicating with four open-air ones iron barred on three sides. The animals placed in these cages showed so distinct a preference for the open air, and improved so materially, that the older range of houses has been entirely reconstructed, and was thrown open to the public on Saturday, September 22, for the first time. As now reconstructed, seven open-air cages are placed along the front of the old house, and communicate with the dens within. The cages are lofty, being between 10 feet and 12 feet in height, about 12 feet wide, and 14 feet long. They are supported upon a brickwork base 4 feet in height, and separated from the public by a stout iron rail, placed 3 feet away from the cage fronts. It is noteworthy that a Rhesus monkey was formerly kept in an outer cage in the gardens for quite a number of years, winter and summer alike, and fared well even in hard frost and snow. When taken into the monkey house, however, it quickly sickened and died.

The news of the death of Monsignor Molloy, Vice-Chancellor of the Royal University of Ireland and Rector of the Catholic University, Dublin, will be received with deep regret by all who knew him in Dublin and elsewhere. Mgr. Molloy was one of the delegates to the Aberdeen University celebrations, and died suddenly at the house of his host in Aberdeen on Monday morning. Dr. Molloy was born at Mount Tallant House, near Dublin, on September 10, 1834, so that he was in his seventy-third year. From 1874–1887 he was professor of natural philosophy in the Roman Catholic University College, Dublin. From an obituary notice in the *Times* we learn that toward the close of 1883 the bishops, who were the governing body of the University, transformed the old buildings in Stephen's Green to the Jesuit Order, and the Rev. W. Delany became president under the new *régime*. Dr. Molloy remained in residence in the college, and, putting his talents as a teacher at the disposal of the new administration, he succeeded Dean Neville, of Cork, as Rector of the University in the same year. During the last quarter of a century Dr. Molloy took an important part in the administration of Irish education. He acted on the Commission on Manual Training in Primary Schools, and filled the post of assistant commissioner under the Education Endowments Act. He was at the time of his death a member of the Intermediate Education Board. As a popular lecturer on scientific subjects Dr. Molloy had few equals in Ireland, and he was a frequent speaker at the lectures of the Royal Dublin Society, of the council of which he was a member. He was the author of several scientific and literary works, including "Geology and Revelation," published in 1870, and "Gleanings in Science," in 1888.

A devastating West India hurricane has quickly followed the China Sea typhoons noted in last week's issue. The permanent Atlantic anticyclone has recently occupied a position more over the south-western quarter of the ocean, while it has been flanked on its north-eastern side by the extensive and stationary high-pressure system which has remained centred over the British Isles for several days past. In these circumstances a disturbance developing anywhere in the neighbourhood of the West Indies would be unable to take the usual sweep round by the great American bight and Bermuda for the Banks of Newfoundland. Instead, an almost direct westerly course would have to be followed into the Gulf of Mexico. This is what appears to have been the case on September 26 and 27, when a violent hurricane, centred on the eastern side of the Gulf, ravaged the Southern States, the coastal regions in particular suffering severely. The tempest raised the waters of the Gulf so high that not only were the low-lying lands inundated, but the streets of Mobile, Pensacola, New Orleans, and other large towns were several feet under water. Numbers of lives were lost, and thousands of families rendered homeless. It is stated that at Pensacola every house along the water front for a distance of ten miles was wrecked, and Fort McCrae, a military station, was completely destroyed, nearly every soul perishing. In the various towns factories and warehouses were demolished, and their contents carried out to sea. There were hundreds of maritime casualties, many of them total losses. One navy vessel was carried 200 yards inland, and a large iron steamer forced through buildings to a distance of a block from the wharf. Inland there was great destruction amongst the cotton, sugar-cane, and other crops, while very considerable structural damage was occasioned by the violence of the wind. The storm is said to be the worst since the one which destroyed Galveston.

Mr. J. A. Reid, Bedford, has just published a reprint, price twopence, of Huxley's essay "Time and Life: Darwin's 'Origin of Species,'" which originally appeared in *Macmillan's Magazine* for 1859.

It is announced in the September number that the *Museum Gazette* will for some time to come take more notice of the "humanities," while attention will also be directed to some of the aspects of botanical studies. Articles on fish as food, a seaside museum, mushroom-eating, the potato-disease, and pea-pods, are included in the contents of the number before us.

With praiseworthy assiduity, Dr. W. L. Abbott, the well-known amateur collector, continues his zoological exploration of the Malay islands. One of the latest areas explored is the cluster of small islands lying between the Malay Peninsula and Sumatra, and collectively known as the Rhino-Linga Archipelago. The large series of mammal skins collected there is described by Mr. G. S. Miller in No. 1485 of the Proceedings of the U.S. National Museum, with the usual liberal allowance of nominal new species, based, in most cases at any rate, on what are nothing more than local phases. No. 1483 of the same serial is devoted to a review, by Mr. P. Bartsch, of the long-spired "urocoptid" land-shells from the American mainland in the collection of the museum, with the description of a number of new forms.

Although Japanese waters, according to Messrs. Jordan and Starks, in a paper published in the Proceedings of the U.S. National Museum (No. 1484), abound in flat-fishes, the most esteemed British representatives of that group, namely, the turbot and the sole, are unfortunately wanting in the far eastern islands, where, indeed, the genera Rhombus and Solea, as restricted by the authors, are absent. The authors make no mention of the respective values as food-fishes of any of the numerous species recorded. They regard the theory that the flounders are related to the Zeidæ, and that both groups trace their ancestry to the extinct Amphistiidæ, as an ingenious guess for which there is no positive warranty. In No. 1486 of the same publication Messrs. Jordan and Snyder discuss the Japanese killifishes (Pœciliidæ), of which only two species are at present known.

According to a writer in the September number of the *Zoologist*, hybrids between blackcock (or grey-hen) and the pheasant are by no means uncommon in England; in Scotland they are more rare, and on the Continent appear to be very unusual. In addition to a portion of Messrs. Clark and Rodd's notes on the birds of the Scilly Islands, the same issue contains a notice of a specimen of the pelagic fish *Scomber thunnina* taken off Yarmouth, being apparently the first of its kind recorded from British waters. There is also a notice of a "sea-monster" seen off the Irish coast. Judging from the sketch sent by one observer, it seems probable that the creature was a basking-shark (*Selache maxima*), unless, indeed, it could have been a straggler of the Indian basking-shark (*Rhinodon typicus*), which attains dimensions more nearly in accord with those estimated by one of the observers for the Irish monster.

We have received a copy of No. 45 of the Journal of the Straits Branch of the Royal Asiatic Society (June), which contains a number of articles on subjects connected with zoology, botany, folk-lore, native manufactures, and such like. Mr. C. B. Kloss communicates notes on the Sumatran pig recently described as *Sus oi*, in the course of which he points out that the species does not occur on the mainland of the Malay Peninsula, but only on the adjacent island of Pulo Battam, the fauna of which is essentially of a Sumatran type. The longest article in the issue is one by Dr. H. N. Ridley, giving an account of a recent expedition undertaken by himself to Christmas Island (Indian Ocean). The author was enabled to make considerable additions to the list of indigenous plants, and communicates some interesting observations on the changes which are taking place in the coast fauna and flora as the result of colonisation. Mr. R. Shelford continues his list of Bornean butterflies, while Mr. Kloss records a 30-feet python from Johore.

We have received the report on the Scientific Investigations of the Northumberland Sea-fisheries Committee for the year 1905. The delay in publication is due to an attempt to induce the Board of Agriculture and Fisheries to undertake the issue of the report. Although the attempt was unsuccessful, it is hoped that in the near future the Board will become more closely associated with fishery researches throughout the country. As the result of fourteen years' trawling experiments, correlated with Government statistics, and a review of the history of the local fisheries, the present report contains a much fuller account of the "white-fisheries" of Northumberland than has previously been possible. The experiments indicate that the stations are subject to gain and loss from the areas immediately outside, and that the inward movements include a certain number of deep-sea fish, especially plaice. When reduced to a common standard, the results demonstrate that while there was a steady improvement in the fish-population from 1892 to 1903, a decline has set in since the latter date. Recently the fish captured have been found to feed chiefly on sand-eels, in place of molluscs and crustaceans, due, apparently, to the scarcity of the two latter. The improvement in the flat-fishes of the district is attributed to protection, and it is considered that protection will likewise lead to a noticeable increase of crabs and lobsters. Important statistics are furnished with regard to the rate of growth and the migrations of flat-fish.

PROF. R. DE C. WARD contributes a valuable paper on the classification of climates to the July and August numbers of the Bulletin of the American Geographical Society. The chief systems of classification described are those of Supan, Köppen, Hult, and Ravenstein, and Prof. Ward comes to the satisfactory conclusion that the first of these is the best for general purposes. Teachers of geography will find this paper extremely useful.

THE present stage of development and the prospects of the magnesite mines of South Africa are described in the *Engineer* (vol. cii., No. 2646). They are situated between Kaapmuiden and Melelana, eighty-seven miles from Delagoa Bay and 300 miles from Johannesburg. The magnesite occurs in nearly vertical beds associated with serpentine in schists, and is worked in open cuttings. The magnesite is of good quality, and the mines have opened out an industry that is likely to be of considerable future importance.

IN the *Engineering Magazine* for September there are eight articles by prominent American engineers, the most striking being a warning by Dr. Louis Bell on the subject of over-specialisation in manufacturing methods. Standardisation, however desirable from a pecuniary standpoint, in the last resort means the cessation of active improvement. Labour-saving machinery, interchangeable parts, and systematised production have their due place to fill in the world's economy. But they need not become, as they are becoming at the present time, an excuse for stagnation; and, above all, they should not be allowed to check the development of the craftsman, who is necessary to the perpetuation of industry. The greatest industrial problem to-day is to maintain the supply of intelligent American labour in spite of the American industrial system.

THE Records of the Mysore Geological Department (vol. v.) contain the general report of the work of the department for the year 1903–4, by Dr. W. F. Smeeth, the State geologist. The work is of a very varied character, and comprises, in addition to geological inquiries, inspection of mines and explosives, prospecting, lectures, and the management of the library, laboratory, and museum. The same volume contains special reports on the Chitaldrug and Tumkur districts, by Mr. E. W. Wetherell; on the Shimoga and Kadur districts, by Mr. H. K. Slater; and on economic minerals, by Mr. V. S. Sambasiva Iyer. In the last report the occurrence of deposits of asbestos, mica, gold, pyrites, magnesite, chromite, garnet, staurolite, and apatite is recorded. In the Memoirs of the Mysore Geological Department (vol. iii., part i.) Mr. E. W. Wetherell gives a general account of laterite, and a description of the more important exposures in the districts of Bangalore and Kolar. The origin and nature of laterite have always been such controversial questions that the author's conclusions are of special interest. He shows that the Bangalore-Kolar laterite is detrital and of lacustrine origin, and that there is no geological relation whatever between the horizontal laterite proper and the clayey lithomargic beds below. The apparent gradation from these beds into laterite is due to the fact that the laterite was lain down in water on the decomposed surface of the preexisting rocks, and subsequently the chemical changes caused by percolating water have acted both upon the laterite itself and upon the decomposed material below it.

THE excellent work that is being done by the South African Philosophical Society is well shown by the varied contents of the Transactions (vol. xvi., part iii.). Dr. R. Broom describes and illustrates *Hortalotarsus skirtopodus*, the South African dinosaur described by Seeley in 1894. Dr. R. Marloth gives some notes on *Aloe succotrina*, which he has found growing at a spot on Table Mountain, and Mr. T. R. Sim summarises the recent information concerning South African ferns and their distribution. The list he gives shows a total of 212 species. Mr. J. R. Sutton discusses the climate of East London, Cape Colony, giving a summary of meteorological observations made during the twenty-one years 1884–1904. Mr. D. E. Hutchins reviews the cycle year 1905, an important one to those interested in long-period weather forecasts, and concludes that farmers may expect general good seasons for the next two or three years, and that after 1908 there will be six years of drought. Mr. A. L. du Toit points out the considerable influence of the geological formation on the storage of underground water, and considers the potentialities of such a supply in south-eastern Bechuanaland. Dr. Thomas Muir makes known a solution to a set of linear equations connected with homofocal surfaces. Mr. W. L. Sclater gives an account of two recently discovered inscribed stones bearing on the history of Cape Colony. One is a boundary stone erected by the governor Joachim van Plettenberg at Colesburg in 1778 to mark the extreme north-eastern boundary of the colony, and the other is a stone in the castle wall with inscriptions by John Roberts, commander of the *Lesser James*, 1622, and by James Burgess, master of the *Abigail*, 1622.

THE last issue of the Journal of the Institution of Electrical Engineers contains an interesting paper on long-flame arc lamps, by Mr. L. Andrews. The paper is of especial interest at the present time, owing to the recent development of the long-flame arc, which is largely due to the enterprise and competition of the gas companies during the last two years. With the perfection of high-pressure gas the electric arc was seriously threatened, as gas lighting, without a doubt, was driving out the arc lamp from both the cost and candle-power points of view. This competition, however, has had a beneficial result, in that the long-flame arc lamp has been developed and can now more than hold its own with high-pressure gas lamps, as is proved by the fact that, after a practical trial of both systems which lasted over some time, the South-Eastern Railway Company has decided to adopt oriflame arc lamps at the renovated Charing Cross Station, as they found by test that, on the price for price basis, the oriflame lamps gave a much better light than the high-pressure gas lamps. Mr. Andrews's paper chiefly deals with one particular kind of flame arc lamp, namely, the Carbone lamp. The paper led, however, to a discussion which opened up the question in its more general form. It is to be hoped, therefore, that the question of long-flame arcs will not be allowed to drop until a much greater development has taken place, as much is needed before we can say that it is perfect, as the efficiency of flame arc lamps still leaves much to be desired.

The August issue of the *Psychological Bulletin* is a pathological number. In addition to an article on the relation of emotional and intellectual functions in paranoia and in obsessions (by Dr. Adolf Meyer, the editor of this number), it contains a discussion by Dr. J. W. Baird of the contraction of the colour zones in hysteria and in neurasthenia. The conclusions to which Dr. Baird's observations lead are (1) that the colour zones of the abnormal subjects examined are, on the whole, of smaller area than those of the normal subjects, and (2) wherever a contraction of the colour zones occurs a definite order is observed —the red and green zones narrow together and the blue and yellow zones together, and there is a greater degree of contraction in the red-green zone than in the blue-yellow zone.

Although it is well established that selenium and tellurium are isomorphous in their compounds, it is still a question of controversy whether the isomorphism extends to the substances in the elementary state. Drs. G. Pellini and G. Vio show in the *Atti dei Lincei* (vol. xxv., ii., p. 46) that the solidifying points of mixtures of these substances are proportional to the percentage compositions, and that the elements are therefore isomorphous. The hexagonal mineral tellurium from Honduras, which contains about 29 per cent. of selenium, would thus appear to be an isomorphous mixture.

A method of isolating radio-thorium from thorium salts is described by Messrs. G. A. Blanc and O. Angelucci in the *Atti dei Lincei* (vol. xxv., ii., p. 90). When sulphuric acid is added to a solution of thorium nitrate containing barium chloride no precipitate is formed in the cold solution, but on warming, part of the barium is precipitated as sulphate, the precipitate carrying down some of the radio-thorium. The sulphate is converted into carbonate by fusion with sodium carbonate, and the product, after thorough washing, is dissolved in acid; on adding ammonia a slight precipitate of radio-thorium is obtained which has an activity about 5000 times as great as thorium hydroxide in a state of radio-active equilibrium.

The use by the Königliche Porzellan Manufactur of fused magnesium oxide in the construction of tubes and crucibles has led Messrs. H. M. Goodwin and R. D. Mailey to publish the results they have obtained in an investigation of the physical properties of fused magnesium oxide (*Physical Review*, vol. xxiii., No. 1). The fused substance is a white, very hard crystalline substance, the size of the crystals depending on the rate of cooling. The melting point of the material is 1910°, the coefficient of expansion being very nearly the same as that of platinum, a fact which will prove of value in its application. The results recorded for the electrical conductivity show that up to 1150° C. fused magnesia is a better insulator than porcelain. Fused salts, as a rule, have very little action on the material, and it is attacked only slowly by cold, dilute mineral acids.

In an article in No. 8 of *Le Radium* Mr. A. S. Eve describes a method of estimating the proportion of radium or thorium in a mineral by means of the γ rays which it emits. Incidentally, it is pointed out that solutions of radium bromide which are intended to serve as standards of radio-activity are liable, unless acidified, to become inexact owing to the deposition of radium on the glass of the vessels containing them. It appears advisable always to control such solutions by reference to a standard of solid radium bromide. Dr. M. Levin contributes an article on the absorption of the α rays of polonium to the same number of *Le Radium*, Mr. H. L. Bronson deals with the transformation periods of radium A, B, and C, and Mr. W. H. Bragg describes investigations of the α particles of uranium and thorium.

Both theoretically and practically the formation of "basic" salts has long been a difficulty to chemists. In the case of the carbonates, for example, no good reason has been given why the carbonates of the metals of the alkaline earths alone should be definite compounds. The current number of the Journal of the Society of Chemical Industry contains an interesting study of the basic carbonates of magnesium, by Mr. W. A. Davis, which throws a good deal of light on these very obscure compounds. The starting point of the work is magnesium bicarbonate. It has been shown by Treadwell and Reuter that whilst a solution of calcium bicarbonate is stable at the ordinary temperature, a solution of the corresponding magnesium compound is only stable in the presence of carbon dioxide. It is known that when the pressure of the carbon dioxide above this solution is removed crystals are deposited of the composition $MgCO_3.3H_2O$, and these have been regarded as hydrated magnesium carbonate. In the present paper the author shows that this substance is really a hydroxy-carbonate,

$$Mg(OH)(CO_3H)2H_2O,$$

since only two-thirds of the water can be driven off at 100° C., or by boiling with xylene. Photomicrographs of both these salts are given. The decomposition products of this hydroxy-carbonate are then studied, and the results applied to the softening of magnesian waters, the Solvay method of manufacturing potassium carbonate with the aid of magnesia, and the formation of mixed carbonates of magnesium and the alkalis. The author claims that various observations which were formerly inexplicable may be interpreted without difficulty in the light of the explanation which has been given of the manner in which basic carbonates are formed.

Prof. Strasburger's interesting book on botanical and other natural characteristics of the Riviera, a review of which appeared in Nature of June 22, 1905 (vol. lxxii., p. 171), has been translated into English by O. and B. Comerford Casey, and is published, with the coloured illustrations, by Mr. T. Fisher Unwin. The English version of this charming book will delight visitors to the Riviera who are unfamiliar with the German language.

A series of instructive experiments in practical photography is described by Mr. T. T. Baker in a booklet entitled "Simple Photographic Experiments," just published by Messrs. Percival Marshall and Co.

Messrs. Constable and Co., Ltd., have just published the third edition of Mr. H. H. Cunynghame's work "On the Theory and Practice of Art-enamelling upon Metals." A short description of a new furnace invented by the author has been added to the volume.

OUR ASTRONOMICAL COLUMN.

Comet 1906*e* (Kopff).—Circular No. 91 from the Kiel Centralstelle contains a set of elements for comet 1906*e*, calculated by Herr M. Ebell from positions observed on August 23 and 31 and September 12.

These elements give the time of perihelion as May 3·09, 1906, and from them Herr Ebell has calculated an ephemeris from which the following is taken:

Ephemeris 12h. (M.T. Berlin).

1906	α (true) h. m.	δ (true) ° ′	1906	α (true) h. m.	δ (true) ° ′
Oct. 2	22 27	+6 30	Oct. 18	22 28	+4 58
6	22 26	+6 4	22	22 29	+4 41
10	22 26	+5 40	26	22 31	+4 26
14	22 27	+5 18			

At present the diminishing brightness of the comet is about half what it was on August 23, when its magnitude was about 11·5.

From the ephemeris it may be seen that this object is still in the constellation Pegasus, about half-way between ζ and 34 Pegasi, and is observable throughout the evening.

Observing at Rome on September 12, Prof. Millosevich found it to be a faint object having a coma which was not symmetrical about the thirteenth-magnitude nucleus.

Finlay's Comet, 1906*d*.—M. Léopold Schulhof continues his ephemeris for Finlay's comet in No. 4122 of the *Astronomische Nachrichten*, from whence the following abstract is taken:—

Ephemeris 12h. (M.T. Paris).

1906	α (app.) h. m.	δ (app.) ° ′	1906	α (app.) h. m.	δ (app.) ° ′
Oct. 4	7 37	+20 33	Oct. 16	8 2	+20 49
8	7 46	+20 39	20	8 8	+20 54
12	7 54	+20 44	24	8 14	+20 59

The comet, according to this ephemeris, is now in the constellation Gemini, travelling directly eastwards towards Cancer, and rises at about 11.30 p.m. It will be about one degree south of μ Cancri on October 16.

Two photographs of this comet are reproduced in the September number of the *Bulletin de la Société astronomique de France*. They were taken at the Juvisy Observatory on August 21 and 22 respectively by M. Quénisset, and show a well-marked nucleus; a rudimentary tail is also seen on the original negative. During the exposure on August 21 the comet passed over a tenth-magnitude star, the light of which was not perceptibly diminished by the interposition of the coma.

A New Form of Wedge Photometer.—In No. 4120 of the *Astronomische Nachrichten* Herr H. Rosenberg describes, and gives a drawing of, a new form of wedge photometer which he has designed. In the ordinary photometer of the "wedge" type the observer is unable to eliminate the influence of the variation in the brightness of the general background of sky, and the eye, becoming fatigued, is unable to determine exactly the point of extinction.

In Herr Rosenberg's apparatus, however, the image of an artificial star, formed by a *constant* light source, is projected alongside the image of the natural star, and the wedge adjusted until the two images are equally bright. By adjusting the brightness of the artificial star, so that it is less than that of the faintest object which is to be examined, and determining its value in magnitudes, one may thus measure the brightness of any stars within the limits of about eight magnitudes. The error caused by the uncertainty as to the exact point of extinction is thus eliminated.

A postscript to Herr Rosenberg's description states that he finds the principle of a similar contrivance was described by Herr Müller in No. 3693 of the *Astronomische Nachrichten*, and an instrument was constructed at the Potsdam Observatory.

Occultation of a Star by Venus.—In a communication to the British Astronomical Association, published in No. 9, vol. xvi., of the Journal, Dr. Downing directs the attention of amateur astronomers in Australasia to the fact that on December 9 Venus will occult the third-magnitude star β Scorpii. As it is such a rare occurrence for a planet to occult so bright a star, he gives the particulars of the occultation for Sydney, Brisbane, and Wellington in the hope that use may be made of them by observers suitably located.

Results of the International Latitude Service, 1902–1906.—In No. 4121 of the *Astronomische Nachrichten* Prof. Th. Albrecht discusses the results obtained by the six international latitude stations during the period 1902·0–1906·0. The variation of the position of the apparent pole is shown on a diagram, which includes the tenths of each year from 1900·0 to the beginning of the present year. The values given for the period 1902·0–1905·0 are final, but those for 1905·1–1906·0 are only provisory, although Prof. Albrecht states that they are probably correct to one two-hundredth of a second.

The Amana Meteorite.—An interesting description of the various meteoritic objects which fell at Amana, Iowa, U.S.A., in 1875, is given by Dr. G. D. Hinrichs in *Das Weltall* for September 15. Two plates accompanying the description show photographic reproductions of the meteorites, together with the names of the museums wherein they are now to be found. Other illustrations give charts of the locality in which these objects were discovered.

BOTANY AT THE BRITISH ASSOCIATION.

The work of Section K was not characterised by the announcement of any discovery of very exceptional interest, nor by any sensational feature. As has been usual in recent years, an effort was made to group the papers presented so that those dealing with allied topics were taken at the same session. The whole number of papers read was not large, and no less than three morning sessions were devoted to discussion of definite topics, the proceedings being opened in each case by one or more papers giving an account of the present position of the subject to be discussed, or presenting facts and conclusions likely to lead to debate. These discussions were to some extent organised beforehand; that is to say, the members most likely to contribute usefully to the discussion of a given topic were informed of the intention to hold the discussion some time before the meeting, and were invited to contribute, abstracts of the opening papers being distributed to them as early as possible, so that they were in possession of the lines to be taken before the meeting. Such of these members as were present and had signified their willingness to speak were called upon in succession by the chairman as soon as the papers were over, the discussion being afterwards open to any member of the section. Although it is true that very good discussions often arise quite spontaneously after papers which are not expected to provoke debate, it is believed that on the whole the best results are obtained by the method of semi-organised discussion described, though it is neither possible nor desirable to limit the sectional meetings entirely to proceedings of this type.

The success of such discussions depends very largely on the selection of topics of suitable scope. On the whole the tendency is to take too wide a subject, with the result that the different speakers are apt to deal with quite distinct aspects of it, and unless the opener has the exceptional power of drawing all the threads together in his reply the impression left on hearers is liable to be somewhat inconclusive and chaotic. On the other hand, if the subject chosen is too narrow, its treatment is apt to become excessively technical, the discussion is of limited interest, and may even languish owing to a lack of sufficiently instructed specialists.

Of the three discussions at the York meeting, the first was taken on Friday morning, August 3, and was really divided into two parts. Dr. D. H. Scott opened the session. Though his title was a wide one—"Some Aspects of the Present Position of Palæozoic Botany"—considerations of time compelled Dr. Scott to limit himself to "the difficult question of the position of the ferns in the Palæozoic flora," "the difficulty arising from the accumulation of evidence showing that most of the so-called

Palæozoic ferns were in reality seed-plants." Dr. Scott showed, in his luminous address, that "a large body of true ferns of a simple type—the Primofilices of Mr. Arber—existed in Carboniferous times," while it is probable that true Marattiaceous ferns also existed side by side with these.

The second part of the discussion, dealing with the formation of the well-known calcareous nodules found in the coal seams of the Lower Coal-measures, though it might be thought to be of purely technical and specialist interest, is in reality of great importance to everyone concerned with Palæozoic botany, because the nodules in question contain the greater part of the plant remains showing histological structure that are known to us from Palæozoic rocks, and their mode of formation is of the first importance as throwing light on the question of how these plants grew. Several geologists specially conversant with the occurrence of Coal-measure fossils had been particularly invited to take part in the discussion, which was an excellent instance of the fruitful concentration of two branches of science upon a special problem. Prof. Weiss opened the discussion with a short general paper stating the problems, and was followed by Miss Stopes, who gave an account of her recent work, which went to show that the nodules were formed *in situ*, the calcareous material being derived by solution and re-segregation from marine shells the remains of which are found in the roof of the same seam. A possible chemical process by which such a solution and re-deposition could be effected was indicated. The most clinching proof of this method of formation was shown in the case of two gigantic nodules lying side by side, in which the petrified remains of plants are found to be continuous from one to the other. It is clear that in such cases at least the plant must have been petrified where it was found. Mr. Lomax brought forward evidence which seemed to him to support the rival hypothesis, that these nodules were often carried by water transport to the situations in which they were found. Mr. Watson, who has worked with Miss Stopes, attacked the views of Mr. Lomax, while Mr. Bolton, of Bristol, Prof. Hull, and other geologists, including Dr. Teall, took part in the discussion.

The second discussion took place in joint session with Section D on Monday morning, August 6, and dealt with the nature of fertilisation. The opening paper was given by Mr. V. H. Blackman. This discussion is dealt with in the account of the proceedings of Section D (NATURE, September 27, p. 551). Here it need only be said that the danger already referred to, that of choosing too wide a subject for discussion, was to some extent apparent. The work bearing on fertilisation is now so varied in kind and occupies so many classes of workers, both zoological and botanical, that it is difficult to focus the interest in a single discussion.

The third discussion was on the phylogenetic value of the vascular structure of seedlings. Papers were read by Mr. Tansley and Miss Thomas, by Mr. T. G. Hill, and by Mr. A. W. Hill. Miss Sargant, Dr. Scott, and Prof. Jeffrey took part in the discussion. The work of Mr. Tansley and Miss Thomas and of Mr. T. G. Hill to some extent covered the same ground. In both cases the comparative anatomy of the vascular system of the hypocotyl in Gymnosperms and Dicotyledons was the subject of investigation. Mr. Tansley and Miss Thomas found that the type of symmetry of this structure had considerable phylogenetic value, thus confirming and extending Miss Sargant's conclusion relating to Monocotyledons, published some years ago. Without going into technical details, it may be stated that nearly all the cases met with fall naturally into a series, and the conclusion is reached that the more complex type, met with among the older Gymnosperms, and also among some Dicotyledons, is phylogenetically the older, while the simpler type, very widely prevalent among Dicotyledons, is derived by reduction, through various transitions, from this older type. Mr. T. G. Hill, while bringing to light many of the same facts, was not in agreement with this view, basing his opinion on the apparently primitive diarchy of the ferns. Mr. Hill showed that the anatomical evidence pointed to the cotyledons of the "polycotyledonous" conifers being derived by splitting, in some cases at least, from a primitive "dicotyledonous" type, a conclusion with which the joint authors of the other paper concurred.

Mr. A. W. Hill sought to show, by a consideration of the seedlings of bulbous and rhizomatous species of Peperomia and Cyclamen, that clues may be obtained to the mode of evolution of the true Monocotyledons, the two cotyledons assuming different functions. Thus in his view the single cotyledon of the Monocotyledon represents only one of the two cotyledons of the typical Dicotyledon, the other being represented by the first foliage leaf. Miss Sargant found herself unable to accept Mr. Hill's suggestions.

Several interesting papers on the vegetation of different parts of the world were read. Mr. Seward communicated a paper by Prof. H. H. W. Pearson, of Cape Town, who is doing excellent work on the natural history of the indigenous Cycads. Mr. Hugh Richardson gave an outline account of the vegetation of Teneriffe, laying stress on its zonal distribution. Mr. C. E. Moss gave a general paper on the succession of plant formations in Britain, in which he dealt with succession from sand dunes, from salt marshes, in lowland and upland peat formations, and in certain types of forest, in all cases from his own observation. He used the term "formation" to mean "an historical series of plant associations," beginning as an "open" and ending as a "closed" association. All these papers were illustrated by lantern-slides.

Palæontological papers of some importance were read by Prof. Jeffrey, of Harvard, and by Prof. Weiss. Prof. Jeffrey dealt with the structure and wound-reactions of the Mesozoic genus Brachyphyllum, a genus of hitherto doubtful affinity, which was now shown to be an undoubted member of the Araucarineæ, mainly from the evidence of recently discovered material with the anatomical structure preserved. One of the most interesting points in the paper was the use the author made of the "traumatic" resin-canals found in Brachyphyllum. It appears that this plant produced definite resin-canals in its wound callus like the modern Abietineæ, and unlike the ancient or modern Araucarineæ. Largely, though not wholly, on this account Prof. Jeffrey concludes that this old genus connects the Araucarineæ with the Abietineæ, removing the former from their somewhat isolated position, and showing them as undoubtedly coniferous. Mr. Seward, in the discussion, while recognising the validity of Prof. Jeffrey's demonstration that Brachyphyllum was a member of the Araucarineæ, found himself unable to accept the evidence of Abietinean affinity, and particularly that based on the occurrence of the traumatic resin-canals. Dr. Scott, on the other hand, saw no reason why such evidence should not be valid.

Prof. Weiss described an interesting new Stigmaria possessing a considerable amount of centripetal primary wood, so that at first sight it has the appearance of a stem of Lepidodendron, though its characteristic periderm with the remains of rootlet cushions attached show that it is undoubtedly of stigmarian nature.

Dr. A. F. Blakeslee described some new results he had obtained in connection with the "physiological sex" which he discovered some time ago in the Mucorineæ. In *Phycomyces nitens*, in addition to the heterothallic spores, homothallic mycelia may be obtained by special methods, but the sexual character of these is unstable, and no fixation of the homothallic character takes place. Dr. Blakeslee's paper was illustrated by a series of beautiful preparations showing the homothallic and heterothallic character respectively of various mycelia. The author also contributed a general paper on differentiation of sex in gametophyte and sporophyte. For the former he uses the terms *homothallic* and *heterothallic*, for the latter *homophytic* and *heterophytic*. Investigations are now proceeding as to the sexual differentiation in the sporophyte of the Bryophytes. The evidence shows that both "male" and "female" spores exist in the sporogonium of *Marchantia polymorpha*, and attempts are being made to determine at what point the segregation of sex occurs. Dr. Lang, Mr. V. H. Blackman, and Mr. R. P. Gregory took part in the discussion on these papers.

Of purely physiological papers, Prof. W. B. Bottomley contributed a very interesting account of his successful attempt to inoculate papilionaceous plants with the root-nodule organisms belonging to non-papilionaceous Leguminosæ and to plants of quite different families, those of Acacia (Mimoseæ) and of Elæagnus and Alnus being chosen. In another paper Prof. Bottomley showed that the long-known effect of sprinkling urine on the floors of greenhouses in order to cause a more luxuriant growth of orchids is due to the presence of both nitrite and nitrate bacteria in the cells of the velamen, which are thus able to utilise the ammonia arising by decomposition of the urine and absorbed along with the water vapour normally condensed by the velamen.

Miss C. B. Sanders, of Oxford, described some experiments carried out in Prof. Gotch's laboratory on the local production of heat connected with the disappearance of starch in the spadices of various Araceæ. Remarks on this paper were made by Dr. F. F. Blackman.

Dr. Ellis, of Glasgow, described experiments to show that ciliation cannot be used as a taxonomic character among bacteria—as has recently been done by Migula—because under appropriate conditions all the members of such groups as Coccaceæ, Bacteriaceæ, and Spirillaceæ, in which this character has been used, can be made to acquire cilia.

The semi-popular lecture was delivered by Prof. Yapp, who took his hearers for a most pleasant excursion through some of the principal regions of South Africa, introducing them to the various types of vegetation met with by means of a series of beautiful lantern-slides from his own photographs.

The section met on Thursday afternoon, August 2, and for a short time on Monday afternoon, August 6. The other afternoons were left free for excursions, of which several were arranged by the local secretary, Dr. Burtt, of the British Botanical Association, and by other local botanists. Those to Askham Bog and to Skipwith Common may be specially mentioned as of great botanical interest.

THE ARCHÆOLOGICAL CONGRESS AT VANNES.

THE second congress of the Prehistoric Society of France was held from August 21–26 in the capital of the department of Morbihan, the classic land of Megalithic monuments, at any rate so far as France is concerned. The attendance exceeded that of the very successful first congress held at Périgueux last year.

The inaugural meeting at 10 a.m. on Tuesday, August 21, was graced by the presence of prominent citizens. Speeches were made by the Mayor of Vannes, Senator Riou, Prof. Adrien de Mortillet, president of the congress, and by Dr. Marcel Baudouin, the secretary, who insisted on the need of providing a special building to house the rich collections of the Société polymathique, and on the desirability of creating a national Megalithic park comparable to the Yellowstone National Park of the United States.

The president of the local committee, M. Morio, welcomed the congress in the name of the Société polymathique, the museum of which was much admired by the parties which visited it in the afternoon. It includes collections from the principal tumuli of the neighbourhood, excavated by the society during its many years of existence; there are, for example, the splendid necklaces of callaïs beads, a fine series of fibrolite axes, curious stone discs, scarcely found outside this area, and huge polished celts. In the evening M. Riou gave a reception at the Mairie, and various toasts were proposed.

The numerous papers and the lively discussions attest the success of the congress. M. Rutot, the curator of the Royal Museum of Brussels, led off with a consideration of the question of the Palæolithic bed of Havre; he maintained that there was no question of displacement; what had taken place was a falling in of the superincumbent earth and erosion of the cliff. Dr. Joussel then described a new prehistoric bed discovered at La Longère, near Nogent-le-Notrou (Eure-et-Loire), where objects of varying appearance and discutable age have been found, assigned by the author to the Flénusien age of Rutot. M. Hue brought forward a new method of measuring the skulls of Canidæ, which M. Baudouin urged all archæologists to apply to the measurement of other animals. Dr. Guébhard appealed to the archæologists of the world to bring into existence a map of prehistoric monuments, the preliminary steps towards which have been made by the Société préhistorique de Paris.

Two long sittings were held on the morning and evening of the second day. The first subject was the Palæolithic age of Brittany, introduced by M. Sageret, of Carnac, who was followed by MM. de Mortillet, Rutot, and Baudouin, who showed why beds of this epoch are rare: the Neolithic period has attracted more attention in Brittany (Mortillet); Brittany is only the central area of Quaternary Brittany, which was united to the British Isles until the Magdalenian period (Rutot), and to a south-western continent which survives in Belle-Ile, Quiberon, Houat, &c. (Baudouin). Some stones of this period were exhibited by M. Landren, of St. Nazaire, under the name of eoliths; the Rennes flints of M. Pavot were not regarded as of prehistoric character. Dordogne, the scene of the last congress, next claimed the attention of the meeting. M. l'Abbé Chastaing offered some remarks on the hammers for use with bones discovered in the cave of Le Moustier, and M. de Ricard directed attention to the new Magdalenian station of Rocheyral, Drôme Valley. Finally, M. de Mortillet brought into prominence the Placard cave (Charente), and the various industries there practised; in this connection there arose a discussion on the pre-Solutrian age of M. l'Abbé Breuil, for which M. Rutot and M. l'Abbé Chastaing took up the cudgels.

M. Rutot spoke on the question of the Micoque beds, on the Vézère, after dealing with the Strépyien of France. He showed that the Chelles-Moustérien of Micoque was in reality Strépyien, and that this stage fell between the Chelléen and the Mesvinien, and not between the Chelléen and the Moustérien. M. Feuvrier (of Dôle) directed attention to a Magdalenian cave in the Jura, and M. J. Dharvent exhibited a sculptured flint of the Moustérien age.

On Wednesday evening Neolithic problems were approached; among the papers were those of Dr. Martin, on the false tumulus of La Motte Beudron (Deux-Sèvres); M. Goby, on the tumuli of the districts of St. Vallier de Thiay, St. Cézaire, and Grasse (Alpes Maritimes); and M. Roerich, of St. Petersburg, on sculptured Neolithic flints. M. Rutot then turned to the Flénusien, or lower Neolithic, in France, and showed that traces could be found from one end of France to the other. Dr. Montelius then gave a summary exposition of the Stockholm collections from the Robenhausen and other periods.

On the morning of Thursday the pottery of the dolmens came up for discussion; M. Fourdrignier, of Paris, showed that the study of finger-prints might be of value, but it was pointed out that the information could throw little light on questions of race. Other papers were those of M. Goby, on the dolmen pottery of the Grasse district, and the micaceous pottery of Camp du Bois-du-Rouret (Alpes Maritimes).

After a remarkable paper by Dr. Stjerna on the Scandinavian origin of the Burgundians came papers on Megalithic monuments, among them those of Dr. Jousset, on the Carnacean age of Perche; Dr. Coutil, on Megalithic monuments in Normandy; M. José Fortès, on Megalithic sculptures in Portugal; M. Tavarès de Proença, on the classification of Portuguese dolmens; M. Coutil, on his exploration and restoration of the tumulus of Fontenay-le-Marmion (Calvados) in 1904 and 1906. Important communications were read by Dr. Waldemar Schmidt, on Megalithic monuments in Denmark; by Dr. Montelius, on the same in Sweden; by Dr. Baudouin, on five years' excavations and restorations of the megaliths of Vendée. A popular evening lecture on the dolmens of Brittany, illustrated by lantern-slides, had already been given in the theatre on the previous evening.

On Thursday evening the subject of prehistoric gold in Brittany and Vendée was treated by Count Costa de Beauregard and Dr. Baudouin, and much was said on the significance of menhirs and of the alignments. For M. de Paniagua they are evidence of a phallic cult, for M. Rutot they are sign-posts, for M. Montelius and for Dr. Baudouin tombstones, and the last view finds support in the results of the excavations of Dr. Baudouin and M. Hue. The views on the alignments were varied; they were *ex-votos*, and they were connected with the Trojan war; but the majority hesitated to express an opinion. M. le Rouzic, Dr. Baudouin and others, subject to more extensive researches in Brittany and elsewhere, were disposed to connect them with a solar cult. Among other papers, Dr. Atgier discussed the Megalithic enclosures, and M. de Clérambant galgals, or cairns, in Indre-et-Loire.

M. de Villemereuil proposed a motion on the State protection of megaliths. Speaking generally, it may be said that both the discussions and the numerous papers were of much interest, and the meetings were attended by more than a hundred members.

The following three days were taken up with excellently organised excursions; weather, vehicles, meals, and speeches, all were of the best, and more than a hundred took part in each excursion. The first day was consecrated to the Gulf of Morbihan, and among the objects visited were the cromlechs of Kergonan, the tumulus of Gavr'inis, and the magnificent dolmens of Locmariaquer, including the largest known menhir. On the second day visits were paid to the little-known alignments of St. Pierre, in Quiberon, and of Erdeven, and to the dolmens of Roch-en-Aud, Crocuno, Rondossec, &c.

The third day was reserved for Carnac and its marvellous alignments Menec, Kermario, and Kerlescant.

Worthy of special mention were the visits to the tumulus of Moustoir-Carnac, and to the Miln Museum, where the secretary of the congress paid a well-deserved tribute to the brilliant efforts of the regretted founder and his enthusiastic and devoted pupil, M. le Rouzic. Finally, a visit was rendered to the splendid tumulus of St. Michel-Carnac, so well cared for by M. d'Ault du Mesnil, president of the Megalithic Monuments Commission, who himself acted as guide.

In the course of the three days numerous speeches were made by foreign members, who were roused to enthusiasm alike by the monuments and by the organisation of the gathering. Mention must be made of the utterances of M. Rutot, on the Gulf of Morbihan; of Dr. Baudouin, on submerged megaliths in Brittany and Vendée, and on the technique of restorations; and of the erudition of M. de Mortillet, as well as of the demonstrations of MM. d'Ault du Mesnil and le Rouzic; the latter also spoke in the Miln Museum on the alignments of Carnac, and on his researches on the spot.

As the scene of the next congress in 1907 Abbeville was suggested by more than one speaker. Before the congress separated, the healths of M. de Mortillet, Dr. Baudouin, and M. Giraux were proposed in eulogistic terms. As M. Rutot said, a society that has been able to accomplish so much in its infancy will do much more in its maturer years, and this was equally the opinion of the foreign savants who attended the meeting.

A NEW SPECIMEN OF THE OKAPI.

In a letter from the Congo Free State, published in the *Times* of September 26, Major P. H. G. Powell-Cotton states that he has succeeded in obtaining the skeleton and skin of a fine male okapi. This animal was killed at Makala, in the Ituri forest, by the native hunter Agukki, who shot the two specimens taken to Europe by Dr. David. After careful inquiry, Major Powell-Cotton is unable to satisfy himself that any European has hitherto killed an okapi. A Swiss official named Jeannet, in the employ of the Congo Government, was, however, in 1905 shown one of these animals by a native as it stood in thick covert, where it was shot by the latter. This the writer believes to be the first living okapi (or "kangi," as it is called by the Makala natives) seen by a European.

According to information furnished by the Mambutti (pigmies), the okapi is generally a solitary animal, the two members of a pair invariably feeding apart, although, together with their single calf, they may frequent the same section of the forest. The calf, which is born in May, is left hidden in covert by the female, who returns to it at intervals for feeding purposes. Hearing and smell are very acute in the okapi, so that the sound of an axe or the faintest scent of man drives it from its feeding grounds into the depths of the forest. Even when feeding it is restless, and it seldom reposes long in the same lair. In the Ituri forest these animals avoid swampy ground, and always drink from clear running streams. During rain they seek shelter in the densest thickets or even under an abandoned roof, and it is at such times that they are most usually seen by the natives.

In the Ituri forest the okapi does not eat the giant leaves of *Sarcophrynium arnoldianum*, which Major Powell-Cotton believes to be the plant alluded to by Captain Boyd-Alexander in his account of the animal in the Welle district. Specimens of four different kinds of leaves which form the food of the Ituri forest okapi are being brought home for identification.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

The honorary degree of LL.D. has been conferred upon Sir Thomas Barlow and Prof. C. S. Sherrington, F.R.S., by Harvard University.

At a Convocation of the University of Durham, held on September 29, the honorary degree of D.Sc. was conferred upon Sir William White, K.C.B., and Prof. Lebour.

Prof. Wien, who occupies the chair of physics at Würzburg, informs us that he has declined the invitation to succeed the late Prof. Drude as professor of physics in the University of Berlin, because the Prussian Government is unable to undertake the erection of a modern physical laboratory there.

Prof. E. A. Minchin, F.R.S., the recently appointed professor of protozoology in the University of London, will deliver his inaugural lecture on "The Scope and Problems of Protozoology" on November 15. The University library, in which is included the Goldsmiths' Company's library of economic literature, will be opened by the Chancellor on the afternoon of Friday, October 26.

The new calendar of University College, London, contains an interesting outline of the history of the college by Dr. G. Carey Foster, F.R.S. The contribution deals with the growth and development of the University of London as a teaching university, and the part played by University College in that development. Particulars are given of the post-graduate courses offered this session in all faculties, and of the original work produced in the college during last session. The number of research and post-graduate students last year was 134, as against 119 in the previous session.

The first volume of the report for 1904 of the Commissioner of the United States Bureau of Education has at last been issued. A gratifying feature noted in the reports of the agricultural and mechanical colleges is the largely increased aid granted them by the several States and Territories. This aid amounted for the year to about 1,131,000*l.*, an increase of more than 200,000*l.* over the amount for the preceding year. A chapter of more than a hundred pages is devoted to the regulations relating to pensions and insurance in all German universities. The data were collected by Prof. Julius Hatscheck, of Heidelberg, for Dr. Theodore Marburg, trustee of Johns Hopkins University, and by the latter presented to the U.S. Commissioner of Education. It appears that in Germany membership in any teaching body means, *nolens volens*, the payment of regular contributions to the pension fund of that body, except in elementary schools, where the State assumes the entire burden of pension payment. Dr. John W. Hoyt contributes a detailed account of the University of Paris during the Middle Ages. Among other chapters of interest in the report, which runs to 1176 pages, may be mentioned two on education at the St. Louis Exposition and one on higher education in England as affected by the Act of 1902, in which prominence is given to Prof. Sadler's reports to various county councils.

At the University of Leeds on Monday, the inaugural address of the new session was delivered by Sir James Crichton-Browne upon the subject of "Universities and Medical Education." In the course of his remarks, he said that centuries ago gifts were given for the promotion of objects equivalent to those which modern universities hold in view, which, considering the pecuniary resources of those who gave them, should put our most open-handed modern millionaires to shame. England has been remiss of late in perceiving and promoting those interests that hinge on scientific and medical research. In this direction Germany has stolen a march upon us, for the various Governments in that Empire have unstintedly provided their universities with fully-equipped research laboratories, organised and conducted by professorial directors. A university is something more than a medical school, a workshop of research, or a home of science. It must have loftier aims than material advancement or commercial prosperity. It must provide for culture in its widest sense, afford intellectual guidance, encourage individuality, take cognisance of the theoretical problems that arise in the progress of civilisation, be a storehouse of knowledge, and a gymnasium for the exercise of all the powers of the mind; and to be truly a university it must be an organism, and not a mere conglomeration of parts. The one great objection to the multiplication of universities is that they may tend to become local seminaries, somewhat parochial in spirit, and fed exclusively from one district, for it would be a misfortune to a boy to pass from a secondary school to a university in the next street, where he would meet as his fellow-students only his old schoolfellows, and where, however amply fed with knowledge, he would still be surrounded by the same traditions and associations and shop amongst which he had been brought up. A provincial university is a contradiction in terms. What is wanted is a group of territorial universities, each with distinctive features of its own, specially adapting it to its environment, but all affording the most liberal instruction, the finest culture, the best intellectual discipline of the day, and collectively meeting the higher educational needs of the whole country.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 28.—"Regeneration of Nerves." By Dr. F. W. **Mott**, F.R.S., Prof. W. D. **Halliburton**, F.R.S., and Arthur **Edmunds**.

Five sets of experiments are recorded as a contribution to the discussion as to whether the regeneration of nerve-fibres is autogenetic or not. The experimental methods approach the subject in different ways, and in no case was any evidence forthcoming of auto-regeneration.

The facts recorded, taken in conjunction with those published by such observers as Cajal and Langley and Anderson, form, on the other hand, strong pieces of evidence in favour of the Wallerian doctrine that new nerve-fibres are growths from the central ends of divided nerve trunks. The experimental facts recorded by those who, like Bethe and Kennedy, hold the opposite view, are susceptible of easy explanation, mainly on the lines emphasised by Langley and Anderson, of accidental and unnoticed connection of the peripheral segments with the central nervous system by means of other nerves cut through in the operation. If such connection is effectually prevented, real regeneration of structure and restoration of function never occur.

Moreover, the regenerated fibres always degenerate in a peripheral direction, and in a peripheral direction only, when the link that binds them to the central nervous system is again severed. Perhaps the most striking of the facts brought out in the present paper is in reference to the development of the medullary sheath; this appendage of the axis cylinder appears earliest at situations near the point where the ends of a nerve have been joined together, and reaches the distal portions later.

What takes place in the peripheral segment of a divided nerve is a multiplication, elongation, and union into long chains of the neurilemmal cells. The same change is even more vigorous at the central termination of the cut nerve; and the view of the phagocytic and nutritive function attributed to this sheath has been supported independently by some striking observations of Graham Kerr which are referred to. At the central end this nutritive function is effective, and provides for the nourishment of the actively lengthening axis cylinders. At the peripheral end, unless the axons reach it, it is ineffective in so far as any real new formation of nerve-fibres is concerned. If, however, the axons reach the peripheral segment, the work of the neurilemmal cells has not been useless, for they provide the supporting and nutritive elements necessary for their continued and successful growth. The neurilemmal activity appears to be essential, for without it, as in the central nervous system, regeneration does not take place.

According to Graham Kerr, the formation of neuro-fibrillæ may possibly take place in the protoplasmic residue of the degenerated axis cylinder; according to Marinesco, this property is assigned to the neurilemmal elements themselves, a proposition which is extremely improbable, seeing that these elements are mesoblastic. In either case these two observers consider that the neuro-fibrillæ, however formed, are ineffective until they are activated by union with those of the central axons. The present observations do not entirely exclude this view, but, on the other hand, they lend it no support. The facts are readily explicable, however, on the theory that the nerve-fibres are growths from the central ends of divided nerves.

"The Ionisation produced by Hot Platinum in Different Gases." By Prof. O. W. **Richardson**. Communicated by Prof. J. J. Thomson, F.R.S.

The present paper forms an account of an experimental investigation of the steady positive ionisation produced by hot bodies, platinum being assumed to be typical.

The following are the chief results:—

The positive ionisation, *i.e.* the number of positive ions produced by 1 sq. cm. of platinum surface per second, possesses a minimum value, which depends on temperature and pressure, in most gases. The positive ionisation in oxygen at a low pressure (less than 1 mm.) is much greater than in the other gases tried. In oxygen at low pressures, and temperatures below 1000° C., the ionisation varies as the square root of the pressure; at higher temperatures and low pressures it varies nearly directly as the pressure; whilst at higher pressures at all temperatures the variation with pressure is slower, so that at pressures approaching atmospheric the ionisation becomes practically independent of the pressure.

The variation with pressure in air is similar to that in oxygen. In nitrogen and hydrogen the ionisation appeared to increase more rapidly with the pressure at high pressures than in oxygen. In very pure helium at low pressures there was a positive ionisation which was a function of the pressure.

The experiments on ionisation by collisions indicate that the positive ions liberated by hot platinum in oxygen are of the same order of magnitude as those set free by the collisions.

The positive leak in oxygen always oscillated around a certain value under specified conditions. It was, therefore, never steady, so the minimum values were taken. This variability was much less marked in the other gases.

The minimum value of the positive ionisation was found to remain practically constant with a wire heated during three months at various times (for 150 hours altogether) in oxygen at 900°–1000° C. Moreover, four different wires of different dimensions after continued heating in oxygen gave nearly the same value for the ionisation at the same temperatures and pressures.

The positive ionisation in air at constant temperature is smaller than that which would be obtained if the nitrogen were withdrawn, so as to leave only oxygen at a low pressure. The nitrogen, therefore, exerts an inhibiting effect on the oxygen.

The minimum value of the positive ionisation at a definite pressure in all gases appears to be connected with the temperature by the relation first deduced by the author for the negative ionisation. This relation may be written $i = A\theta^{\frac{1}{2}}e^{-Q/2\theta}$, where i is the ionisation, θ is the absolute temperature, and A and Q are constants. The value of the constant Q, which is a measure of the energy associated with the liberation of an ion, is in most cases smaller for the positive than for the negative ionisation.

These results refer to wires which have been heated in a vacuum, and subsequently in the gas considered, for a long time. New wires exhibit peculiar properties, especially in regard to their behaviour under different electromotive forces. Old wires also exhibit hysteretic effects with change of pressure.

The view is developed that the positive ionisation is caused by the gas adsorbed by the metal and the consequence examined of supposing the ionisation to be proportional to the amount of the adsorbed gas present. In the case of oxygen, by making the assumption that the rate of increase of the amount of the adsorbed gas is proportional jointly to the concentration of the external dissociated oxygen and to the area of "unoccupied" platinum surface, whilst the rate of breaking up is proportional to the amount present, a formula is obtained which agrees with the experimental results. This formula is that the ionisation $i = Ap/(B+p)$, where $p=(kP+\frac{1}{4}k^2)^{\frac{1}{2}}-\frac{1}{2}k$, P being the external pressure and k the dissociation constant of oxygen; A, B, and k are constants depending on the temperature, and are of the general form $a\theta^{\frac{1}{2}}e^{-b\theta}$. Thus this view accounts for both the temperature and pressure variation.

The positive ionisation from the outer surface of a hot platinum tube in air is increased when hydrogen is allowed to diffuse through from inside the apparatus. The increase in the ionisation is proportional at constant temperature to the quantity of hydrogen escaping from the surface in unit time.

The negative ionisation from hot platinum in air is unaltered when hydrogen is allowed to diffuse out through the platinum.

These results show that neither the negative nor the positive ionisations usually observed with hot platinum heated in air or oxygen are due to residual traces of absorbed hydrogen.

A wire which has been heated in hydrogen furnishes a negative ionisation which is very big compared with that from a wire heated in oxygen at the same temperature. If the hydrogen is at a pressure of the order of 1 mm. the negative ionisation can be rapidly reduced to a much smaller value by applying a high negative potential to the wire. The wire subsequently recovers its ionising power if the potential is reduced again. Under these conditions the ionisation varies in an interesting way with the time. The reduction in the ionising power of the wire appears to be caused by the bombardment of the surface by positive ions produced by collisions.

When a platinum wire, which has previously been allowed to absorb hydrogen, is heated for a long time in a good vacuum so as to expel the gas, its ionising power does not appear to be reduced. The ionisation apparently is not a definite function of the quantity of gas absorbed by the wire.

PARIS.

Academy of Sciences, September 24.—M. A. Chauveau in the chair.—The colour and spectra of solar prominences: M. **Ricco.** Direct observation of the eastern group of protuberances during the total eclipse of 1905 showed that the colour was different in different parts, and especially at the edges, the latter showing a play of colours. The body of the protuberance was purple-red, the outside was violet-blue, the summit was pure violet, nearly white, and exceedingly brilliant. Two photographs of the spectrum were taken, enlarged reproductions of which are given.—The application of M. E. Borel's method of summation to generalised trigonometrical series: A. **Buhl.**—The amplification of sounds: M. **Dussaud.** The vibrations from any source of sound are received on a membrane, and this, either directly, or through a solid, acts on a jet of compressed air. The sound is in this way faithfully reproduced by the jet of air, the amount of amplification depending only on the power of the motor used in the compression.—The recent scientific cruise of the *Otaria*: Teisserenc **de Bort.**

NEW SOUTH WALES.

Linnean Society, August 1.—Prof. T. P. Anderson Stuart, president, in the chair.—The Australian Melaleucas and their essential oils, part i.: R. T. **Baker** and H. G. **Smith.** In this series of papers on the Melaleucas and their essential oils, of which this is the first, it is the authors' intention to follow out this research on the same lines as those adopted in the work on Eucalypts and their essential oils. Bulk material was employed in obtaining the results given in the paper. The Melaleucas are commonly known as "tea trees," and are distributed throughout the whole continent of Australia, and so are familiar plants in the bush. Two species form the subject of this paper, viz. *M. thymifolia*, Sm., and *M. linariifolia*, Sm.—*Vitis opaca*, F.v.M., and its enlarged rootstock: R. T. **Baker** and H. G. **Smith.** The occurrence of these enlarged rootstocks, weighing from 20 lb. to 25 lb., in the Australian species of Vitis, has been recorded by Baron Mueller, Thozet, Roth, and others, but no chemical investigation of their composition appears to have been made. Such an investigation forms the basis of this paper. From the results a close affinity between the carbohydrates of this "tuber" and those belonging to the true gums is shown, and the alteration products are more in the direction of the sugars than the starches.—Investigation of the disease in cattle known as "rickets," or "wobbles," and examination of the poisonous principle of the Zamia palm (*Macrozamia Fraseri*): E. A. **Mann** and T. I. **Wallas.** The authors for some time have been carrying on investigations on the above subject, as the result of which they have come to the conclusion that the effects upon cattle induced by eating the *Macrozamia Fraseri* are caused by the presence in the plant of acid potassium oxalate (salts of sorrel). This is a confirmation of the results of an analysis made by a Mr. Norrie prior to 1876, and reported to the Royal Society of New South Wales by Dr. F. Milford (Journal of the Society, vol. x., p. 295).

CONTENTS.

THURSDAY, OCTOBER 11, 1906.

ELEMENTS OF ELECTRICAL ENGINEERING.

Electrical Engineering in Theory and Practice. By G. D. Aspinall Parr. Pp. viii+447; illustrated. (London: Macmillan and Co., Ltd., 1906.) Price 12*s*. net.

THIS book is the first of two or more volumes dealing with the subject named in the title. It is introductory, and treats of the elementary theory and testing methods while describing the simpler apparatus used in electrical engineering. Direct and alternating current machinery are to be dealt with in a later volume.

Magnetism is first considered, then electrostatics. Electric currents and electromagnetic effects follow, and in this way the more practical portions of the work are approached. Each chapter ends with a set of examples, chosen, for the most part, from papers set by recognised authorities. The student who works through these examples after reading each chapter will obtain a good grasp of its contents, even though one or two of the examples are perhaps unfortunate, as, for instance, that specially worked out on p. 85, which relates to a rather impossible generator the voltage of which drops noticeably when a high-resistance voltmeter is connected across its brushes. The author has taken considerable trouble to bring the book up to date, both in the descriptions of apparatus and by frequent reference to the more important of recent papers.

There is much, however, in the book, and chiefly in its earlier chapters, which to the present writer seems open to criticism. It professes to be a text-book introductory to the subject of electrical engineering. As such, its functions are surely to show clearly how the various elementary formulæ used by the electrical engineer are derived, and to describe the appliances by which electrical and magnetic quantities are measured, and also the simpler commercial applications. Many books have been written which have had this aim, but few have attained it. Either a theorist writes a text-book which, however perfect theoretically, is so far removed from actual practice as to be almost useless to the engineer, or a book is written like the present, which is full of useful information, but is not sound theoretically; or perhaps one should say rather that it is incomplete on that side. Rigid proof of fundamental formulæ is shirked, and the student loses that confidence in them which always goes with a precise knowledge of the way in which they have been derived. Text-books on electrical engineering, at any rate, should not now be written to which either of the foregoing reproaches can be urged, for the day is gone in which it was questioned whether a sound theoretical training was necessarily the basis of a practical engineer's knowledge.

The present work is quite large enough to deal thoroughly with the theory without even increasing the space devoted to this part of the subject; and yet, when reading it, just where one would expect an exact statement of the way in which a given formula has been derived, one reads that "it can be shown," or that "space will not permit a proof here." Such passages occur frequently; for instance, when deriving the magnetic force near a long wire (p. 129) or that in a long solenoid (p. 131); or, again, when obtaining the relation between hysteresis loss and the area of curves of cyclic magnetisation (p. 147), the pull along magnetic lines of force (p. 157), the capacity of a condenser (p. 173) or of condensers in series (p. 180), and the energy stored in an inductive circuit (p. 197). It is true that in one or two of these cases some very elementary application of the calculus would have been required; but even this may surely now be expected of any reader to whom the theoretical portion of the book shall be of any use at all. An equivalent graphical proof may frequently be given with advantage instead of the symbolical one, so that even this difficulty may be met. These comments do not apply to the derivation of the more complicated expressions, but only to the derivation of those which form the basis of other formulæ which the engineer may frequently have to use.

The section entitled "Electrical Resistance" includes, not only an account of the various standard and testing resistances employed, but also much useful information on insulating materials and the forms they take in practice. A matter of importance to electrical engineers is the subject of contact resistance, and particularly that occurring with carbon brushes on commutators. Exact information on this point is now available which should find a place in such text-books as the present. A few pages might also have been devoted to resistances for the absorption of power, and more than a casual reference to the use of micanite as an insulator. Considerable space is devoted to the magnetic qualities of iron stampings. One of the best chapters is that on electrical and magnetic instruments, in which the various types now used in testing and switchboard work are well described. It may be remarked, however, that under hot-wire instruments, that of Hartmann and Braun, which is the only such instrument widely used, is not described.

Although the book is generally quite readable, the English is by no means perfect throughout. The reasoning is here and there unsatisfactory, loose language creeps in, or the style becomes diffuse. These are, however, small matters, which will no doubt be remedied in a later edition.

The book includes a large number of excellent tables of physical constants and data useful to the engineer, from which much redundant matter has been excluded and modern information put in its place. Such data should always, in the present writer's opinion, be so stated as to give an idea of the percentage accuracy attainable in their measurement. To quote the hysteresis loss in tungsten steel as 216,864 ergs per cycle (p. 150), or the specific resistance of paraffin wax as $13,385 \times 10^6$ megohms per inch cube (p. 107), is to give a false impression of the useful accuracy attainable. Three significant figures in the former and two in the latter would be ample. Indeed, those familiar with insulation resistance measurement will agree that to get results concordant even in the exponent of 10, let alone the significant figures, is not always easy with such material as paraffin wax, and a much greater accuracy in stating the measurement has, therefore, no meaning.

The illustrations, of which there are nearly 300, are on the whole good, especially those of apparatus. Among the illustrations, however, there are some diagrams, such as Fig. 88, which are singularly poor, chiefly through faulty perspective drawing.

The section on glow-lamps is good and up to date, and includes a very full account of the construction and use of vacuum pumps. The subject of arc-lamps and of illumination is also well treated. The concluding section, on the "production of electromotive force" (induced voltage being, presumably, excluded), contains an account of thermoelectric effects and of primary and secondary cells, the latter being given due prominence, as becomes their importance to the engineer.

The descriptive portion of the work is throughout very carefully written and illustrated. It is full of representative information as to recent types of apparatus. It will thus be seen that Mr. Parr has placed before us a book on the elements of electrical engineering which, if not satisfying from every point of view, is nevertheless a good example of the type of text-book which will introduce the student at once to the theory and to the elementary practice of his subject. D. K. M.

COLLECTED WORKS OF ERNST ABBE.

Gesammelte Abhandlungen. Zweiter Band. By E. Abbe. Pp. ii+346. (Jena: G. Fischer, 1906.) Price 7.50 marks.

THE first volume of Prof. Abbe's works has already been noticed in the pages of NATURE (vol. lxix., p. 497). The contents of the second volume, while extremely interesting, are more miscellaneous in their character. The editors did well in collecting together in one volume their author's epoch-making papers on the theory of the microscope and his original papers on optical problems.

Abbe's friends, however, will value the possession of his complete writings, and the volume now under review shows the width of his interests and the extent of his knowledge. It opens with his inaugural dissertation at Göttingen in 1861 on the experimental foundation of the law of the equivalence of heat and mechanical energy, a paper which deals chiefly with the thermodynamics of a perfect gas so far as they can be deduced from the first law. This is followed by two astronomical papers of somewhat local interest communicated to the Frankfort Physical Association.

The fourth paper is Abbe's dissertation on receiving authority to teach in the philosophical faculty at Jena in 1863, and is on the law of the distribution of errors in a series of observations.

Abbe's interest in optics was, as is well known, first aroused by the request to help Carl Zeiss in his construction of the microscope, and it is clear that as a young man other branches of science attracted him.

A paper reprinted from the Jena *Zeitschrift für Naturwissenschaft* for 1874 follows, occupying some eighty pages of the volume, and gives his own account of two of his best-known instruments. It is entitled "New Apparatus for the Determination of Refractive Indices and Dispersion Constants," and in it are described the Abbe refractometer and the method of determining refractive indices by total reflection.

The Abbe refractometer is well known, and in the skilful hands of the Jena firm has developed into a most useful and valuable instrument. Abbe's own account of its development and of the reasons which led him to its adoption are full of interest; it was one of his earliest instruments in which the principle of autocollimation was employed; the light from the collimator is made to fall normally on the second face of the prism the index of which is required and to retrace its path; when this is the case the angle of refraction is equal to the angle of the prism, and can be easily measured; the angle of incidence can also be measured, and from a knowledge of the two the refractive index is obtained. The principle which forms the basis of the method described in the second part of the paper has been further developed by Pulfrich in his well-known total refractometer.

Another interesting article is the first list of the productions of the glass technical laboratory of Schott and Company at Jena, dated July, 1886. The story of this work has often been told; the growth of the Jena firm in the twenty years which have elapsed since the first list was published affords conclusive proof of the fertility of the union of the mathematician who had the skill to apply his knowledge in aid of the needs of industry and the manufacturer who realised that Abbe's science had a commercial value, and could be made a factor of real importance in the struggle for progress.

The introduction to this first catalogue of optical glasses opens thus:—

"The industrial undertaking which is here first brought before the notice of the public arose out of a scientific investigation into the dependence of the optical properties of solid amorphous fluxes on their chemical composition which was undertaken by the undersigned with a view to bring to light the chemico-physical foundations of the production of optical glass"—

and though at present there are many problems which confront the glass maker, thanks to the researches of Abbe and Schott the knowledge of 1906 is far in advance of that of 1886.

Enough has perhaps been written to show the interesting character of the book. Among the other papers are accounts of some of the various apparatus designed by Abbe, including the now well-known prism binocular, and some reviews and notices, both of books and men. Of these, perhaps the most noticeable is an address delivered in the hall of the Physical Institute at Jena on March 5, 1887, to commemorate the centenary of the birth of Fraunhofer, in which in eloquent words Abbe traces the debt of opticians to that great man.

At some future day a pupil of Abbe's will carry on the story and show how the next great advance in practical optics was the work of Abbe himself. His friends have done well to collect with loving care these writings of their master, and we who know him chiefly through his works are grateful to them for the manner in which they have discharged their task.

OUR BOOK SHELF.

Magnetische Kraftfelder. By H. Ebert. Second edition. Pp. xii+415. (Leipzig: J. A. Barth, 1905.) Price 7 marks.

This is a second edition of Prof. Ebert's well known treatise on magnetic fields of force, which first appeared in 1902. The author handles his subject as before with a wealth of illustration, and with a theoretical grasp, which make the book valuable alike to student and teacher. Indeed, the teacher will find in its pages many useful suggestions. Of these is the magnetic vane of Jaumann, depicted on p. 23, which recalls the appliance of Petruscheffsky, in which a small bar magnet was suspended through one pole, with a counterpoise to make it lie horizontally, and act as a one-pole magnet. Again, the little frame depicted on p. 29 for holding bar magnets during the operation of manufacturing their filing figures on a sheet of glass above them is worthy of notice. The author adopts as a brief synonym for "a point in a magnetic field to which we direct our attention" Boltzmann's term "Aufpunkt," for which we have no English equivalent. On p. 206 he uses the term "Billiontel" for 10^{-9}, which is surely a slip, since in German, as in English, a billion is 10^{12}, not 10^{9}. On p. 54 his definition of unit pole is that it is such as to repel with a force of 1 dyne a similar pole when at a distance of 1 centimetre apart *in vacuo*, whereas hitherto the accepted definition has been when *in air*. The difference may be unimportant, but it should not pass without challenge. In this edition the author has cut out most of the section upon cyclical systems, and certain deductions of the Maxwell-Hertz equations which were formerly included. On the other hand, he has introduced new matter relating to the electronic view of electricity in its relation to magnetism and to the Zeeman phenomenon. While this part of the book has been shortened, there have been added at the end fresh sections on induction, on the magnetic circuit—a distinctly valuable chapter—and another of lesser merit on dynamo-machines. The author erroneously attributes to Pixii, on p. 359, the invention of the split-tube commutator. What Pixii used in 1832, on the suggestion of Ampère, was the divided mercury-cup familiar to electricians in the primitive motors of Ritchie.

It is distinctly interesting to find a summary of recent work on kathode rays, Becquerel rays, and the rays emitted by radium, appearing as an integral part of a chapter which opens with the action of the magnetic field upon a movable conductor carrying a current. The doctrine of the electron appears to be thoroughly accepted as an essential part of electromagnetism. But the definitions which the author gives on pp. 157 and 158 of an electron apparently exclude anything and everything that is not actually moving with a high velocity:—"Unter Elektron hat man die sich mit grosser Geschwindigkeit bewegende negative Elementarladung zu verstehen." Is an electron not an electron when it is at rest?

S. P. T.

Inheritance in Poultry. By C. B. Davenport. Pp. v+134. (Washington, D.C.: The Carnegie Institution, 1906.)

This is a valuable addition to the rapidly-increasing literature dealing with the subject of inheritance. It affords a good example of the growing complexity of the theories which have been founded on the famous discovery of Mendel. The simplicity of the original Mendelian system has now to be supplemented by such conceptions as those of "imperfect dominance," "incomplete segregation," "compound allelomorphs," and the like. The author of the present treatise, well known as the director of the station for experimental evolution at Cold Spring Harbour, New York, deserves much credit for the care with which his experiments have been devised and their results recorded. Each experiment is methodically described under the heads of "Statement of Problem," "Material," "Results," "Conclusions," and the general bearing of the whole series on evolutionary theory receives full and candid discussion in a final section. The author's standpoint, as was to be expected, is in the main Mendelian, but he recognises the facts that both dominance and recessiveness are frequently incomplete, and that "an adequate theory of gametic purity has not only to explain the simple Mendelian formula, but also the facts of imperfect dominance, impurity of extracted forms, latency and atavism, and occasional particulate inheritance." Prepotency (in Bateson's sense) he holds to be as truly important in inheritance as dominance. It is worth noting that de Vries's dictum as to the sharp separation of the constituent units which make up the characteristics of organisms, between which units transitions exist "as little as between the molecules of chemistry," is, in the author's opinion, not borne out by the present experiments; nor does he find confirmation of the same biologist's assertion as to the different modes of inheritance of "specific" and "varietal" characteristics.

There are a few marks of carelessness in the text, as where the birds represented by Figs. 1 and 2 are spoken of as "black-crested white Polish." The plates are generally admirable, but in the absence of colour it is difficult to distinguish between true white and reflected high lights—a point which in some cases is of great importance.

F. A. D.

German Scientific and Technological Reader. Book i., pp. ix+105; Book ii., pp. viii+115. By E. Classen and J. Lustgarten. (London and New York: Harper and Brothers, 1906.) Price 2s. net each.

These two books should serve a useful purpose in familiarising students of science who are anxious to read scientific works in the German language with expressions and terms common in such works, but not to be found in school-books. Both volumes consist of descriptive accounts of principles and properties relating to various departments of science, and of technological processes, plainly printed in Roman characters, and suitable for reading by students who know the rudiments of German grammar.

The descriptions in the first volume deal with the propædeutics of physical and chemical science, dyeing, metallurgy, electrotechnics, and engineering; and those in the second volume are concerned, in addition, with some special points in physics, chemistry and chemical technology, spinning and weaving, and brewing. There is a vocabulary in the first volume, but not in the second, which is somewhat more advanced, and requires the use of a dictionary.

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.*]

Biometry and Biology: A Reply to Prof. Pearson.

In reply to Prof. Pearson's letter in Nature of September 6 (p. 465), I desire, in the first place, to express my extreme regret if the criticism which I ventured to offer on biometrical work in my address at York has caused pain in a quarter where I should least desire to give offence. Had I foreseen that this was likely to happen I certainly should have refrained from making any criticism on that occasion.

Prof. Pearson wishes me to explain how Dr. Pearl's paper, "A Biometrical Study of Conjugation in Paramæcium," an abstract of which appeared in the Proceedings of the Royal Society (B, 518, p. 377), lays him open to the advice that he should make sure that the problem he seeks to elucidate is sound from the standpoint of biology. I think that there is no course open to me but to comply.

Dr. Pearl states that his work on *Paramecium caudatum* was undertaken for the purpose of obtaining answers to the questions:—

"(*a*) Is the portion of the Paramæcium population which is in a state of conjugation at a given time differentiated in respect of type or variability, or both, from the non-conjugating portion of the population living in the same culture at the same time?

"(*b*) Is there any tendency for like to pair with like ("homogamy") in the conjugation of Paramæcium, and if so, how strong is this tendency?"

In making the first inquiry, and in dealing with it, Dr. Pearl appears to ignore the fact that the differentiation of the conjugants of this species is already well established. Maupas (*Arch. de Zool. exp.*, ser. 2, T. vii., p. 184), writing in 1889, says:—"Tous les observateurs qui se sont occupés de la conjugaison du *Paramecium caudatum* ont signalé la petitesse de taille des individus accouplés." He goes on to say that he has never found them to exceed 225 μ in length, usually 180 μ to 210 μ, while it is not rare to find non-conjugants attaining 300 μ or even 320 μ; so that when Dr. Pearson states that "Dr. Pearl *demonstrates* for the first time that conjugant Paramæcia are differentiated from the non-conjugant population," he appears to be in error.

It may, however, be claimed that by the application of the biometrical method of dealing with the series of measurements he has given a more precise measure of their differentiation.

I would submit that Dr. Pearl's material and modes of procedure are singularly unfitted for yielding such a result. In the first place, the specimens have been preserved and fixed, a process which every practical biologist knows to be attended with distortion.

They were prepared by different hands, partly by Dr. Pearl himself in Leipzig, partly by Prof. Worcester in America.

Dr. Pearl tells us (p. 377) that "in the measuring conjugant pairs were taken quite at random, and then in each case the two undistorted non-conjugant individuals which were lying nearest in the field of view of the microscope to the conjugant pair were measured."

Now let us consider what would happen with this mode of procedure. Paramecium, as is well known, is not a symmetrical animal. It has been described as "slipper-shaped"—not a very good comparison, but it will serve to bring out the fact that the proportion of length and breadth presented to the observer will vary according to the aspect from which the individual is viewed. At whatever stage of the proceedings the Paramecia took up the position on the slide in which they were measured, they must have sunk through a layer of fluid the depth of which was small, no doubt, but considerable in relation to their size. The conjugant pairs being attached mouth to mouth would tend to settle on the broad base presented by the sides of the attached pair, so that one side of each rested on the slide while the other side would be directed to the observer. The non-conjugants might settle on any lateral aspect. Hence a larger proportion of conjugants would be measured in side view than of non-conjugants. This would be another source of error.

To illustrate the next point I shall refer to another ciliate infusorian, allied to Paramecium, *Leucophrys patula*, to which I shall have to return later. It also was investigated by Maupas (*ibid.*, ser. 2, T. vi., p. 237, and T. vii., p. 250). The ordinary individuals of this species were found to vary in length from 80 μ to 150 μ. They have a wide œsophageal recess bordered by vibratile lips (*cp.* ser. 2, T. vi., Plate xii., Figs. 1–8). The formation of the conjugants occurs by a series of divisions, with progressive reduction in size, of an ordinary individual and of the resulting fission products, giving rise to from eight to thirty-two little conjugants 50 μ to 60 μ in length, and so unlike the non-conjugant form that unless their mode of origin had been ascertained, Maupas says, they might be referred to a distinct genus. There are neither vibratile lips nor œsophageal recess, the mouth is closed, and their movements are much more active. Here, then, is a still more marked case of differentiation of gametes than that presented by *Paramecium caudatum.*

Now the non-conjugant population of the latter species measured by Dr. Pearl to ascertain the range of their variability would include, not only ordinary individuals, but all stages of individuals in process of differentiation as gametes. The non-conjugants are a heterogeneous population; the conjugants are, on the other hand, approximately homogeneous. This appears to me another and grave source of error in his results on the degree of differentiation and variability of the conjugants.

Hence, though I am far from denying that it may be true, it appears to me that Dr. Pearl's conclusion is beset with several sources of error when he attempts to give a measure of the degree to which (p. 379) "conjugant individuals when compared with non-conjugants are found to be . . . less variable in both length and breadth."

I desire to do Dr. Pearl all the justice I can, and his case for homogamy in the conjugation of the gametes appears to me to rest on a sounder basis and to be of interest, though I am doubtful as to the validity of the explanation which he offers for this phenomenon; but that there is any analogy between it and assortative mating in man, as Dr. Pearl and Prof. Pearson conclude, seems to me problematical in the extreme. The phenomenon in man which is comparable with the conjugation of the differentiated gametes of Paramecium is the union of the differentiated gametes of man, and I am not aware that it has been shown that there is any correlation between their external characters and the external characters of the human adult.

Similarly, the conclusion contained in Dr. Pearl's ninth and last heading appears to me altogether unsound. He says (p. 383), speaking of the differentiation of conjugants, "if the individual Paramæcia of a given race must conform to a definite and relatively fixed morphological type every time they conjugate, what they may acquire during fission generations is clearly of no particular account to the evolutionary history of the race in the long run." This is to ignore the conclusion to which Dr. Pearl's results point (though it had already been established by Maupas and others), that the conjugants are differentiated gametes. It is the nature of a gamete that it is able to transmit the characters of the organism from which it springs, although itself of a size and bodily shape wholly different from that organism. Are the gametes of *Leucophrys patula*, though unlike the ordinary individuals in size and other characters noted above, unable to give rise to like forms? As a matter of fact, if proof were needed, Maupas watched them in process of differentiation into ordinary individuals.

In my address at York I urged biometricians to make sure that the problems they seek to elucidate are sound from the biological point of view. When asked by Prof. Pearson for an instance of failure in this respect I gave him, while away on my holiday, and in a private letter, Dr. Pearl's paper. He has now seen fit, although I twice asked him to wait for a full answer until my return to Cambridge, to challenge me to show in the pages of Nature how my advice was applicable to that paper. I must leave your readers to judge how far I have succeeded in so doing.

The task has been far from an agreeable one. I should never have thought of singling Dr. Pearl's paper out for public criticism in this manner had I not been challenged to do so. I can only say that if he feels himself aggrieved at the result, he can be in no doubt whom he has to thank.

J. J. Lister.

St. John's College, Cambridge, October 1.

Radium and Geology.

In the Proceedings of the Royal Society for May and August there appeared important papers by the Hon. R. J. Strutt upon radium in the earth's crust and the earth's internal heat. Taking known values of the heat production of radium, per gram per second, assuming Lord Kelvin's estimate of the conductivity of rocks *in situ* and Prestwich's estimate of the temperature gradient at the surface, Mr. Strutt shows that, if the gradient expresses the outflow of heat due to radium in the earth, the radium must be confined to a comparatively thin crust, because his laboratory experiments prove that the smallest radium content existing in the rocks examined would give a much higher gradient than the one observed if the radium were distributed throughout the entire earth.

In the present connection the crust must be defined by the depth beyond which no heat is caused by radium. In these circumstances, if we adopt a certain temperature gradient at the surface, there is only one value of the radium content which will correspond to any assumed thickness of the crust, and there will also be one corresponding temperature at the bottom of the crust and throughout the interior. I have calculated these at intervals of five miles, both for Prestwich's estimate of the gradient, viz. 1° F. for 42·2 feet descent, and also for the more commonly accepted one of 1° F. for 60 feet.

Gradient 1° F. *in* 42·2 *Feet.*

Thickness of the crust in miles	Radium content per cubic centimetre	Temperature at bottom of crust, Cent.	Temperature at bottom of crust, Fah.
		°	
15	$15 \cdot 39 \times 10^{-12}$	519	966
20	$11 \cdot 55 \times 10^{-12}$	692	1277
25	$9 \cdot 13 \times 10^{-12}$	865	1589
30	$7 \cdot 70 \times 10^{-12}$	1038	1900
35	$6 \cdot 60 \times 10^{-12}$	1211	2211
40	$5 \cdot 77 \times 10^{-12}$	1384	2464
45	$5 \cdot 13 \times 10^{-12}$	1557	2834

Gradient 1° F. *in* 60 *Feet.*

Thickness of the crust in miles	Radium content per cubic centimetre	Temperature at bottom of crust, Cent.	Temperature at bottom of crust, Fah.
		°	
15	$10 \cdot 27 \times 10^{-12}$	363	676
20	$8 \cdot 08 \times 10^{-12}$	484	894
25	$6 \cdot 39 \times 10^{-12}$	606	1112
30	$5 \cdot 09 \times 10^{-12}$	727	1330
35	$4 \cdot 62 \times 10^{-12}$	848	1547
40	$3 \cdot 84 \times 10^{-12}$	969	1725
45	$3 \cdot 59 \times 10^{-12}$	1090	1984

From the above tables it appears that the radium contents corresponding to such values as are usually assigned to the thickness of the earth's crust by geologists and seismologists are well within the amounts contained in the rocks examined by Mr. Strutt, and that consequently the surface gradient can be fairly accounted for by the theory. But we have also some indication of internal temperature from volcanic products. Prof. Bartoli found the temperature of lava issuing from Etna to be 1060° C. If this came up from beneath the crust it would correspond to a thickness of from thirty to forty miles, according to the rate of increase which we attribute to the gradient. So far all seems favourable to the theory.

Since any reasonable assumption for the mean radium content of the crust would supply sufficient heat to maintain the observed gradient, it follows that no heat can pass up from the interior, because, if it did, the gradient would be higher than it is. The conclusion would be that the earth is not a cooling body, and it is consequently reduced to a state of thermal stability.

Thus a fundamental belief of geologists is shattered at a blow. Sir A. Geikie writes in his chapter on dynamical geology that "it is useful to carry in mind the conception of a globe still intensely hot within, radiating heat into space, and consequently contracting in bulk." . . ."Wide geographical areas are upraised or depressed." These changes of level are constantly going on, such as have been described by Prof. Hull and Dr. Spencer, and the recency of these movements shows that, if they are due to a cooling globe, that process is still in progress, and the primeval heat not yet exhausted. Although there may be differences of view as to the exact mode of its operation, yet it is not too much to assert that there is a consensus of opinion among geologists that the movements of the crust are chiefly attributable to the ultimate cause so concisely expressed by Sir A. Geikie.

It seems clear that one or other of these views concerning the internal heat of the earth must yield. They cannot both be correct; and if the radium theory is to hold the field, how are the movements of the earth's crust to be accounted for?

O. Fisher.

Graveley, Huntingdon, September 28.

If the internal heat of the earth is mainly due to the radium present therein, must we not assume that the same is the case with the moon? If such were the case, then the internal heat of the latter would be far greater than we have hitherto supposed, and it would be difficult to explain the lack of volcanic activity there.

The age of our satellite is not sufficient for us to assume that all the radium is dead or that none is being produced.

B. J. Palmer.

Technical Schools, Southend, October 4.

Vectors, &c., at the British Association.

In the report (August 30) of the discussion on the use and notation of vector analysis at the British Association it is stated that I "deplored the substitution of vectors for quaternions." The statement is misleading, for was it not Hamilton more than any other single man who taught us how to use vectors in product and quotient combinations? What I did and do deplore is the substitution of non-quaternionic vector algebras in all their variety of notation for the Hamiltonian or quaternionic vector algebra—a very different thing.

I should like to add that (notation excepted) I was thoroughly in sympathy with all that Prof. Henrici said in opening the discussion. He showed admirably the conciseness of vector methods in attacking both geometrical and physical problems, and so far as he went in the limited time at his disposal there was absolutely nothing to choose between his mode of presentation and that which Hamilton himself might have adopted in the same situation. In his reply at the end of the discussion he pointed out that the quaternion, *as a quantity*, could be got quite easily from his system by taking the difference of his vector and scalar products. That, of course, is self-evident, but it does not seem to me to touch the real issue. It leaves his system still non-associative in vector products, and in higher applications, especially with the differential operator ∇, this introduces difficulties which are unknown to the quaternionist. It is a suggestive fact that both Gibbs and Jahncke, in order to develop their respective systems, found it necessary to introduce quite other kinds of products of vectors—products which are as different from one another as each is from the quaternion product, and yet have not the geometrical significance of Hamilton's creation.

There is an idea in some minds that there is a rivalry between vector analysis and quaternions. There is nothing of the kind. There is a quaternion vector analysis and a crowd of other vector analyses known best by the names of their authors, such as Grassmann, O'Brien, Gibbs, Heaviside, Bücherer, Jahncke, Henrici, Peano, Macfarlane, &c., no two of whom, curiously enough, agree with one another. Of all these, Hamilton's is the only vector analysis associative in its vector products. The importance of this associative law does not, of course, appear so long as we restrict ourselves to products of two vectors only, and, as a matter of fact, many vector analysts never really get to higher products. When, however, three or more vectors are to be combined, the associative law must be fulfilled if simplicity and flexibility of operation are to be retained. The vector analysis which admits the associative law in product combinations *is* the quaternion vector analysis, however it may be disguised by arbitrary symbolism and notation. C. G. KNOTT.

Edinburgh University, September 21.

I ALSO deplore the use of the current but misleading phraseology which Prof. Knott points out. Quite certainly Prof Knott's more detailed statement should be substituted in the interests of "terminological exactitude."

THE WRITER OF THE REPORT.

Remarkable Rainbow Phenomena.

WHEN I read Mr. Spence's interesting letter (p. 516), it occurred to me that the appearance of the second primary rainbow was due to the reflection of the sun from the sea. The apex of this second bow would be above that of the first bow, the angular distance between the apices being about equal to double the sun's altitude at the time of the observation.

Taking approximate figures, I make Deerness to be in longitude eleven minutes of time west of Greenwich, and in latitude 59° north. Assuming Mr. Spence's times to be Greenwich times, the sun's altitude at 6h. 30m. p.m. was about 4°, so that the angular distance between the apices of the bows would be about 8°, a result differing but little from Mr. Spence's estimate of 5° or 6°. As the sun sank this distance would diminish.

I should be glad to know if Mr. Spence observed any difference in the intensity of the light. One would expect the higher bow to be the fainter of the two, as it was due to a reflected sun, though the loss of light by reflection would be diminished by the very low altitude of the sun. By Fresnel's formula, the reflected sunlight would be to the direct sunlight in the ratio of 13 to 20. If we neglect the slight polarisation of this reflected light, these numbers will also express the relative brightness of the higher and lower bows, other conditions being alike.

Probably the most remarkable case on record is that of the octuple rainbow, seen in 1841, by the late Mr. Percival Frost, from the top of Dunstaffnage Castle, near Oban. The sea, both behind and before the observer, was perfectly smooth. Four bows were seen in the sky, viz. ordinary primary and secondary bows due to direct sunlight, and, above these, primary and secondary bows due to sunlight reflected from the water behind the observer.

Seen in the water in front were also four bows, inverted by reflection. These bows were not images of tbe first four, but images of four bows that could have been seen in the sky had the water been removed and the observer brought down vertically to a position as far below the sea-level as the actual observer was above it. The eight bows formed four intersecting circles. For further details and an illustration reference should be made to NATURE, vol. xli. (p. 316). C. T. WHITMELL.

Invermay, Hyde Park, Leeds, September 29.

Suspended Germination of Seeds.

THE letter of "H. B. P." in NATURE of September 27 (p. 540), while giving an interesting instance of the sudden appearance of the foxglove on a bare hill in the north country, does not appear to be conclusive as to the seedlings having developed from long-buried seeds. They might have originated equally well, it appears to me, from wind-blown seeds being conveyed to a recently disturbed soil, where they had an opportunity of germinating, and where they were not subject to the competition of other and stronger species. On the extensive shingle deposit near Dungeness, in Kent, one of the earliest species to appear on the newly deposited shingle is the foxglove. The first is usually the oat-grass *Arrhenatherum avenaceum*, and the third is often the wood-sage *Teucrium Scorodonia*; the seeds of all these must have come from some considerable distance, and it is not suggested that the plants arose from long-buried seeds.

I am by no means asserting that seeds may not under suitable conditions remain dormant for considerable periods, but we want instances to prove this in which other factors have been carefully and completely eliminated. This does not appear to be the case in the above instance, where it is also possible that the seeds produced in the summer may have been blown into the interstices of the wall, the disturbance of which led to their dispersal over the site, and this might account for the absence of the seedlings from the neighbouring turf-surface which had also been disturbed, and which should have yielded them had the seeds been blown from the dry capsules of the plant after the destruction of the wall in the spring.

Yardley Lodge, Oxford. G. CLARIDGE DRUCE.

The Rusting of Iron.

HAS anyone inquired whether the rusting of iron may not be associated with some micro-organisms? The facts that oxygen, water, and carbon dioxide are necessary; that iron does not rust when immersed in boiling water and then sealed up; that certain solutions are said to inhibit rusting (*e.g.* potassium ferrocyanide, a poison), and that certain other solutions encourage rusting (*e.g.* ammonium chloride and perhaps sea-water, compare the composition of plant-culture solutions); that iron is a constituent of chlorophyll, and that rusty nails sometimes cause blood-poisoning, all these facts suggest a case for inquiry. There is, I think, an iron bacterium noted in some of the bacteriological books. The precipitation of iron carbonate might conceivably hold a place in the life of some organism corresponding to the precipitation of calcium carbonate by foraminifera.

HUGH RICHARDSON.

12 St. Mary's, York, October 1.

Colour Illusions.

WITH reference to Mr. T. Terada's letter in your issue of September 27 (p. 540), I noticed some similar effects while making experiments with a form of colour top last year. An old gramophone motor forms a very convenient way to observe this, and by using various discs painted in different rings and segments many curious optical effects may be seen.

I was, in fact, trying to see whether the effect of the persistence of vision could not be used to indicate the speed, and, to a certain extent, it can no doubt, but the effect is not sufficiently definite, and there is too much of the personal equation present to make it of practical use. If a disc is painted in two or more rings, and each ring is divided into a different number of segments, in colours or black and white, it is well known that each ring will become a uniform colour above a certain speed, according to the number of segments; the effect takes place at about forty alternations per second. Very interesting stroboscopic and complementary colour effects may be obtained in this way, some of which I have not seen mentioned yet; the complementary colours only appear at a certain speed, and show best in sunlight; the effect is peculiar—almost iridescent sometimes. B. J. P. R.

October 3.

LOWELL'S OBSERVATIONS OF THE PLANET MARS.[1]

In the year 1893 the important volume on Mars, entitled "La Planète Mars et ses Conditions d'Habilabilité," was noticed in these columns (vol. xlvii., p. 553). This work, the outcome of an immense amount of labour on the part of M. Camille Flammarion, brought together every available observation and piece of information that could be gathered from published and unpublished works. In fact, the history of the observations made on this interesting planet was traced from the time of the earliest record (1636) down to the opposition of 1892.

Fourteen years have now elapsed, numerous workers have been busy studying his surface markings, and steady progress has been made in corroborating old and discovering new features. The time seems, therefore, ripe for a work supplementary to that above named which should bring together the mass of valuable material which is now scattered through many different pamphlets and journals.

Such an undertaking would undoubtedly consume much time and labour on the part of the compiler, but would prove a valuable addition to the literature of planetary astronomy.

Failing such a work at the present time, we have, however, a volume which will not only fill up the gap temporarily, but will reduce to a very considerable extent the labour of the future compiler to whom reference is made above.

This very handsome and valuable publication gives a detailed account of the observations made by Mr. Percival Lowell himself during the oppositions of 1894, 1896, and 1903; the supplement to the volume contains the observations of Mr. Douglass, assisted by Mr. Drew, at the opposition of 1898, owing to Mr. Lowell's absence through illness, and of Mr. Lowell and Mr. Douglass at the 1900 opposition.

In the arrangement of the subject-matter Mr. Lowell follows the classic memoirs of Schiaparelli, considering each opposition by itself, and adopting a chronological and topographical order for the observations themselves. In this way, during an opposition, the story runs "on in time while making meanwhile the circuit of the planet."

As is well known, Mr. Lowell preserves Schiaparelli's nomenclature, which he refers to as an "at once appropriate and beautiful scheme." He makes, however, one important change, which is necessitated in the light of advance of our knowledge of the interpretation of the planet's markings. In the place of "Lacus" he adopts the word "Lucus," an alteration of a single letter, for markings which were previously considered to represent water are now looked upon as probably oases of land. It was Mr. W. H. Pickering's observations and deductions which first suggested this inversion of the then general idea of the dark and light shadings, and this knowledge was considerably extended by Mr. Lowell's observations.

In the observation of details on a planet's surface it is well to bear in mind that the power of the telescope is of less importance than steadiness and clearness of the air and keenness of the observer's vision. In fact, Schiaparelli's observations of the canals made with his 6-inch telescope were not corroborated at once by observers who were armed with very much more powerful instruments.

That keen-eyed observer Dawes was accustomed to cut down the aperture of his telescope according to the kind of night experienced. Thus he termed his observing nights 6-inch night, 4-inch night, &c., according to the "seeing."

In considering Mr. Lowell's observations of Mars, the reader must bear in mind that, unlike most astronomers who make their observations from where the observatory is permanently situated, Mr. Lowell investigated the "seeing" conditions of a great number of regions in order to choose the most efficient spot for the observation of planetary details, and hence the position for his observatory. The steadiness of the air at Arizona thus allowed him to use larger apertures efficiently, and, coupled with his keen sight and expertness in this kind of observation, his observations are of the first importance. He, like Dawes, found that the aperture of the telescope had to be suited to the night. Thus of the opposition of 1900–1, using a 24-inch refractor, he writes (p. 101):—

"Observations were made with the 24-inch objective of the observatory and usually with the full aperture of the objective. On occasions, however, this was capped down to an aperture of 12 inches; an optical device which usually improved the seeing; . . . but because by so doing the harmful effects of the air currents were reduced. For the same reason at times even the 6-inch could be serviceably used."

FIG. 1.—Lowell's drawing of Mars at longitude 90° at the opposition of 1903, showing Solis Lacus near the top.

[1] "Observations of the Planet Mars, during the Oppositions of 1894, 1896, 1898, 1901 and 1903, made at Flagstaff, Arizona." By Percival Lowell. ("Annals of the Lowell Observatory," vol. iii., 1905.)

At the opposition of 1894 an 18-inch glass made by Brashear was employed, but for the oppositions of 1896 and later the 24-inch objective mentioned above was made and mounted for the observatory by Alvan Clark and Sons, "the last glass, as it chanced, of that famous firm."

Even at Flagstaff Mr. Lowell was not content with the astronomical conditions of seeing all the year round. For this reason, at the opposition of 1896–7, he determined to try the conditions in Mexico for the winter months; observations were therefore terminated in November, 1896, and not resumed until December 30. In the meantime the dome and telescope were transported and set up at Tacubaya, near the city of Mexico, in latitude 19° 26′ N. This temporary change resulted in a long series of post-opposition observations.

With regard to the method of recording the observations, drawings, notes, and micrometer measures formed the usual routine. The drawings were made on circles about 40 mm. in diameter, a convenient size for combining "most satisfactorily sufficient space with possibility of keeping proportions." As a rule, we are told, the drawings were of the complete disc, and were made as nearly instantaneously as possible.

FIG. 2.—Longitude 270° at the opposition of 1901 with Syrtis Major near the centre of the disc (Lowell).

Coming now to the observations themselves, and the numerous clear drawings which accompany them, it seems extremely difficult to refer to any particular set of them, as they are all so full of interest. The observations bring out, however, very clearly the apparent discrepancies which have arisen between observations taken of the same region, but at different times, by well-known Martian observers. Thus, to take a case in point, in the opposition of 1894 Mr. Lowell relates how, in observing the region about Syrtis Major, which was central on the disc, the most prominent features were tongues of shade which lay between Hellas and Naochis, and nearly joined the Syrtis to the blue band bordering the cap. "For the rest no detail could be made out upon the disc, except for two dark spots where the coast-line dipped to enter the Great and Little Syrtes respectively; the only salient points these of an otherwise featureless face. Not only was there no sign of a canal, but even the main markings showed dishearteningly indefinite."

Such an apparent lack of markings was, as Mr. Lowell points out, a matter of the Martian date. It was, as he says, "the very nick of time to see nothing. For the part of the planet most presented to the earth was then at the height of its dead season." Mr. Lowell states, further, "when we consider that such is always the face the planet shows when at its nearest to the earth, and that till lately such time was commonly chosen for examining its disc, it is small wonder that previous to Schiaparelli the strange canal-system should have escaped detection."

The above extracts will, we think, convey to the reader the pitfalls into which the Martian observer can stumble in consequence of the seasonal changes on the planet.

Again, Mr. Lowell gives instances of markings which undergo a secular variation covering many years. Thus a conspicuous single canal, called by Lowell Sitacus, connecting the eastern fork of the Sabaeus Sinus with the north-east corner of Aeria, was not seen by Schiaparelli. It was such a salient feature in 1894 that he could not have missed it had it been there. Cerulli noticed it in 1896, and it has been seen at all subsequent oppositions as a fairly conspicuous canal. This canal exemplifies, as Mr. Lowell says, "the truth of a deduction of Schiaparelli that the canals were curiously subject to secular wax and wane."

Another canal, Ulysses, unrecorded by Schiaparelli, which in 1894 was comparable in strength with the Gigas or the Titan, is a further instance of secular change.

It is interesting to note that Mr. Lowell gracefully explains the great difference between the number, 183, of canals seen at Flagstaff at the opposition of 1894 and that recorded by Schiaparelli, 79, as "due solely in consequence of better observational conditions of one sort and another."

Among other results of this opposition was the clear detection of the seasonal change; an increase in the number of the oases which lie at the intersection of the canals; an extension of the canals in the dark regions which conclusively showed that the dark areas were not "seas"; observations on the changes of shades of the dark areas showing that they were not bodies of water; and, finally, peculiar markings, termed "nicks," were observed where the canals entered the light regions.

Space does not permit one to enter into anything like detail with reference to the observations made at the succeeding oppositions. In that of 1896 there was sufficient evidence to show that, as Schiaparelli had pointed out, the doubling of the canals was not wholly a seasonal effect. Another observation of importance was the identification of a rift in the snow-cap with the subsequent canal called Jaxartes.

In the opposition of 1900 the Phosin and Euphrates were always seen double, as in 1896. Mr. Lowell suggests that probably the two epochs of gemination of the canals on Mars as laid down by Schiaparelli may not be epochs of gemination, but epochs of greater conspicuousness of the gemination at one time than at another; this would bring apparently discordant facts into line.

During this opposition Solis Lacus was not seen with its usual distinctness, and it is inferred that as it was at its dead season it had turned sear and yellow. White equatorial spots of long duration were an important feature at this time.

The observations of 1903 were very fruitful with results, and special reference should be made to the relationship between the oases and the double canals.

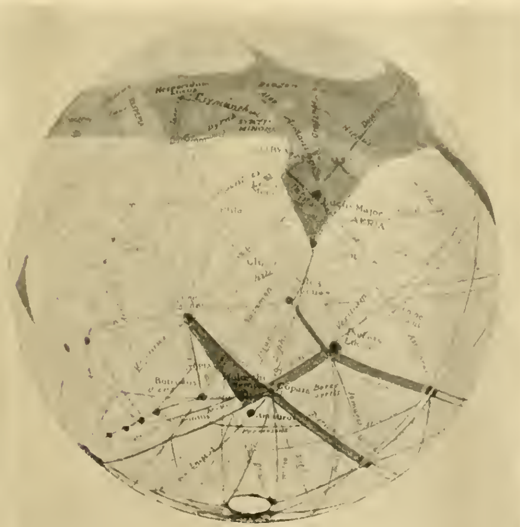


Fig. 3.—The same longitude (270°) as in Fig. 2 from observations made at the opposition of 1903 (Lowell).

The reader should also direct his attention to the semi-annual flux in the development of the canals which was revealed, showing that two waves of development sweep alternately over the planet's surface in the course of one of its years, this being clearly illustrated in Lowell's cartouches.

Regarding the appearance of cloud on the planet's surface, Mr. Lowell is inclined to think that the large, whitish marking named Hellas to the north of Syrtis Major represents either mist or cloud. In the opposition of 1901 it was never seen as white as the polar cap, although it approximated to it more than to all the regions outside of it. He was thus led to believe that it was not formed of snow, but of "something which would thus hold an intermediate position between snow and ground, namely, cloud or mist."

Another, among other references to cloud, is mentioned at the opposition of 1903, in relation to the region about the Mare Acidalium and the pole, this region being obscurely semi-white. On January 23 Mr. Lowell wrote: "No sharp limit to polar cap. Think it surrounded by spring cloud."

Many other points of interest in connection with these and similar observations might be dwelt on at some length, but the reader must be referred to the volume itself for a more intimate study.

In addition to a good index to the volume, there is a special index of the names on the maps and globes. In the latter there are fifty-four regions, 392 canals, and 172 oases mentioned, which will give the reader some idea of the number of Martian markings seen at Flagstaff.

In addition to the frontispiece, which is a reproduction from a photograph of the 24-inch equatorial, there are thirteen plates and seventy-six illustrations in the text, all of which are of first-class quality.

Printed in large, clear type on smooth, stout paper, and occupying about 350 pages, the volume contains a valuable increase to our knowledge of Mars, and forms a handsome addition to the astronomical library.

On the production of this volume Mr. Lowell and his staff are to be sincerely congratulated, the more so that since its publication success has rewarded their endeavours in recording the canals of Mars on a photographic plate (Roy. Soc. Proc., Ser. A, vol. lxxvii., p. 132).

William J. S. Lockyer.

THE PLACE OF THE MODERN UNIVERSITY IN THE STATE.

THE recent quatercentenary celebrations of the University of Aberdeen, and especially the speeches of the venerable Chancellor of the University on that occasion, again direct the attention of thoughtful men to the vital connection between national efficiency and well-being and the provision made by a State for the higher education of its people in modernised universities. The presence of the King and Queen to open the new buildings at Marischal College serves admirably to accentuate the fortunate fact that in their endeavours to provide this country with institutions adequately equipped to supply instruction of the highest grade and with facilities for research in all departments of knowledge, our statesmen, our men of science, and our men of wealth are receiving some of that encouragement of their efforts which it is the power of our Sovereigns to bestow.

The brilliant gathering of learned men eminent in every sphere of human endeavour, and representative alike of science, art, and letters, may be taken as a happy augury of the unanimity that prevails to spare no effort in the pressing work of supplementing and extending the supply of seats of the highest learning in every part of the country, with a view to place Great Britain on terms of equality with other great nations in the keen competition which is the outstanding characteristic of international relations at the beginning of the twentieth century.

With these evidences of educational enthusiasm and endeavour before us, it seems a fitting opportunity to consider briefly what appears to be the current plan of procedure and to inquire how far this is likely to meet the prevailing needs. Enthusiasm, unless well directed, is not enough. British educational endeavour has too often proved unproductive because of its haphazard character, and instances are extant where in neighbouring countries better results have followed a smaller expenditure of money and trouble, because each new development has made an addition to a carefully conceived plan. The policy of muddle is, at all events, fatal in education.

There must, in the first place, be an intimate connection—a close association throughout, indeed—between the systems of elementary and secondary education on one hand, and the colleges and universities on the other. The trinity of grades must form an organic whole dominated by the same ideals, imbued from base to apex with the same spirit of earnest thoroughness, where at every stage the learner must be taught to be content with nothing short of the best. A boy's opportunities for progress should be limited only by his natural aptitudes; and brains, wherever found, must be regarded by educational administrators in every district as a national asset to be trained, developed, and sharpened to their full extent. How far this is from being the case at present many recent articles in Nature and other contributions to current literature have shown. Not only is the amount of preliminary training received by boys seeking admittance to college insufficient, but the kind of education they have received is unsuitable.

The principal of the Manchester Municipal School of Technology, who is particularly well qualified to speak on this subject, wrote in an article (*School World*, April) published this year:—

"Those who are familiar with the standards of entrance to our advanced schools and colleges of science know only too well how low are the standards of admission. Whatever may be the 'face' requirements of matriculation, the actual marks required for a pass are extremely low, necessarily so in the present state of our secondary education. It is further well established that the average time actually spent in the secondary schools is not much, if any, more than a third of that required in German and Swiss schools of similar rank—in short, either the pupils go in too late or they finish too early. In any event, they leave without an adequate training, alike in respect of both time spent and subjects studied. Moreover, the age of admission to our universities and specialised schools of applied science is two years below that of similar institutions on the Continent. In these circumstances, how is it possible that the output, in respect of the quality of the students, can rival that of foreign institutions?"

Commenting upon the kind of secondary education given in this country, a writer in Nature of March 23, 1905 (vol. lxxi., p. 487), states:—

"The custodians of English education are still actuated by mediæval ideals. The entrance of the student of science to the older universities is still obstructed by an obsolete and ludicrous test in Greek. There is a tendency even yet among those in charge of our Department of Education to discourage and hamper the instruction in science in our elementary and secondary schools."

Lord Strathcona did well to emphasise in his address at the Aberdeen graduation ceremony the stimulating influence which Scottish universities have had upon the schools of that country, for it is especially to the improvement of the type and standard of English secondary education that attention must be at once seriously directed if full advantage is to be made of English universities and technical colleges. We have arrived at the stage when the pressing need is neither suitable buildings nor qualified teachers—these we have in a more abundant measure than is necessary to meet present needs—but students suitably prepared and thoroughly grounded in the fundamentals of a sound secondary education. The number of day students in our technical schools and colleges is still ridiculously small, and too many of those in attendance are reaping little benefit, because they lack habits of serious study and the acquaintance with fundamental principles they should have acquired at school. It is in this direction that immediate improvement is required. In Germany, to quote an example of what can be done, the secondary schools are turning out youths trained to think and to reason, trained in the methods of acquiring knowledge, and inspired with an earnest desire to study the subjects necessary to enable them to occupy positions of command in their country's industrial army. But the German boy is, as a matter of course, allowed to remain at the secondary school to the age of eighteen or nineteen, and parents willingly make the necessary sacrifice, having learnt how abundant in later years is their reward. In some way or other, if we are to compete on anything like equal terms with other nations, we must import a spirit of greater earnestness into our secondary schools, allow our boys to remain in them longer, and adjust our curriculum to modern needs. The British boy, if rightly directed, has no superior in ability, earnestness, and intelligence generally, and it is little short of criminal to handicap him with an antiquated course of study and a curtailed school career.

But it is not only the bonds which connect the secondary school with the university which must be drawn closer and strengthened; the systems of elementary and secondary education must be rendered more interdependent. Our capacity-catching machinery has improved in recent years, it is true, but it is far from perfect; and the endeavours made to open a way for boys of exceptional brain-power in the elementary school, through the secondary school, to the university, have been spasmodic and not in accordance with a carefully thought-out scheme. Indiscriminate scholarship giving has in many cases resulted only in the manufacture of surplus clerks and ill-trained schoolmasters, and the absence of clear aims and a definite policy as to what education is expected to accomplish for these exceptional boys has resulted in waste of money, loss of opportunity, and a growing disbelief in the efficacy of higher education. Instead of benefiting our industries and strengthening the hands of our manufacturers, our educational muddling has given rise to discontent, whereas a policy of clear thinking and the application of the methods of science to educational problems would have produced a well-balanced and judiciously graded system of national education—capable of providing the country with trained workers for every sphere of activity.

Equally striking would be the effect on the universities themselves if such a coordinated scheme of education could be brought into being. Instead of the glorified boarding-school type which at present functions as a university, where young men continue to play games and practise "good form" to the exclusion of serious work, all our universities would be institutions filled with well-trained youths earnestly intent upon acquainting themselves with the triumphs accomplished by modern research, and upon fitting themselves in their turn to extend the bounds of knowledge.

Lord Strathcona in his address at the graduation ceremony also wisely insisted upon the national character of the Scottish universities, and brought into high relief a feature which should distinguish all modern universities. It is too often forgotten in this country that the provision of universities is primarily a national obligation, and that the State which is content to leave to private initiative and to individual generosity the all-important work of raising and endowing seats of the higher learning is neglecting one of the most potent means for securing its own vitality. The recognition by statesmen of this national duty need not discourage local effort and enthusiasm; indeed, experience tends to show that both are quickened in districts where such State universities are established. The duty has been fully recognised by foreign Governments, and the lavish generosity of the State in Germany and the United States was ably pointed out by Sir Norman Lockyer in 1903. Sir James Crichton Browne has repeated the warning more recently. Speaking at the University of Leeds at the beginning of the month, he said:—

"England has been remiss of late in perceiving and promoting those interests that hinge on scientific and medical research. In this direction Germany has stolen a march upon us, for the various Governments in that Empire have unstintedly provided their universities with fully-equipped research laboratories, organised and conducted by professorial directors."

The importance of securing this exercise of what should be regarded as a State prerogative consists, not only in ensuring an immediate and adequate supply of institutions of university standing, but—in an equal degree—in realising the right atmosphere in the university when it gets itself established. The parochial spirit is fatal to university development. The boy proceeding from the school to the university should pass from an institution dominated by local aspirations to one imbued with Imperial instincts, where thought is unfettered and ambitions are free to soar. Sir James Crichton Browne expressed the same thought very distinctly at Leeds when he remarked:—

"It would be a misfortune to a boy to pass from a secondary school to a university in the next street, where he would meet as his fellow-students only his old schoolfellows, and where, however amply fed with knowledge, he would still be surrounded by the same traditions and associations and shop amongst which he had been brought up. A provincial university is a contradiction in terms. What is wanted is a group of territorial universities, each with distinctive features of its own, specially adapting it to its environment, but all affording the most liberal instruction, the finest culture, the best intellectual discipline of the day, and collectively meeting the higher educational needs of the whole country."

Another point made by Lord Strathcona may be considered profitably in conclusion. Speaking of American universities, the Chancellor said:—

"They found out long ago that law and medicine and theology are not the only legitimate points of academic study; and in their faculties of applied science they are training their young men to do work that is most loudly called for. They have never accepted the view that universities must necessarily be institutions cloistered and apart from the main current of public life and service. On the contrary, they make a training for citizenship and for public usefulness the basis and foundation of much of their educational activity. The reward they have is that —fully as much as we do here—they find their *alumni* in every walk of life, not in the 'learned professions' only; and some of the most notable benefactions which the American universities have lately received come from men whose desire it is to connect them still more closely with practical work."

In other words, a university training is valuable in every department of work. The culture which is the gift of every living university to each of its sons is capable, in addition to equipping for remunerative labour, of affording intellectual guidance in all life's difficulties, of encouraging individuality, and of promoting a symmetrical intellectual development. Besides providing men able to compete worthily in the international struggle for industrial supremacy, the modernised university, which is actually the crown and summit of a sanely planned system of secondary and elementary education, will send out men of wide sympathies, above insular prejudices, and in all things dominated by a sweet reasonableness.

NOTES.

THE seventh annual Huxley memorial lecture of the Anthropological Institute will be given on Thursday, November 1, at 8.30 p.m., in the theatre of the Civil Service Commission, Burlington Gardens, W., when Prof. W. M. Flinders Petrie, F.R.S., will deliver an address on "Migrations." Tickets can be obtained on application to the secretary of the institute, 3 Hanover Square, W.

THE inaugural meeting of the session of Guy's Hospital Pupils' Physical Society will be held on Saturday next, October 13, when Prof. T. Clifford Allbutt, F.R.S., will deliver an address on "Words and Things." The chair will be taken at 8 o'clock by Sir Samuel Wilks, F.R.S.

DR. THOMAS HARRISON, formerly Chancellor of the University of New Brunswick, died on September 18 in Fredericton, at the age of sixty-eight. He was professor of mathematics in the University from 1885 to 1892, and Chancellor from 1892 until last August, when he retired on a Carnegie pension.

A REUTER message from Wellington, New Zealand, reports that a monument to Captain Cook was unveiled on October 8 in the presence of a large gathering of both races at Poverty Bay, on the east coast of the North Island, at the spot where the explorer first landed.

WE learn from the New York correspondent of the *Times* that Sir William Perkin was the guest of honour at Delmonico's on October 6 at a dinner given by four hundred American chemists and manufacturers of chemical products. Prof. Chandler presided, and many well-known Americans were among the guests. Dr. Nichols presented to Sir William Perkin the first cast of a gold medal to be known as the Perkin medal, and to be awarded each year to some American chemist who has distinguished himself in the field of research. Another gift to Sir W. Perkin was a silver service as a personal tribute from the chemists and manufacturers who were present.

IT was mentioned last week (p. 545) that the Governor of Hong Kong had appointed a committee to inquire into the alleged failure of the observatory to give warning of the violent storm that burst over the colony on September 18. According to a Laffan message from Hong Kong on October 8, the report of Zi-ka-wei Observatory at Shanghai shows that a published warning was issued against the passage of a typhoon two days before it struck Hong Kong. The latter place was not warned because for years the Hong Kong Observatory has refused to exchange warnings with the Jesuit observatories at Shanghai and Manila.

IT is announced in the *Lancet* that the first International Congress on Alimentary Hygiene and a Rational Diet for Man, to be held at the Paris Faculty of Medicine on

October 22–27, will include the following sections:—(1) biological physics; (2) biological and physiological chemistry; (3) rational food systems and dietetics; (4) analytical chemistry, adulteration, and legislation; (5) bacteriology, toxicology, and parasitology; (6) statistics, instruction, and ways and means; (7) application of hygienic principles in the manufacture and preparation of food, and conveyance of food from place to place; (8) the hygiene of food and rational food systems in the home and elsewhere; (9) cooperation and competition; (10) distribution of food gratis or at reduced prices; (11) food in relation to the prevention of alcoholism and tuberculosis; and (12) the diffusion of knowledge in schools and elsewhere with respect to rational food systems and the hygiene of food. The first seven of these twelve sections constitute Division 1 of the congress, dealing with scientific methods, and Prof. Bouchard and Prof. Armand Gautier will preside. The five last sections constitute Division 2 of the congress, dealing with social questions relating to food; the president will be M. Jules Siegfried.

The annual Huxley lecture was delivered at Charing Cross Hospital on October 1 by Prof. Ivan Pawlow, of St. Petersburg, the subject being the scientific investigation of the psychical faculties or processes in the higher animals. All the experiments were made on dogs, and the excretion of saliva was made the test of the response of the animals to external impressions. As is well known, the salivary glands secrete, not only when the stimulus of appropriate substances is impressed on the mouth, but also when other receptive surfaces, including the eye and the ear, are stimulated; the latter actions have received the name of psychical stimuli, but have unquestionably much in common with ordinary reflex action, and are termed by Prof. Pawlow "conditioned reflexes," to distinguish them from the ordinary or unconditioned reflexes. The greater part of the lecture was devoted to the development of this conception of the nature of the conditioned reflexes, which would thus be removed from psychical phenomena and be relegated to the domain of physiology.

The winter session of the London School of Tropical Medicine was opened on Monday last with an address by Colonel Kenneth Macleod. In the unavoidable absence of the Duke of Marlborough the chair was taken by Sir Francis Lovell, the dean of the school, who, in introducing the lecturer, briefly described the aims and objects of the school. Colonel Macleod, after paying a tribute to the work of Sir Patrick Manson, briefly detailed the inception of the school, and pointed out that, while the debt has been paid off, a sum of at least 60,000*l*. is needed for endowment. Prominent among the needs of the school at present is the appointment of an entomologist. The trend of modern investigation and thought has forced into the forefront the fascinating subject of comparative pathology. In the tropics all life, and particularly parasitic life, is exuberant; the lower life is rampant, and the higher heavily handicapped. The salutary effect of drainage, cultivation, and cleansing is well illustrated by the banishment of malaria from England. To develop and strengthen the resistive and curative elements of the animal organism is one of the chief objects of medical science, and the principle which underlies the great discovery of Jenner is, after the lapse of a century, obtaining new and remarkable applications. Examples were also given by the lecturer of problems still awaiting solution. In the evening the staffs and past and present students of the London Schools of Tropical and of Clinical Medicine held their annual dinner at the Hotel Cecil, Sir W. Hood Treacher in the chair. Among the guests were Prof. Blanchard, of Paris, the medical director-general of the Navy, Sir John McFadyean, and others.

With regard to the series of demonstrations in practical microscopy mentioned in Nature of September 13 (p. 496), the committee of the Quekett Microscopical Club has made the following arrangements:—November 16, Mr. H. F. Angus, on "Axial Substage Illumination with Artificial Illuminant"; December 21, Mr. Angus, on "Dark-ground Illumination"; January 18, 1907, Mr. C. L. Curties, on "Polarised and Multicolour Illumination" and "Various Methods of Recording Observations"; March 15, Mr. Conrad Beck, on "The Illumination of Opaque and Unmounted Objects"; April 19, Mr. Beck, on "The Comparison of Objectives"; May 17, Mr. F. W. Watson Baker. The next ordinary meeting of the club will be held at 20 Hanover Square, W., on Friday, October 19, at 8 p.m., when the following papers will be read:—On *Tetramastix opoliensis*, a rare rotifer, C. F. Rousselet; and on the reproduction of mosses and ferns, J. Burton. Cards of admission to the demonstrations or the ordinary meetings may be obtained from the hon. sec., Mr. A. Earland, 31 Denmark Street, Watford, Herts.

"Ueber die Zelle" (Leipzig: W. Engelmann, price 60 pf.) is the title of a fragment (45 pp.) of a work on the cell begun by the late Prof. Alfred Schaper. It contains a short historical introduction wherein the chief stages in the development of the cell theory are given, and also a discussion of the more modern views as to the structure of the cell constituents. Its chief interest will probably be for those who knew its author.

Some phases of the gastrulation of the horned toad (*Phrynosoma cornutum*) form the subject of a paper by Messrs. C. L. Edwards and C. W. Hahn published in the *American Journal of Anatomy* (vol. v., No. 3). The egg in the genus Phrynosoma comes nearer to those of lower vertebrates than does that of any other of the Amniota in that its protoplasmic pole seems less encumbered with yolk, while the elevation of the blastoderm renders the processes taking place therein as independent as in amphibians. Phrynosoma is, in fact, a connecting link in this respect between other reptiles and the axolotl, and thus with the mollusc Bithynia.

To the *Zeitschrift fur wissenschaftliche Zoologie* (vol. lxxxiv., part iii.) Mr. H. Schlichter communicates a paper on the electrical organs of the proboscis-fish (*Mormyrus oxyrhynchus*) of the Nile, dealing specially with their histology, which has hitherto received little or no attention, although the organs themselves have been long known. Although situated in the tail, as in Torpedo and Raia, the electric organs of Mormyrus (which have but little power) have each plate composed of a whole bundle of modified muscular fibres instead of a single fibre, so that they must be regarded as representing the union of numerous electro-blasts. Special attention is devoted by the author to the manner in which the nerves supplying these organs terminate, and to the nature of such terminations. Another and longer article in the same issue, by E. Rossbach, is devoted to the anatomy and developmental history of the "redia"-stages of the trematode worms infesting (in the above-mentioned stage) the pond-snails *Paludina vivipara*, *Limnaea stagnalis*, and certain other species of the same genus as the latter. The budding, degeneration, and regeneration phenomena of certain marine ectoproctous Bryozoa form the subject of the third article, by Mr. O. Römer.

In the *Revue Scientifique* (September 1) Dr. A. Calmette discusses the channels of entrance of the tubercle bacillus into the organism. The chief conclusion is that both in man and animals the tubercle virus usually gains access by the digestive tract, particularly the intestine.

The *Bio-Chemical Journal* for September (vol. i., Nos. 8 and 9) has a number of important papers, including a study of the digestive gland in mollusca and crustacea, by Mr. H. E. Roaf; variations in the gastric hydrochloric acid in carcinoma, by Mr. F. W. Morton Palmer; an investigation of the staining act with eosin-methylene blue, by Dr. Wakelin Barratt; secretin in relation to diabetes mellitus, by Messrs. F. A. Bainbridge and A. P. Beddard; and further observations on the treatment of diabetes by acid extract of duodenal mucous membrane, by Prof. B. Moore, Mr. E. S. Edie, and Dr. J. H. Abram.

In the opening article of the sixth number (July) of the *Philippine Journal of Science*, published at Manila, Mr. P. G. Woolley discusses the disabilities against which the serum-laboratory has had to contend in its crusade against rinderpest in the islands, one of these being the difficulty of procuring cattle sufficiently susceptible to the disease. As the investigations connected with the nature of the virus are only in their infancy, it will suffice to state that the results at present obtained are not in all ways in accord with previous theories. As the result of a preliminary survey of the Lobu Mountains, in the Batangas province, Mr. W. D. Smith is enabled to report the occurrence of post-Eocene strata containing the gastropod genus Vicarya, so widely distributed in the Indo-Malay countries. The remaining articles are devoted to the vegetation of the Lamao forest, a catalogue of Philippine Hymenoptera, with descriptions of new species, and notes on Mindoro birds.

An extension of cotton cultivation is again recorded in the annual report for 1905–6 on the botanic station in Antigua, the crop being estimated at forty tons. A new variety, Centreville, received from the Department of Agriculture in the United States, and said to be immune to wilt, was grown experimentally; the yield was good, but the staple proved to be irregular. An experiment is being fostered by the curator, Mr. T. Jackson, to grow broom corn with the object of manufacturing brooms to supply local requirements.

In an article on Antarctic botany, printed in the *Scottish Geographical Magazine* (September), Mr. R. N. R. Brown discusses our present knowledge and future problems. Only two flowering plants have been collected in the Antarctic regions as compared with about 400 species from Arctic countries, but the lichens and algæ are better represented, and fifty mosses have been recorded. Seeing that the mean summer temperature never rises to 32° F., the vegetation is richer than would be expected. Much still remains to be done in collecting, especially from the Pacific and Indian sides, to obtain data that may throw light on the former configuration of land and water.

In the annual report for 1905–6 on the botanic station and experimental plots in St. Kitts, the curator, Mr. F. R. Shepherd, notes that a number of cacao and rubber plants have been distributed, the latter being principally specimens of *Castilloa elastica*; a first consignment of Hevea plants was received during the year. The crops grown on the experimental plots included sweet potatoes, cassava, yams, onions, and cotton. The cotton exports from St. Kitts, Nevis, and Anguilla, amounting to 120 tons of lint, showed a very large increase over the preceding year. A trial was made in St. Kitts of growing wrapper tobacco under shade and Sumatra tobacco in the open; as this was a first attempt, the curing presented difficulties that might be avoided in the future.

We have received a short pamphlet referring to the preservation of a portion of the primeval forest, known as Riccarton Bush, that still exists on the Canterbury Plains in New Zealand, about two miles from Christchurch. The pamphlet gives some details as to the indigenous and rare plants growing there, and contains a list of the flowering plants and ferns. The dominant tree is the *kahikatea*, *Podocarpus dacryoides*, but there are large specimens of two other species of Podocarpus and two species of Elæocarpus. There are also found the urticaceous milk-tree *Paratrophis heterophylla*, a Pseudopanax with protean foliage, the pepper tree, *Drimys colorata*, and other specialities. The acquisition of forest land containing so many unique specimens merits the consideration, not only of the citizens of Christchurch, but of the inhabitants of New Zealand generally. An influential committee has been formed to raise the necessary funds, and the Government of New Zealand has promised a vote of about one-fifth of the sum required.

A memoir of the Geological Survey on the water supply of the East Riding of Yorkshire, by Mr. C. Fox-Strangways and Dr. H. R. Mill, has just been published by the Board of Agriculture and Fisheries. The memoir contains an outline of the geology of the East Riding and of portions of the vales of York and Pickering, with especial reference to the water-bearing strata. It includes records of all known sinkings and borings in the area, together with analyses of waters and a bibliography. There is also a section on the rainfall, with a colour-printed map. Copies may be obtained from any agents for the sale of Ordnance Survey maps, or directly, or through any bookseller, from the Ordnance Survey Office, Southampton, price 3*s*.

The latest addition to the series of reports designed by the Geological Survey to describe the mining centres of Western Australia is a report (Bulletin No. 22, Perth, 1906) by Mr. H. P. Woodward on the auriferous deposits and mines of Menzies, North Coolgardie goldfield. It covers ninety-two pages, and is accompanied by two maps and six plates of sections. The area embraced covers about fifty square miles, and consists of a complex series of basic rocks through which have been intruded a series of acidic dykes. The quartz veins, which are confined to the greenstones, are of various types, most of the gold having been obtained from segregation veins of lenticular form. From the area described there have been produced 403,787 ounces of gold, derived from the treatment of 348,967 tons of quartz. The deepest mine in Menzies, the Menzies Consolidated Gold Mine, has yielded 65,875 ounces from 99,371 tons of quartz. The vein in this case is clearly of the true fissure type.

The standardisation of error is a difficult problem to which the attention of the Engineering Standards Committee has been directed. Much has been written on the limits of error, but no attempt has hitherto been made to deal with the subject in the exhaustive manner that it is treated in reports No. 25 (London: Crosby Lockwood and Son, price 10*s*. 6*d*. net) and No. 27 (price 2*s*. 6*d*. net), issued by sectional committees of the Engineering Standards Committee Report No. 25 deals with errors in workmanship, based on measurements carried out for the committee by the National Physical Laboratory. In order to assist them in the formulation of a system for limit gauges, the committee, in addition to collecting evidence from both manufacturers and users, carried out a comprehensive series of measurements on actual work, and a record of these measurements is contained in report No. 25, but no system of limits is laid down therein, the recommendations being contained in report No. 27, which deals with British standard systems for limit gauges (running fits). The measurements were carried out on a number of plain cylindrical shafts and holes from 2 inches to 12 inches in diameter. The recommendations based on these measurements deal with running fits, and cover diameters of $\frac{1}{4}$ inch up to 12 inches. It is proposed that the allowance for a running fit shall be made in the hole, and not on the shaft. The standard tolerances and allowances are clearly shown graphically and in tabular form. Four grades of work are provided for, the highest being intended for special cases in which extreme accuracy is necessary. The reports should be carefully studied by all mechanical engineers, and it is to be hoped that the committee will carry its investigations still further, and ascertain whether it is possible to draw up recommendations for standardising driving fits.

A PAPER by Mr. Wilkinson in the current number of the Journal of the Institution of Electrical Engineers, on waste in incandescent lighting, is of particular interest in view of the recent recommendations of the standardising committee in connection with incandescent lamps. Mr. Wilkinson deals very fully with the question, and gives examples of waste due to various causes, and suggests remedies to counteract them. The need for local laboratories and standardising of the pressure of supply is very strongly insisted upon, and several pressure charts are given which show how irregular the pressure regulation is at various supply stations. Automatic regulators in the generating stations are the author's solution of the latter difficulty, the benefit of which has already been proved at Harrogate, where they are installed. Mr. Wilkinson also finds that "local control" of lamps to be used on the supply mains is effective in ensuring that the lamps supplied by the manufacturers are up to specification, and at the same time leaves the contractors the benefit of the trade in lamps.

MR. F. HOWARD COLLINS has sent us a specimen of the "360° Mariners' Compass Card," designed and registered by him. There is nothing new in the idea of marking by degrees, it having been suggested for use in ships of H.M. Navy so far back as about 1896. But though the plan is a good one, the great difficulty is to get it made universal. Ships nowadays generally do steer by degrees, but the card is marked from N. and S. 90° each way to E. and W. Thus a ship would steer N. 80° W. present style, new style 280°, which would convey very little to a poorly-educated sailor man. As regards compasses in use ashore for surveying and similar purposes, they have been marked to 360° for a very long time; and the only other markings on the card are the cardinal points, the method of recording being similar to that suggested. The system has much to commend it, and if it could only get generally known there is no doubt its advantages would in time lead to its adoption throughout the fleets of the world.

THE development of certain species of moulds, such as Penicillium and Aspergillus, is shown by B. Gosio in the *Atti dei Lincei* (vol. xxv., ii., p. 59) to be accompanied by the transformation of carbohydrate into phenolic derivatives containing a closed carbon chain. In certain cases coumarin and its derivatives seem to be formed, which show characteristic colour reactions with alkalis and with ferric chloride. The production of such substances, it is suggested, may prove a valuable means of detecting changes in maize caused by parasitic agency, and a method of diagnosis in cases of pellagra, which is generally regarded as due to the toxic action of substances elaborated in maize owing to the development on it of certain fungi.

WE have received a copy of vol. xix. of the annual reports on the advancements of pharmaceutical chemistry and therapeutics, issued by Messrs. E. Merck, of Darmstadt. The work comprises 260 pages of information of a character sufficiently defined by the title, and supplies a really valuable summary of recent pharmacological research. Each substance is dealt with under the heading of its name, the names of the drugs being arranged alphabetically. A useful index of diseases and symptoms is appended as a guide to the appropriate drugs for their treatment. The fact that particulars are given of the chemical nature and properties of new drugs which have been put on the market with fancy names makes the report valuable, not only to the medical man, but to the chemist. The work is sent free to medical men and others interested in pharmacology or therapeutics on application at Messrs. Merck's London office, 16 Jewry Street, E.C.

IN No. 85 of the Communications from the Physical Laboratory of the Leyden University Prof. H. Kamerlingh Onnes and Dr. W. Heuse describe some experiments made on the coefficient of expansion at low temperatures of Jena and of Thüringen glass. An ordinary dilatometer method was employed, the temperature of the rods of glass, which were about 1 metre long, being measured by an appropriate platinum-resistance method, accepting for this platinum the relation between resistance and temperature obtained in experiments described in Communication No. 77, $R_t = R_0(1 + 0.003864t - 0.00000103t^2)$. The steady, low temperatures were obtained by means of liquid gases contained in an ingeniously constructed vacuum vessel open at both ends, into the outer wall of which was sealed about the middle point a kind of "aneroid box," to take up the strains due to the very different expansion of the outer and inner glass tubes. The results of the experiments gave for the range −182° C. to +16° C. the following values of the coefficients in the ordinary formula for linear dilatation, $L_t = L_0(1 + \alpha t + \beta t^2)$:—

For Jena glass 16''', $\alpha = 7.74 \times 10^{-6}$, and $\beta = 0.00882 \times 10^{-6}$
For Thüringen glass, $\alpha = 9.15 \times 10^{-6}$, and $\beta = 0.0119 \times 10^{-6}$

The authors seem unaware of the experiments by Dr. Travers on the same subject, and their result gives for mean expansion of ordinary glass a value considerably greater than that found by him.

AMONG the articles in the current number of the *Monthly Review* are two dealing with scientific subjects. M. Henryk Arctowski deals with polar problems and the international organisation for their solution. He first directs attention to the conference held on September 7 in Brussels, when the three questions it is suggested might be solved by international cooperation were discussed, viz. the problem of the North Pole, the geographical problems of the Antarctic regions, and the scientific problems necessitating simultaneous expeditions and universal cooperation. M. Arctowski gives a brief historical sketch of polar research up to the present time, considers critically the difficulties yet to be surmounted, and suggests several new plans which would possibly prove successful in clearing up outstanding questions. Mr. S. Leonard Bastin discusses the possibility of an intelligence in the plant. The purpose of the paper is to bring together a few instances which seem to point to a limited intelligence in the vegetable kingdom. The cases selected are those not easy to explain as direct response to any special stimuli. The Droseraceæ provide Mr. Bastin with several instances. The study of roots and the opening and shutting of floral envelopes add other interesting examples to a readable article. The same number of the magazine contains some reflections upon English and German education, by Mr. R. B. Lattimer.

The Proceedings of the Royal Physical Society, Edinburgh, for September (vol. xvi., No. 6), contains an interesting account of certain blood-inhabiting protozoa by Miss Muriel Robertson, including the description of a new trypanosome from a python. Other papers are a note on a rare sponge from the *Scotia* collection, by Prof. Arthur Thomson and Mr. J. D. Fiddes; notes on fossils from the Falkland Islands, by Mr. E. T. Newton; note on the geology of Gough Island, by Mr. J. H. Harvey Pirie; and notes on the petrology of Gough Island, by Mr. R. Campbell.

A second revised edition of Prof. E. Mach's "Erkenntnis und Irrtum" has been published by the firm of J. A. Barth, Leipzig. The original work was reviewed in Nature of November 30, 1905 (Supplement, p. vii).

The practical treatise on "Nitro-Explosives," by Mr. P. Gerald Sanford, published by Messrs. Crosby Lockwood and Son ten years ago, was reviewed in Nature of September 3, 1896 (vol. liv., p. 410). The second edition, revised and enlarged, which has just appeared, embodies accounts of important advances since the publication of the original work, and the chapter on smokeless powders has been considerably enlarged.

OUR ASTRONOMICAL COLUMN.

The Relation between the Spectra of Sun-spots and Stars.—The conclusion arrived at by Sir Norman Lockyer regarding the similarity of the spectra of sun-spots and Arcturian stars (Proc. Roy. Soc., vol. lxxiv., 1904) receives confirmation from a research carried out at the Mount Wilson Observatory. The results of this research are published by Mr. W. S. Adams in No. 2, vol. xxiv., of the *Astrophysical Journal*. During the latter part of June some spectrograms of sun-spots were obtained, including the blue end of the spectrum, and these were compared with a spectrogram of Arcturus secured with the Snow telescope and a grating spectroscope, with a total exposure of twenty-three hours. The comparison showed that a striking resemblance exists between the sun-spot and the star spectra. Not only are the lines intensified in the spot found to be intense in the star, but the absolute intensities are very similar.

From this evidence Mr. Adams concludes, as did Sir Norman Lockyer, that the physical conditions prevailing in the atmosphere of Arcturus are nearly identical with those existing in sun-spot vapours. Hence, on the probable supposition that sun-spots are cooler than the general solar photosphere, Arcturus and similar stars must be placed on a lower temperature level than the sun.

The Mount Wilson Spectroscopic Laboratory.—An interesting illustrated account of the spectroscopic laboratory attached to the solar observatory on Mount Wilson is given by Prof. Hale in No. 2, vol. xxiv., of the *Astrophysical Journal*. As Prof. Hale points out, it is now necessary, if research in solar physics is to produce the most fruitful results, to be able to imitate, as nearly as is possible in the laboratory, the conditions of temperature, pressure, &c., obtaining in the sun. To this end the laboratory at Mount Wilson has been equipped, and the means are always at hand to obtain, immediately, spectrograms for which the light-source has been subjected to enormous pressure or temperature, or has been placed in a strong magnetic field, is in an attenuated atmosphere, or, in fact, is under any special conditions which may possibly account for peculiarities observed in the solar phenomena.

The Utility of Short-focus Reflectors.—In No. 39 of the *Naturwissenschaftliche Rundschau* Dr. A. Berberich discusses the advantages of short-focus reflectors in nebula photography, and describes the results obtained at Potsdam with an astrographically mounted reflector of 41 cm. diameter and 92·7 cm. focal length. The mirror is an exceptionally good one, made by Schmidt, of Mittweida, Saxony, and giving well-defined small images, over a large field, with the full aperture. When the full aperture is used in photographing the Pleiades, the resulting photograph, with thirty minutes' exposure, shows all the details of the nebula secured by Prof. Keeler, with the Crossley reflector, in four hours.

Similarly, forty minutes' exposure on γ Cassiopeiæ shows as much detail in the nebula as was obtained by Dr. Roberts, with his reflector of 51 cm. aperture and 250 cm. focal length, in ninety minutes. With the aperture reduced to 24 cm., the Potsdam instrument will photograph the Orion nebula in one hour, and show all the details and all the stars shown on Dr. Roberts's photograph after an exposure of three hours twenty-five minutes.

Prof. Barnard's "Unexplained Observation."—In a letter to the *Observatory* (No. 375) Mr. Charles L. Brook suggests that the object seen by Prof. Barnard in 1892, for which he was unable to account by any known object, and therefore published a note on the subject only quite recently, may have been a new star. The reason for suggesting this possibility is that, with but one exception, all the known Novæ have appeared in the Milky Way; and Venus, which Prof. Barnard was examining when he made the unexplained observation, was on that date either on the border of or in the galaxy.

Jupiter's Sixth Satellite.—As Jupiter is now approaching opposition, the search for the smaller satellites has been commenced at Greenwich. Owing to unfavourable meteorological conditions no photographs were obtained until August 28, but on that date, and on August 31, the sixth satellite was successfully photographed with the 30-inch reflector, giving exposures of twenty-eight and forty-five minutes respectively. Several other successful photographs have been obtained since (the *Observatory*, No. 375).

Observations of Long-period Variables.—In No. 4116 of the *Astronomische Nachrichten* Prof. A. A. Nijland publishes the results of a series of observations of a number of long-period variable stars. The list includes thirteen Algol variables, four short-period and forty-one long-period variables, and the observations were made with the 10-inch telescope and 3-inch finder of the Utrecht Observatory, the "step" method being employed.

THE CONGRESS OF AMERICANISTS AT QUEBEC.

The fifteenth International Congress of Americanists was held at Quebec on September 10–15 under the presidency of Dr. Robert Bell, of the Geological Survey of Canada. There were about 133 members and associates, most of whom were Canadians; a noticeable and pleasing feature of the congress was the large number of French-

Canadian clergy and missionaries who attended the conferences; the missionaries were hearty, bronzed, bearded men, mainly in the brown or white robes of their several orders; many of them contributed papers, and several joined in the discussions. An exceptionally large number of papers was promised, but owing to the non-appearance of many authors, most of whom were Americans, the actual number read was not excessive, and there was generally time for a short discussion; it is a common fault of congresses that too much time is occupied by the reading of papers, many of which are of limited interest, and too little time is provided for discussion of problems of general interest; it is scarcely an exaggeration to state that the most valuable discussions were the informal ones that took place on the precipice-poised Dufferin Terrace.

The papers that were read fell into two or three groups, of which the more important were Canadian ethnology and Central American archæology. The former were mainly provided by missionaries, who, from their long residence among the tribes of whom they treated and their knowledge of the languages, were able to give faithful and detailed accounts of the customs and mode of life of the people; but the scientific hearers could not always feel a perfect reliance upon the interpretation of customs and ideas by certain observers, their point of view being so different.

The genial Father Morice was much in evidence, and he read a long paper on the position of women among the Dénés, or Athapascans, as they are generally termed. He described the five different ways in which marriage may be contracted, and related the deplorable part of the women during the funeral ceremonies which accompany cremation, and during widowhood in general. He repeatedly referred to the slight consideration paid to women, the men treating them no better than dogs; one would like to hear what the women themselves really think of the matter, but this information could only be obtained by sympathetic white women from native women. This side of similar questions has hardly ever been obtained, and it promises most important results. Father Pacifique, a missionary among the Micmacs, considers the *manitus*, or guardian spirits, of that tribe as of "truly diabolical nature," and states that these Indians have now conceived a profound aversion against them, and gained such an attachment to the true God and to the Church that religion has become a second nature to them. The good man apparently has not realised that the Indians were previously saturated with spiritual ideas, and that their religious sense is by no means the result of the foreign doctrine.

The Rev. J. Jetté, S.J., stated that the Ten'a, an Alaskan tribe living on the Yukon River, not only have no chiefs or rulers, but lack a word that signifies chief, or authority, or even family. Individual authority in any form is unbearable to the tribe. They are controlled solely by public opinion, and no individual thinks for himself; as they do act spontaneously they are most untrustworthy, and the stupidity of their obedience is appalling. Wealth and influence make the people who own them the natural advisers of the tribe, but they do not confer any real authority. Dr. F. Boas gave a valuable paper on the most important unsolved ethnological problems in Canada; of particular importance is archæological investigation of the extreme north-western Arctic region, in order to determine the influence of the Indian and of the Asiatic cultures upon the western Eskimo. The prehistoric distribution of types, as well as the present types, of the interior of Labrador and of the Mackenzie Basin require investigation. The linguistic subdivisions of the Algonquin and the Athapascan are not sufficiently known, and extended collections of linguistic material from the Salish tribes, from the Nootka, as well as from the northern branches of the Kwakiutl of British Columbia, are required. The early history of the eastern Algonquin still presents many obscure points. A particularly promising region is the interior of Labrador.

Prof. McCurdy exhibited a large number of lantern-slides to illustrate an extensive collection of pottery in Yale University from Chiriqui which is decorated with representations of the armadillo, the treatment including all stages from realism to extreme conventionalism, and Dr. Gordon, of the Philadelphia Museum, illustrated an analogous series of rattlesnake motives in Central American and Mexican art. Miss Angel de Cora, of the Winebago tribe, described her efforts to revive among the Indian students of the Government school at Carlisle the decorative art of their respective tribes; the experiment has met with great success, and the Indians have begun to recover their national pride and an interest in their legendary lore. Miss Natalie Curtis, who has travelled much in North America and lived among various tribes in order to study their music and songs, sung before the congress a delightful series of various types of Indian songs; these were faithfully rendered with great spirit.

Several papers were given by the veteran Dr. Seler on his recent discoveries in Mexico, and he joined in many discussions; and Senor L. Batres, of Mexico, gave a long, copiously illustrated account of his recent excavations in Teotihuacan. Dr. Tozzer gave an interesting account of his field work in Central America. The Maya of Yucatan are at present all Catholic, but they still retain a considerable number of their old beliefs and customs, although in a modified form. The Lacandones, who are comparatively free from outside influence, retain many of their ancient customs. They make pilgrimages to ruined cities, where they offer incense to the gods, making offerings of copal placed in the bowls of incense burners. Idols are anointed with blood drawn from the ear. The names and attributes of deities recorded by early Spanish writers have also survived; but no knowledge of the hieroglyphic writing survives, a circumstance which appears to be due to the extinction of the noble and priestly castes; the surviving population probably represents the descendants of the ancient common people, who, while having a general superficial knowledge of ceremonial religion, would not be instructed in esoteric religion or in ceremonial lore.

The above are some of the subjects brought before this congress, and are sufficient to show the range of subjects dealt with; from this point of view the congress was very successful, and not less was this the case from the social aspect. Government officials and private citizens did their best to render the congress a success, and especial thanks are due to the staff of Laval University, who by their assiduity, urbanity, and diplomacy helped to make everything go smoothly. The weather, too, was all that could be desired.

Abstracts of nearly all the papers were printed and distributed to members and associates, who were also provided with a local guide-book and various publications, amongst which may be noted a special number of the Transactions of the Department of Archæology of the University of Pennsylvania (vol. ii., part i.). The Provincial Government of Quebec gave two volumes dealing with geographical names in Quebec. The Provincial Government of Ontario presented the archæological report of the Department of Instruction; this contains a number of valuable papers on the archæology, anthropology, and ethnology of Canada by authors of repute; indeed, it forms a very welcome statement of the present state of our knowledge of these subjects. The University of California contributed a report, by Putnam and Merriam, on cave exploration in California, and the American Anthropological Association a report on anthropology in America since the New York meeting, 1902. A series of publications, by L. Batres, was given by the Commission of Inspection and Preservation of Antiquities of Mexico.

It is to be hoped that one result of the congress will be to encourage the central and provincial governments and the learned societies of the Dominion to take a greater interest in their native peoples. Unfortunately there has been great neglect in this respect, and if those in authority do not bestir themselves it will soon be too late, as the opportunities for successful work are rapidly disappearing. The British Association has given a small grant for many years towards ethnological research in British Columbia, and for the last year or two the Government grant committee has continued this work; valuable results have been obtained, but this is but a drop in the bucket, and ethnologists look to the Canadian governments to complete the work in a manner worthy of a great country.

A. C. HADDON.

THE STUDY OF FOSSIL FISHES.[1]

THE discovery of general principles in the study of fossils is much hampered by the imperfection of the geological record. As every geologist is aware, we are dependent for our knowledge of the life of past ages on a few isolated episodes which have been locally preserved. There is no continuous history of the life of long periods in the rocks of any region that has hitherto been well explored. Cessations in the deposit of sediment, the recurrence of unfavourable conditions, and extensive migrations, among other causes, have all contributed to this result. An increasing acquaintance with scattered episodes in the secular development of life, however, tends to reveal its main outlines; and if we are unable to discover the actual facts we can at least arrive at an approximation to them which serves all immediate purposes. If we can determine the "fashion," so to speak, which prevailed during each successive period in the geological history of a race of animals, we are able to distinguish between those changes in anatomical structure which led to stagnation or extinction, and those which were necessary for evolution to a higher plane. An acquaintance with the precise links between one grade and the next is not of supreme importance.

In the case of fossil fishes, some general principles are already discoverable, and they may be treated as an illustration of the results which palæontology is now attaining.

The earliest remains of fish-like animals satisfactory enough for discussion are those from the Upper Silurian rocks, both of Europe and North America. They suggest that long before the latter part of the Silurian period fishes had already become a flourishing and varied race, but could not be preserved among fossils because they had not

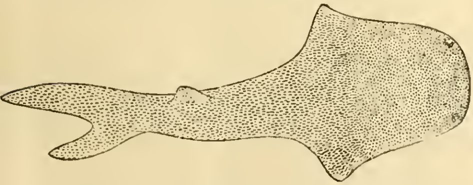


FIG. 1.—*Thelodus scoticus*, Traquair; head seen from above, the tail twisted to show dorsal fin and heterocercal tail mainly in side-view, about one half nat. size.—Upper Silurian; Lanarkshire. To illustrate the most primitive skeleton of separate skin tubercles. [After Traquair.]

acquired a hard skeleton. The Upper Silurian fossils show how this skeleton first began, and, if we may assume that the order in which the different kinds of hard parts successively predominate is the order in which they evolved, it is easy to perceive how they gradually arose. Fortunately all the phenomena can be traced in one compact group of lowly fish-like animals, the Ostracodermi or Ostracophori, which are so readily distinguished from the fishes proper that there is no risk of confounding with them members of any other line of descent. The hard skeletal parts were confined exclusively to the skin, and in most of the earliest members of the group they were merely scattered tubercles of limy matter like the shagreen of modern sharks (Fig. 1). The tubercles fused together into armour plates in two different ways. Sometimes (as in the Cephalaspidæ) a few regularly spaced tubercles grew larger than the others, and each of these became a centre of attraction round which the immediately surrounding tubercles coalesced to form polygonal plates. These coalesced again in accordance with the shape and motions of the underlying soft parts. More rarely (as in the Asterolepidæ) fusion of the tubercles occurred first along the sensory canals, thus eventually producing overlapping armour plates which were symmetrically arranged like those of Pterichthys.

No link is known between the Ostracoderms and the typical fishes which have a lower jaw and paired fins; and it is evident that the latter had already appeared in Silurian times before they possessed a skeleton hard enough to be preserved among fossils. The Silurian and earliest Devonian Acanthodians (Fig. 2), however, cannot be far from the beginning of these typical fishes, and they seem to show how paired fins began. These very old Acanthodians are known because they are completely covered by small, hard skin-granules like those of the oldest fossilised Ostracoderms. Not only did the armour begin here in the same way as in the Ostracoderms, but there was also an occasional fusion of the skin-granules into plates where stiffness was possible or necessary. A few rows of the granules fused together at the front edge of the median fins above and below the body, thus forming cut-waters or "spines"; and as a double series of exactly similar "spines" occurs along the lower border of the abdomen where the two pairs of fins are found in later fishes, it is reasonable to infer that these are likewise the stiffened front edges of fins. In other words, paired fins were not originally restricted to two pairs, but formed a double series along the entire length of the abdomen. The later Acanthodians (Fig. 2, C, D) had only the ordinary two pairs

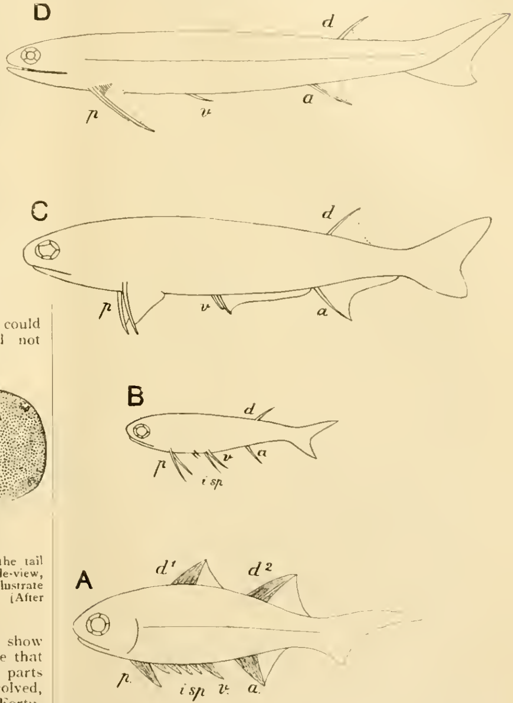


FIG. 2.—Outlines of Acanthodian Fishes, illustrating their gradual elongation in shape and loss of "intermediate spines," as they are traced upwards in geological formations. A, *Climatius scutiger*, Egerton; Lower Old Red Sandstone, Forfarshire. B, *Mesacanthus mitchelli* (Egerton); *ibid.* C, *Acanthodes sulcatus*, Agassiz; Lower Carboniferous, Edinburgh. D, *Acanthodes gracilis*, Roemer; Lower Permian, Bohemia. [Figs. B, C after Traquair, D after Fritsch.] *a.*, anal fin; *d.*, dorsal fin; *i. sp.*, pairs of spines between paired fins ("intermediate spines"); *p.*, pair of pectoral fins; *v.*, pair of pelvic fins.

[1] Abridged from the Presidential Address to the Geologists' Association, February 2, 1906. (Proc. Geol. Assoc., vol. xix., pp. 266–282, figs. 1–15.)

of fins; but as these were unsuited for further elaboration, the primitive fishes of this grade did not advance further. They became long-bodied or almost eel-shaped before their final extinction.

Fishes only began to make real progress when their fin-flaps were stiffened by internal rods of cartilage in addition to the hard skin-structures. Such fins were essentially paddles, and could be used for crawling in the mud as well as for ordinary swimming in water. It is therefore interesting to observe that during the Middle and Upper Devonian periods, when four-legged lung-breathers must have been just beginning to appear on the land, nearly all the highest fishes had their fins in the shape of paddles (Fig. 3, A). It seems as if at that time there was a general tendency for the fashionable and most advanced fishes to become crawlers rather than swimmers; and there cannot be much doubt that the known Crossopterygii, or "fringe-finned ganoids," as these fishes are commonly termed, are the unsuccessful survivors of the race which originally produced the earliest crawling lung-breathers or Labyrinthodonts. The Dipnoi, or paddle-finned fishes, which breathe both by gills and by a modified air-bladder (almost a lung), were also especially abundant at the same period. In fact, in having the fundamental part of the upper jaw fused with the skull instead of loosely suspended from it, the Dipnoi agree more closely with the land animals than do the Crossopterygii; but before this feature had been acquired, the roof-bones of the skull had subdivided into smaller plates, such as could not have changed into the skull-bones of an ordinary Labyrinthodont, while the teeth had curiously clustered into plates, so that they could never have produced the Labyrinthodont dentition. The few survivors both of Crossopterygians and Dipnoans at the present day exhibit the usual long-bodied or eel-shaped contour of decrepit derelicts.

The next grade of fishes, the Chondrostei (Fig. 3, B), which specially characterised the Carboniferous and Permian periods, had fins in which the internal cartilages formed only an effective basal support, while the greater part of their expanse was stiffened by flexible skin-fibres, which had become "fin-rays." Some of these fishes degenerated into eel-shaped creatures in the Triassic, Rhætic, and Liassic periods, while others grew to unwieldy proportions and eventually passed into the modern sturgeons.

Thus far there had been scarcely any ossification of the internal skeleton of the head and trunk in fishes; but by the dawn of the Triassic period a large number of the Chondrostei had passed into the Protospondyli, and then the formation of a hard brain-case and vertebral column began. This only happened after the median fins had become absolutely complete, namely, after the upper lobe of the tail had shortened so that the tail-fin formed a flexible fan-shaped expansion at the blunt end of the body, while each separate ray in the other median fins was provided with its own definite support. The Protospondyli (Fig. 3, C) characterised the Triassic, Rhætic, and Jurassic periods, and exhibited endless variety; but their sole survivors at the present day are the long-bodied Lepidosteus and Amia of American fresh waters.

Associated with almost the earliest Protospondyli, there were a few precocious fishes which evidently completed their vertebral column at once. This race, including such genera as Pholidophorus and Leptolepis, seems to have temporarily exhausted itself in the effort, for it always occupied a secondary place in the fish-faunas until the beginning of the Cretaceous period, when it rapidly multiplied, became fashionable, and replaced the Protospondyli. Thus arose the modern fishes of the same grade as the herring and salmon, characterised, not only by a complete vertebral column, but also by a simplified lower jaw, which consists only of two pieces on each side (without the splenial bone which forms so conspicuous a feature of the earlier fishes). The Isospondyli, as they are termed, being thus provided with a completely bony internal skeleton as well as completed fins, admitted of many more variations than any of their forerunners. The typical fish-head now began, for the first time in its history, to exhibit essential changes. The supraoccipital bone often grew upwards to project on the roof, and thrust outwards the now well-ossified and enlarged ear-capsules (Chirocentridæ); while the premaxilla sometimes extended backwards to slip beneath the maxilla and exclude the latter from the margin

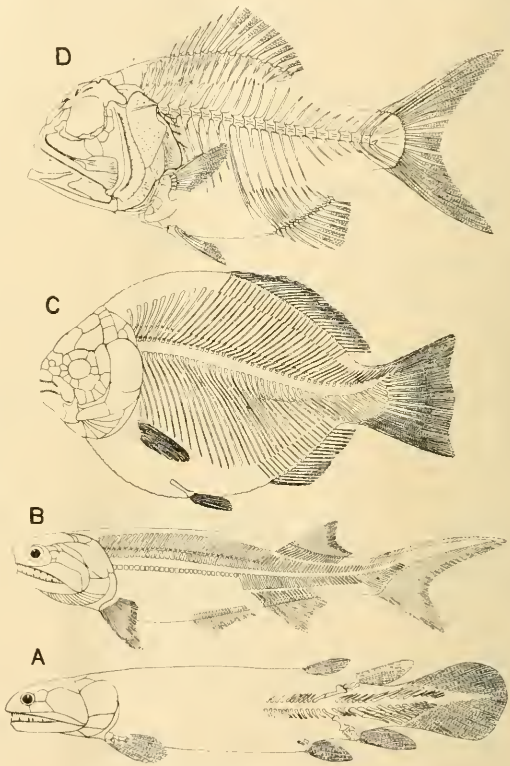


FIG. 3.—Diagram illustrating grades in the evolution of bony fishes.—A, Paddle-finned fish (Rhizodont Crossopterygian) characteristic of the Middle and Upper Old Red Sandstone periods, internal skeleton only partially shown in drawing; *tendency* towards shortening lobes of fins and simplifying their internal supports. B, Ray-finned fish (Palæoniscid) characteristic of the Carboniferous and Permian periods, showing the extended pelvic fin with numerous supports, the dorsal and anal fins with supports fewer than rays, and the caudal fin heterocercal; *tendency* towards shortening upper lobe of tail, and towards equality in number between rays and their supports in the other median fins. C, Ray-finned fish (Dapedius) characteristic of the Triassic and Jurassic periods, showing short-based pelvic fin with one large support, the dorsal and anal fins having a separate support for each ray, and the caudal fin almost homocercal; *tendency* towards acquisition of bony vertebræ and ossification of the cartilaginous skull. D, Modern ray-finned bony fish (Hoplopteryx) characteristic of the Upper Cretaceous and Tertiary periods, showing premaxilla below maxilla, completed internal skeleton, pelvic fins far forwards, and some spinous fin-rays; *tendency* towards extreme development of ear-capsules, supraoccipital bone, and premaxilla, besides a fixed number of spinous fin-rays and the forward position of the pelvic fins.

of the upper jaw (Enchodontidæ). The pelvic fins in a few fishes were now displaced forwards, so that their supports even touched the bones bearing the pectoral fins (Ctenothrissidæ). Still more interesting, the bones of the gill-cover began for the first time to develop spines (Enchodontidæ).

Among fishes, as among other animals, spines characterise only the latest representatives of the class. When the skeleton is well ossified, races which have reached or just passed their prime tend to acquire more skeletal matter than they actually need, and the surplus is then arranged as spines and bosses, usually in a symmetrical manner. In the case of fishes, some of the fin-rays become hardened, and spines arise chiefly on the cheeks and gill-covers. The Acanthopterygii ("spine-finned") are thus the highest and latest fishes of all, though they sometimes eventually descend from their high estate by degeneration. They exhibit all the peculiar changes in the skull, upper jaw, and pelvic fins noticed as first appearing in a variable manner in the Cretaceous Isospondyli. They also differ from all the earlier races of fishes in the common numerical fixity of their vertebræ and fin-rays. There are whole families in which the number of vertebræ never varies, and there are large genera in which all the species have the same definite number of spinous fin-rays.

The spiny-finned fishes began by Berycoids and possibly Scombroids in the Chalk, closely resembling, but not identical with, genera living at the present day. The so-called Beryx of the Chalk (Hoplopteryx, Fig. 3, D) is now proved to be very different from the existing genus bearing that name. By the Eocene period, however, nearly all the modern groups of Acanthopterygii had become completely separated and developed, and their sudden appearance is as mysterious as that of the early Eocene Mammalia.

The study of fossil fishes, as now pursued, is thus an attempt to solve the following fundamental problems:—

(1) The nature and order of the successive advances in anatomical structure which have suddenly infused new life into the class—the "expression points," as Cope termed them.

(2) The new possibilities of development which arose with each successive "expression point."

(3) The direction of the various abortive lines of advance and degeneration in each successively higher grade.

The results of such a study have an important bearing on the most fundamental questions concerning "living" matter as contrasted with "dead" matter; for, in my opinion, we are much more likely to approach some explanation of life by studying the secular development of whole races than by examining the vital processes of individuals or by comparing the members of a single contemporaneous fauna.

A. SMITH WOODWARD.

FORTHCOMING BOOKS OF SCIENCE.

MR. EDWARD ARNOLD announces:—"Western Tibet and the British Borderland, the Sacred Country of Hindus and Buddhists, with an Account of the Government, Religion, and Customs of its Peoples," by C. A. Sherring, with a chapter describing an attempt to climb Gurla Mandhata, the highest mountain in western Tibet, by Dr. T. G. Longstaff, illustrated; "A Guide to Diseases of the Nose and Throat and their Treatment," by C. A. Parker, illustrated; "The Diagnosis of Nervous Diseases," by Dr. P. Stewart, illustrated; "The Chemical Investigation of Gastric and Intestinal Diseases by the Aid of Test Meals," by Prof. V. Harley and Dr. F. Goodbody; and "Midwifery for Nurses," by Dr. H. R. Andrews, illustrated.

In Messrs. Baillière, Tindall and Cox's list are:—"High-frequency Currents," by Dr. H. E. Crook; "Röntgen Rays," by R. H. Cooper; "The Common Sense of Voice Development," by Madame I. S. Carolo and Dr. Daniel; and "Practical Agricultural Chemistry," by F. Robertson.

Messrs. George Bell and Sons announce:—"Electrons, or the Nature and Properties of Electricity," by Sir Oliver Lodge, F.R.S.

Messrs. A. and C. Black give notice of:—"Rudolf Eucken's Philosophy of Life," by W. R. B. Gibson; "British Dogs at Work," by A. C. Smith, illustrated; "Savage Childhood, a Study of Kafir Children," by D. Kidd, illustrated; "Tuberculosis: its Origin and Extinction," by Dr. W. P. Turner, illustrated; "The Sense of Touch in Mammals and Birds, with special reference to the Papillary Ridges," by Dr. W. Kidd; "Through the Telescope," by the Rev. J. Baikie, illustrated; "Arithmetical Exercises for Junior Forms," by R. B. Morgan; "Man: his Manners and Customs," by Prof. L. W. Lyde, illustrated; and "Descriptive Geography of the British Empire," by F. D. Herbertson, illustrated.

Messrs. Wm. Blackwood and Sons will issue: "The Century's Progress in Astronomy," by H. Macpherson, jun.; "$CHCl_3$-Problem," by R. Gill; and "Development of Greek Philosophy," by R. Adamson, edited by Prof. Sorley and R. P. Hardie.

The list of Gebrüder Borntraeger (Berlin) contains:—"Allgemeine Botanik," by E. Warming and W. Johannsen, German translation by Dr. Weinecke; "Die kristallinen Schiefer," by Prof. U. Grubenmann, II. Theil; "Einführung in die mikroskopische Analyse der Drogenpulver, eine Anleitung zur Untersuchung von Pflanzenpulvern," by Prof. L. Koch, illustrated; "Jugendformen und Blütenreife im Pflanzenreich," by Dr. L. Diels, illustrated; "Über Vererbungsgesetze," by Prof. C. Correns; "Arten und Varietäten und ihre Entstehung durch Mutation," by Prof. H. de Vries, German translation by Prof. H. Klebahn, illustrated; "Das Berneroberland und Nachbargebiete," ein geologischer Führer von Prof. A. Baltzer, Zwei Teile, illustrated; "Geographische Beobachtung," by Prof. A. Penck; and "Biophysikalisches Centralblatt," vollständiges Sammelorgan für Biologie, Physiologie und Pathologie mit Ausschluss der Biochemie unter Leitung, by W. Biedermann, E. Hering, O. Hertwig, F. Kraus, E. von Leyden, J. Orth, R. Tigerstedt, Th. Ziehen, edited by Drs. C. Oppenheimer and L. Michaelis; and a new edition of "Die Harze und die Harzbehälter," Historisch-kritische u. experimentelle, in Gemeinschaft mit zahlreichen Mitarbeitern ausgeführte Untersuchungen by Prof. A. Tschirch.

The Cambridge University Press announcements include:—"Trigonometry for Beginners," by J. W. Mercer; "Theory of Differential Equations," by Prof. A. R. Forsyth, F.R.S., vol. v.; "A Treatise on the Theory of Alternating Currents," by A. Russell, vol. ii. (the Cambridge Physical Series); "Reports of the Anthropological Expedition to Torres Straits by the Members of the Expedition," edited by Dr. A. C. Haddon, F.R.S., vol. iii., "Linguistics"; and new editions of "Theoretical Mechanics, an Introductory Treatise on the Principles of Dynamics with Applications and Numerous Examples," by Prof. A. E. H. Love, F.R.S.; "Notes on Qualitative Analysis: Concise and Explanatory," by Dr. H. J. H. Fenton, F.R.S.; "Conduction of Electricity through Gases," by Prof. J. J. Thomson, F.R.S. (the Cambridge Physical Series); and "Mendel's Principles of Heredity," a defence by W. Bateson, F.R.S., with a translation of Mendel's original papers on hybridisation.

Messrs. Cassell and Co., Ltd., announce:—"Nature's Carol Singers," by R. Kearton, illustrated; "Paradoxes of Nature and Science," by W. Hampson; and new editions of "British Birds' Nests," by R. Kearton, illustrated; and "Popular Natural History," by H. Scherren, with coloured plates.

Messrs. W. and R. Chambers, Ltd., promise:—"Discoveries and Explorations of the Century," by C. G. D. Roberts, "Progress of Education in the Century," by J. L. Hughes and L. R. Klemm, "Progress of Science in the Century," by Prof. J. A. Thomson (Nineteenth Century Series); "How to Keep Well," by Dr. A. Wilson; and a new edition of Chambers's "Concise Gazetteer of the World."

The list of Messrs. Chapman and Hall, Ltd., includes:—"Electrochemistry of Organic Compounds," by Dr. W. Löb, authorised translation from the author's enlarged and revised third edition of "Electrolysis and Electrosynthesis of Organic Compounds," by Dr. H. W. F. Lorenz, illustrated; "Collected Studies on Immunity," by Prof. P. Ehrlich and his collaborators, with several new contributions, including a chapter written expressly for this edition by Prof. Ehrlich, translated by Dr. C. Bolduan; "General Principles of Organic Syntheses," by Prof. P. Alexeyeff, authorised translation with revision and additions by Dr. J. M. Matthews; "Outlines of Practical Sanitation, for Students, Physicians, and Sanitarians," by Dr. H. B. Bashore, illustrated; "Manual of Wireless Telegraphy," by A. F. Collins, illustrated; "Symmetrical Masonry Arches, including Natural Stone, Plain Concrete, and Reinforced Concrete Arches, for the Use of Technical Schools, Engineers, and Computers in Designing Arches according to the Elastic Theory," by Prof. M. A. Howe, illustrated; "Forest Mensuration," by H. S. Graves, illustrated; "Hypnotism and Spiritism, a Critical and Medical Study," by Dr. G. Lapponi, translated by Mrs. P. Gibbs; and new editions of "The Adjustments of the Engineer's Transit and Level," by H. C. Ives; "The Cyanide Process, an Introduction to the Cyanide Process, including the Determination of the Applicability of the Process to an Ore," by Prof. A. S. Miller, illustrated.

The Clarendon Press List contains:—"A New English Dictionary, founded mainly on the Materials collected by the Philological Society," edited by Dr. J. A. H. Murray:—Further portion of vol. vi. (M), by Dr. Bradley; (N), by Mr. Craigie (L completed); further portion of vol. vii. (P), by Dr. Murray (O completed); further portion of vol. viii. (R), by Mr. Craigie (Q completed); "Life and Letters of Sir Henry Wotton," edited by L. Pearsall-Smith; "Guide to the Bodleian Library," by A. Clark, illustrated; "The Oxford Geographies," by Dr. A. J. Herbertson, illustrated:—Vol. i., "The Preliminary Geography," vol. iii., "The Senior Geography"; "Historical Geography of the British Colonies," by C. P. Lucas, C.B., vol. vi., "Australasia," by J. D. Rogers; "The Dawn of Modern Geography," by C. R. Beazley, vol. iii.; "The Evolution of Culture and Other Essays," by the late Lieut.-General A. Lane-Fox Pitt-Rivers, F.R.S., edited by J. L. Myres, with an introduction by H. Balfour; "Solereder's Anatomical Characters of the Dicotyledonous Orders," authorised English translation, by L. A. Boodle and F. E. Fritsch, revised by H. D. Scott; Jost's "Vorlesungen über Pflanzenphysiologie," authorised English translation, by R. J. H. Gibson; "Hermann von Helmholtz," by L. Koenigsberger, translated by Frances A. Welby, with preface to the English edition by Lord Kelvin, O.M., F.R.S.; "Surgical Instruments in Greek and Roman Times," by J. Milne; and "A Catalogue of the Herbarium of Dillenius," by G. C. Druce, with the assistance of Prof. S. H. Vines, F.R.S.

Messrs. Archibald Constable and Co. announce:—"Harvard Psychological Studies," vols. i. and ii., by Prof. H. Munsterberg, illustrated; "Egyptian Excavations: Biban el Moluk, the Tomb of Hatshopsitu," by T. M. Davis:—The Life and Monuments of the Queen, by E. Naville, Description of the Finding and Excavation of the Tomb," by H. Carter, illustrated; "Natives of Australia," by N. W. Thomas, illustrated, "Natives of British Central Africa," illustrated, "Natives of British Columbia," illustrated, "Race Prejudice," by J. Finot, translated by F. Wade-Evans ("The Native Races of the British Empire"); "Indian Trees, an Account of Trees, Shrubs, Woody Climbers, Bamboos, and Palms, indigenous or commonly cultivated in the British Indian Empire," by Sir D. Brandis, K.C.I.E., assisted by Indian foresters, illustrated; "The Religion of Ancient Egypt," by Prof. W. M. Flinders Petrie, F.R.S., "Islam," by Syed Ameer Ali, "Islam in India," by T. W. Arnold, "Buddhism," by Prof. T. W. Rhys Davids, 2 vols., "Scandinavian Religion," by W. A. Craigie, "Judaism," by I. Abrahams, "The Religion of Ancient Persia," by Dr. A. V. W. Jackson, "Primitive or Nicene Christianity," by Dr. J. S. Black, "Shintoism," "Mediæval Christianity," "The Religion of Ancient Italy" ("Religions: Ancient and Modern"); "Electric Traction Engineering," by H. F. Parshall and H. M. Hobart, illustrated; "The Corpuscular Theory of Matter," by Prof. J. J. Thomson, F.R.S., illustrated; "Precision Grinding," by H. Darbyshire, illustrated; "Modern American Machine Tools," by Prof. C. H. Benjamin, illustrated; "Time and Clocks, a Description of Ancient and Modern Methods of Measuring Time," by H. H. Cunynghame, F.R.S., illustrated; "The Principles of Microscopy, being an Introduction to Work with the Microscope," by Sir A. E. Wright, F.R.S., illustrated; "The Integrative Action of the Nervous System," by Prof. C. S. Sherrington, F.R.S.; and a new edition of "Lettering for Draftsmen, Engineers, and Students, a Practical System of Freehand Lettering for Working Drawings," by C. W. Reinhardt.

Messrs. J. M. Dent and Co. give notice of:—"T. H. Huxley," by Prof. J. R. A. Davis, "John Dalton," by J. P. Millington ("English Men of Science," edited by Prof. J. Reynolds Green, F.R.S.); "The Tourmaline Expedition," by Major Gibbon Spilsbury; "A First Statics," by C. S. Jackson and R. M. Milne; "Trigonometry," by C. Hawkins; and "German Scientific Reader," by C. R. Dow.

Messrs. Duckworth and Co. promise:—"Text-book of Mycology," by G. Massee, illustrated; and "Life and Evolution," by F. W. Headley.

Messrs. Everett and Co. give notice of:—"Practice of Equine Medicine," by F. T. Barton; "Chart of the Diseases of the Horse," by G. Cresswell; "Horses, their Points and Management," by F. T. Barton, illustrated; "Retriever, its Points, Management, and Training," by F. T. Barton; and "Elements of the Practice of Comparative Medicine," by F. T. Barton and G. Cresswell.

Messrs. R. Friedländer and Son (Berlin) announce:—Abel's "Researches on Gun-cotton," deutsch. bearb. v. Dr. B. Pleus, i.; "Fauna u. Flora des Golfes von Neapel," Monogr. 28:—"Ichthyotomus sanguinarius," by H. Eisig, illustrated; "Die organische Natur in Lichte der Wärmelehre," by T. Fischer; "Os Mosquitos do Parà (Brazil)," by E. A. Goeldi, illustrated; "Die Vergletscherung der Erde von Pol zu Pol," by M. Gugenhan, illustrated; "Die Vögel der paläarktischen Fauna," by E. Hartert, part iv.; "Amerikanische Bibliotheken und ihre Bestrebungen," by A. B. Meyer; "Résultats des Campagnes scientifiques du Prince Albert I. de Monaco," Fasc. 32: "Mollusques de l'Ouest de l'Afrique," by P. Dantzenberg and H. Fischer, illustrated; "Sylloge Fungorum," by P. A. Saccardo, vol. xviii.; "Phylogenese der Lanius-Arten," by G. Schiebel, illustrated; "Fleurs de la Glace (Snow Crystals)," by H. Schoentjes, illustrated; "Ueber die Sperrfischerei bei den Finnisch-Ugrischen Völkern," by U. T. Sirelius, illustrated; and a new edition of "The Anthropology of the State of São Paulo," by H. v. Ihering.

Mr. Alexander Gardner announces:—"Familiar Scottish Animals," by A. N. Simpson.

The announcements of Messrs. Charles Griffin and Co. include:—"A Manual of Petrol Motors and Motor-cars, comprising the Designing, Construction, and Working of Petrol Motors," by F. Strickland, illustrated; "Paper Technology, an Elementary Manual on the Manufacture, Physical Qualities, Chemical Constituents, and Testing of Paper and Paper-making Fibres," by R. W. Sindall, illustrated; "General Foundry Practice: a Practical Handbook for Iron, Steel and Brass Founders, Metallurgists, and Students of Metallurgy," by A. C. McWilliam and P. Longmuir, illustrated; "Proportional Set Squares applied to Geometrical Problems," by Lieut.-Colonel T. English, illustrated; "Lectures on the Marine Steam Turbine," by Prof. J. H. Biles, illustrated; "The Thermodynamic Principles of Engine Design," by L. M. Hobbs; "Locomotive Compounding and Superheating," by J. F. Gairns, illustrated; "Shaft Sinking in Difficult Cases," by J. Reimer, translated from the German by J. W. Brough, illustrated; "A Vocabulary of Sea Terms and Phrases: English-Spanish, Spanish-English," by Fleet-Paymaster G. Hewlett; "Peat: its Use and Manufacture," by P. R. Björling and F. T. Gissing, illustrated; and new editions of "A Handbook on Petroleum, for Inspectors under the Petroleum Acts and Others," by Captain J. H. Thomson and Sir B. Redwood, illustrated; "Lubrication and Lubricants: a Treatise on the Theory and Practice of Lubrication and on the Nature, Properties, and Testing of Lubricants," by L. Archbutt and R. M. Deeley, illustrated; "Principles and Practice of Brewing, for the Use of Students and Practical Men," by Dr. W. J. Sykes, revised by A. R. Ling, illustrated; and "Road Making and Maintenance, a Practical Treatise for Engineers, Surveyors, and Others," by T. Aitken.

Mr. William Heinemann announces: "The World's History: a Survey of Man's Record," edited by Dr. H. F. Helmolt: Vol. v., "Eastern Europe," vol. vi., "The Teuton and Latin Races," vol. viii., "Western Europe since 1800 The Atlantic Ocean"; "Motors and Men, a Guide for Non-technical Readers to the Construction, Management, and Use of the Automobile," by H. Norman, M.P., illustrated; "The Desert and the Sown: Tales of Syrian Travel," by G. Lowthian Bell, illustrated; "The Garden Library":—"Roses, and how to Grow Them, a Manual for Growing Roses in the Garden and under Glass," illustrated, "Ferns, and how to Grow Them," by G. A. Woolson, illustrated; "A Handbook of Metabolism," by Prof. C. von Noorden, 3 vols., translated; "Medical Hygiene" (The Harben Lectures, 1906)," by Prof. E. Metchnikoff; "The Criminal Prosecution and Capital Punishment of Animals," by E. P. Evans; "Hints on the Management of the Commoner Infections," by Dr. R. W. Marsden; "Eclipse, and the Modern Thoroughbred," compiled and edited by T. A. Cook, with the assistance of various experts, illustrated; "The Dog Book," by J. Watson, 2 vols., illustrated; and new editions of "Sex and Character," by O. Weininger; "The Nature of Man: Studies in Optimistic Philosophy," by Prof. E. Metchnikoff, edited by Dr. P. C. Mitchell.

Messrs. Hodder and Stoughton's list includes:—"Panama to Patagonia, the Isthmian Canal and the West Coast Countries of South America," by C. M. Pepper, illustrated; "The Nature and Origin of Life in the Light of Modern Knowledge," by Prof. F. le Dantec; "Physical Diagnosis," by E. Le Ferre; "The Pathology of the Eye," by Dr. J. H. Parsons; "Dental Materia Medica and Prescription Writing," by E. H. Long; and "The Home in Order," by Dr. A. T. Schofield.

Messrs. T. C. and E. C. Jack's list contains: "Wireless Telegraphy," by W. J. White, illustrated; and "Spiritualism," by E. T. Bennett, with preface by Sir Oliver Lodge, F.R.S., illustrated.

Mr. John Lane promises:—"Rifle and Romance in the Indian Jungle, Record of Thirteen Years of Indian Jungle Life," by Captain A. I. R. Glasfurd, illustrated; (Practitioner's Handbooks):—"Forms of Paralysis," by J. S. Collier, "Post-mortem Handbook," by C. R. Box, "Minor Operations," by E. M. Corner; (Country Handbooks):—"Stable Handbook," by T. F. Dale, illustrated, and a new edition of "Tree Book," by M. R. Jarvis; (Handbooks of Practical Gardening):—"Book of Pruning and Grafting," by R. L. Castle, "Book of the Flower Show," by C. H. Curtis, and "Book of the Chrysanthemum," by P. S. Follwill.

Mr. Werner Laurie announces:—"Lotus Land, being an Account of the Country and the People of Southern Siam," by P. A. Thompson, illustrated.

In Messrs. Crosby Lockwood and Son's list we notice:—"Gold Mining Machinery, its Selection, Arrangement, and Installation, for Use of Mine Managers and Engineers, with a Chapter on the Preparation of Estimates of Cost," by W. H. Tinney, illustrated; "Engineering Standards Committee's Publications"; "First Lessons in Coal Mining for Use in Primary Schools," by W. Glover; "Blast Furnace Calculations and Tables for Furnace Managers and Engineers," by J. L. Stevenson; "Electric Wiring, Diagrams, and Switchboards, Practical Guide for Wiremen and Others," by N. Harrison; "Portfolio of Measured Drawings," issued annually by the School of Architecture of the University of Liverpool under the direction of C. H. Reilly, vol. i.; "Handbook of Reinforced Concrete, for Architects, Engineers, and Contractors," by F. D. Warren; "Practical Farming in relation to Soils, Manures, Crops," by E. T. Shepherd; "Leather Manufacture, Handbook of Tanning, Currying, and Chrome Leather Dressing," by A. Watt; "Practical Patternmaking," by W. F. Barrows, illustrated; "Cultivation and Preparation of Para Rubber," by W. H. Johnson; "Concise Interest Calculator," by A. M. Campbell; and a new edition of "Art and Science of Sail-making," by S. B. Sadler, illustrated.

Messrs. Longmans and Co. give notice of:—"A Memoir of Thomas Hill Green, late Fellow of Balliol College, Oxford, and Whyte's Professor of Moral Philosophy in the University of Oxford," by R. L. Nettleship, reprinted from the third volume of "The Works of Thomas Hill Green," with a short preface specially written for this edition by Mrs. T. H. Green; "The Design of Lathes for High Speed and Heavy Cutting," by J. T. Nicolson and D. Smith; "The Electron Theory: a Popular Introduction to the New Theory of Electricity and Magnetism," by E. E. Fournier D'Albe; "Producer Gas," by J. E. Dowson and A. T. Larter; "Practice and Science of Religion: a Study of Method in Comparative Religion," by J. H. Woods; and "The Mammals of Great Britain and Ireland," by J. G. Millais, vol. iii., illustrated.

Messrs. Macmillan and Co., Ltd., announce:—"Pagan Races of the Malay Peninsula," by W. W. Skeat and C. O. Blagden, 2 vols., illustrated; "The Lower Niger and its Tribes," by Major A. G. Leonard; "At the Back of the Black Man's Mind; or, Notes on the Kingly Office in West Africa," by R. E. Dennett, illustrated; "Berkshire," by J. E. Vincent, illustrated (Highways and Byways Series); "An Outline of the Idealistic Construction of Experience," by Prof. J. B. Baillie; "The Structure and Growth of the Mind," by Prof. W. Mitchell; "Studies in Humanism," by Dr. F. C. S. Schiller; "Alcohol and the Human Body: a Survey of Modern Knowledge on the Subject," by Sir Victor Horsley, F.R.S., and Dr. Mary D. Sturge, with a chapter by Dr. A. Newsholme; "Studies in the Bacteriology and Etiology of Oriental Plague," by Dr. E. Klein, F.R.S., illustrated; "The Clinical Study of Epilepsy," by Dr. W. A. Turner; "Some Points in the Surgery of the Brain and its Membranes," by C. A. Ballance, illustrated; and new editions of "A System of Medicine," by many writers, a new edition, edited by Prof. T. Clifford Allbutt, F.R.S., and Dr. H. D. Rolleston, vol. ii., in two parts; "Anaesthetics and their Administration," by Dr. F. W. Hewitt; "A Handbook of Metallurgy," by Prof. C. Schnabel, translated and edited by Prof. H. Louis, vol. ii., illustrated; "History of Chemistry from the Earliest Times to the Present Day," by Prof. E. Meyer, translated by Dr. G. McGowan.

Messrs. Methuen and Co. promise:—"The Hygiene of Mind," by Dr. T. S. Clouston, illustrated; "A Concise Handbook of Shrubs," by Mrs. G. Lewis, illustrated; "Tommy Smith's Other Animals," by E. Selous, illustrated; and "Plant Life," by H. F. Jones, illustrated.

Mr. Murray's list includes: "The Shores of the Adriatic: an Architectural and Archæological Pilgrimage, the Italian Side," by F. H. Jackson, illustrated; "An Idler in the Wilds," by T. Edwardes, illustrated; "Heredity," by Prof. J. A. Thomson (The Progressive Science Series); "A Philological Study of the English Language," by Prof. H. C. Wyld; "Recent Advances in the Study of Variation, Heredity, and Evolution," by R. H. Lock, illustrated; "Simla Village Tales: or, Folktales from the Himalayas," by A. E. Dracott, illustrated; "The Life of Isabella Bird" (Mrs. Bishop), by Miss A. M. Stoddart, illustrated; "Recent Development in Biological Science," by W. B. Hardy, F.R.S.; "Exercises in Physics, for the Use of Schools," by J. H. Leonard and W. H. Salmon; and "Science Progress in the Twentieth Century, a Quarterly Journal of Scientific Thought," No. 2.

Messrs. George Newnes, Ltd., give notice of:—"A Technological and Scientific Dictionary."

Messrs. J. Nisbet and Co., Ltd., promise:—"Experiments on Animals," by S. Paget; and "Alcoholism," by W. C. Sullivan.

Messrs. George Philip and Son, Ltd., announce:—"Model Duplex Maps," a series of maps for scholars' use, showing a photo-relief model and a political map coloured opposite one another, with summaries of geographical information, sixteen varieties; and a new series of "Geographical Readers," by H. J. Mackinder, illustrated.

In Messrs. G. P. Putnam's Sons' list we notice:—"The Evolution of Religions," by E. Bierer; "Diagnosis of Organic Nervous Diseases," by Dr. C. A. Herter, illustrated; "The Family: an Ethnographical and Hisorical Outline, with Descriptive Notes, planned as a Text-book for the Use of College Lecturers and Directors of Home-reading Clubs," by Dr. E. C. Parsons; "On the Great American Plateau: Wanderings among Canyons and Buttes in the Land of the Cliff Dweller, and the Indian of To-day," by T. M. Prudden, illustrated; "Scientific Sanction for the Use of Alcohol, Proved and Popularly Expanded by a Physiologist," by Dr. J. Starke; "Hunting Big Game with Gun and with Kodak: how Wild Animals Look and Live in their Haunts, from Personal Experiences in the United States, Dominion of Canada, and Old Mexico," by W. S. Thomas, illustrated; "A Manual of Prescription Writing, with a Full Explanation of the Methods of Correctly Writing Prescriptions, and Rules for Avoiding Incompatibilities and for Combining Medicines," by Dr. M. D. Mann; "Science and a Future Life," by Dr. J. H. Hyslop; "Enigmas of Psychical Research," by Dr. J. H. Hyslop; "The Interpretation of Nature," by Prof. C. Lloyd Morgan, F.R.S.; and "Life in the Open: Sport with Rod, Gun, Horse, and Hound in Southern California," by C. F. Holder, illustrated.

The Religious Tract Society promises:—"Stories of Animals," illustrated; "Stories of the Seasons," illustrated; "Animal Life," illustrated; "Round the Sun," illustrated; "By-paths in Nature," by F. Stevens, illustrated; "Every Boy's Book of British Natural History," by W. P. Westell, with an introduction by Lord Avebury, F.R.S., illustrated; and new editions of "How to Study Wild Flowers," by Rev. G. Henslow, illustrated; and "Walks and Talks in the Zoo," by H. Scherren, illustrated.

Messrs. E. Grant Richards will publish: "Christopher Columbus and the New World of his Discovery," a narrative by F. Young; and "Voyages of Captain William Dampier," edited by J. Masefield, illustrated.

In Messrs. Alston Rivers's list appears:—"Tibet the Mysterious," by Sir Thomas Holdich, K.C.M.G.

Messrs. Smith, Elder and Co. promise:—"The New Physics and Chemistry: a Series of Essays on Physical and Chemical Subjects," by W. A. Shenstone, F.R.S.; "South Polar Times," reproduced in facsimile, with coloured sketches by Dr. Wilson, and other illustrations, brought out by the officers of the National Antarctic Expedition on board the *Discovery*, during the winters of 1902 and 1903; and "Animal Life," by Dr. F. W. Gamble.

Messrs. Swan Sonnenschein and Co., Ltd., direct attention to:—"Thought and Things: a Study of Logical Process," by Prof. M. Baldwin, vol. ii., "Experimental Logic," vol. iii., "Real Logic"; "The History of Philosophy," by Dr. J. E. Erdmann, revised by W. B. Erdmann, an English abridgment, translated and edited by W. S. Hough; "A Treatise on Psychopathology," by Prof. Storring, translated by Prof. T. Loveday; "Physiological Psychology," by Prof. W. Wundt, translated by Prof. E. B. Titchener, vol. ii., illustrated; "The Student's Text-book of Zoology," by A. Sedgwick, F.R.S., vol. iii., illustrated; "The Natural History of Our Shores," by J. Sinel, with chapters on collecting and preserving marine specimens, methods of microscopic mounting, and the marine aquarium, illustrated; and "How to Study Geology," by E. Evans, illustrated.

The University Tutorial Press will issue:—"Geometry, Theoretical and Practical," by W. P. Workman and A. G. Cracknell, parts ii. and iii.; Clive's "New Shilling Arithmetic"; "The Junior Chemistry," by R. H. Adie; "Technical Electricity," by Prof. H. T. Davidge and R. W. Hutchinson; "Elementary Science of Common Life (Chemistry), Subject xxvi. of the Board of Education Science Examinations," by W. T. Boone; "New Matriculation Physics, Heat, Light, and Sound," by Dr. R. W. Stewart and J. Don; and "Certificate Hygiene," by R. A. Lyster.

In Mr. T. Fisher Unwin's list we observe:—"The Principles and Practice of X-Ray Diagnosis and Therapy," by Dr. J. Rudis-Jicinsky, illustrated; "The Horse: a Guide to its Anatomy for Artists," 110 drawings (reproduced by photolithography) by H. Dittrich, with explanatory notes by Profs. Ellenberger and Baum; "Methods in Plant Histology," by Dr. C. J. Chamberlain, illustrated; "The Psychology and Training of the Horse," by Count E. M. Cesaresco; "The Sanitary Evolution of London," by H. Jephson; "The Psychology of Child Development," by I. King; and a new edition of "Australian Sheep and Wool: a Practical and Theoretical Treatise," by A. Hawkesworth, illustrated.

Messrs. F. Vieweg and Son (Brunswick) direct attention to:—"Prüfungen in elektrischen Zentralen," by Dr. E. W. Lehmann-Richter, II. Teil, illustrated; "Die chemische Düngerindustrie," by L. Schucht, illustrated; "Die Anilinfarben und ihre Fabrikation," by Dr. K. Heumann, vierter Teil, edited by Prof. G. Schultz, Zweite Hälfte, erste und zweite Abteilung; "Sechs Vorträge über das thermodynamische Potential und seine Anwendungen auf chemische und physikalische Gleichgewichtsprobleme," by J. J. van Laar; "Die Nichtzuckerstoffe der Rüben in ihren Beziehungen zur Zuckerfabrikation," by Dr. A. Rümpler; "Technisch-Chemisches Jahrbuch, 1904," edited by Dr. R. Biedermann; "Die Untersuchung des Erdöles und seiner Produkte," by M. A. Rakusin, illustrated; and "Handbuch der chemischen Technologie," edited by Profs. Bollen and Birnbaum, sections 13 and 14.

Messrs. Watts and Co. announce:—"A Picture Book of Evolution," by D. Hird, illustrated; "The New Scientific System of Morality," by Dr. G. Gore, F.R.S.; and "The Cultivation of Man, according to the Teachings of Common Sense," by C. A. Witcheil.

Messrs. Whittaker and Co. promise:—"Modern Practice in Coal Mining," by D. Burns and G. L. Kerr; "A Pocket-book of Aëronautics: a Practical Treatise for Balloonists," by H. W. Moedebeck; "Electricity in Mining," by P. R. Allen; "Electric Lamps and Photometry," by L. Gaster; "Concrete Steel Buildings: a Treatise giving the Examples of Reinforced Concrete Construction," by W. N. Twelvetrees; "A Guide to Electric Lighting," by S. R. Bottone; "Motor Construction," by T. Gray; "The Care of Motor-cars," by T. Gray; "An Advanced Text-book on Steam, Gas, and Oil Engines," by J. W. Hayward; "A Treatise on Fuels," by T. Gray; "Motor-car Ignition Methods," by W. Hibbert; and "Sound, Light, and Heat," by J. R. Ashworth.

Messrs. Williams and Norgate direct attention to:—"The Surgical Anatomy of the Horse," by J. T. Share Jones, in four parts.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. W. L. H. Duckworth, Jesus College, has been appointed demonstrator in anatomy for one year.

Mr. J. F. Cameron, Caius College, and Mr. G. T. Bennett, Emmanuel College, have been nominated moderators, and Mr. A. Munro, Queens' College, and Mr. R. H. D. Mayall, Sidney Sussex College, examiners in part i. of the mathematical tripos for the year beginning May 1, 1907.

The proposed alterations in the regulations for the mathematical tripos will be voted upon at a Congregation fixed for 2 o'clock on Thursday, October 25.

DR. G. C. SIMPSON has resigned his post as lecturer in meteorology at the University of Manchester on his appointment as assistant to the director of observatories under the Indian Government.

ON Tuesday evening, October 9, Prof. H. G. Seeley, F.R.S., began a course of lectures at King's College, London, on some of the larger questions of geology, including (1) atmospheric denudation; (2) jointing in rocks; (3) internal heat of the earth; (4) the relations of rock masses; (5) minerals which form rocks. The lectures will be delivered on alternate Tuesday evenings, at 6 p.m., during the Michaelmas term.

THE Merchant Venturers' Technical College at Bristol was totally destroyed by fire early on Tuesday morning. The fire appears to have broken out in the chemical laboratory on the top floor, and in a short time the whole building was in flames. The college, which was attended by more than two thousand students in the day and evening classes, was erected in 1885 by the Society of Merchant

Venturers at an outlay of about 50,000*l*., which is covered by insurance, but not the least heavy loss sustained is that of books and manuscripts in the library of the principal, Prof. Wertheimer.

At the distribution of prizes awarded to successful students of the Royal College of Science, for the session 1905–6, on October 4, Prof. W. A. Tilden, who presided, remarked that two public events of great importance to the college have occurred since the prize distribution last year. The first is the publication of the final report of the departmental committee appointed to study the condition, appliances, purposes, and work of the Royal College of Science and the Royal School of Mines, and to consider what could best be done with them. The committee well described the main object of the institution to be the teaching of science, especially in its application to industry. The other event is the practical completion of the great museum buildings, which have been in progress for seven or eight years. Dr. T. E. Thorpe, who presented the prizes, in an address to the students said those whose business it is to examine students recognised that the system of examinations, like all human institutions, is liable to fall into error. Nevertheless, it is the conviction of those who have given dispassionate consideration to the matter that, faulty and fallible as the system may be, it affords the best method of arriving at the relative positions of schools and students. As a rule, in England a university takes only its name from the place in which it is situated. What has made the Aberdeen University an integral part of the life of the people is that the people make special efforts to create and maintain it, and their self-sacrifice on its behalf gives them an abiding interest in it. It is an unfortunate thing for education in London that London is so vast it is impossible to get collective effort and collective influence enlisted for any of its educational institutions.

A SERIES of articles on public-school education was commenced in the *Times* of September 10, and among the subjects which have been dealt with in the eight contributions which have been published already are mathematics, science, and engineering. Mr. T. J. Garstang, in his article on the teaching of mathematics (September 13), traces the course of development which has led to the adoption of reformed courses of geometry, arithmetic, and algebra in our schools. Much, however, remains still to be accomplished. As Mr. Garstang points out, the commercial arithmetic still exacted through examinations is largely either a survival of past commercial method or a collection of artificial fictions. Mr. W. D. Eggar, writing on science in public schools (September 20), considers what school science is now compared with what it was thirty years ago. Thanks largely to Prof. Armstrong's efforts, science teaching by lectures or talks illustrated by curious experiments has given place to practical work, by which pupils measure and weigh and accumulate experience by and for themselves. If nature-study forms part of the English teaching in schools, and practical measurement part of the mathematical work, Mr. Eggar thinks it is possible in one stage of every boy's career to give him a real chance of learning scientific method. In some middle portion of the school through which all boys must pass, a year's course with four hours a week should be mapped out. To this work the main energies of the laboratory staff must be directed, and the classes must be small. The most suitable subjects Mr. Eggar believes to be heat or chemistry or magnetism and current electricity. The subject should be one in which mathematical theory may be kept in the background until a thorough practical acquaintance with facts has been gained; also one which gives ample scope for cultivating the scientific virtues of accuracy and honesty. The Rev. F. Stephenson describes (October 9) what is done by a public school to train boys who intend to become engineers. In his concluding paragraph he remarks:—"The public school caters mostly for those whose means and brains alike are limited, and attempts to combine the teaching of the science of engineering in the class-room with practice in the workshops in such a way that at eighteen a boy may be ready to take full advantage of the opportunities offered him in large commercial works, and may neither waste six months in picking up as best he may from mechanics the purport of nuts, valves, and cylinders, nor allow himself to sink in manners and morals to lower standards that may not unnaturally be prevalent among associates of a humbler class."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 28.—"An Investigation of the Influence of Electric Fields on Spectral Lines." Preliminary Note. By Prof. G. F. **Hull.** Communicated by Prof. J. Larmor, Sec.R.S.

In general the electrical fields used were those concomitant with the luminous electric discharge. An interferometer of the Michelson form and an echelon spectroscope of eighteen plates were used to analyse the radiations. The results may be summarised as follows:—

(1) End-on discharge tubes of special design in which the light-source was a uniform column of luminous mercury vapour, viewed in the direction of discharge, showed no change of wave-length so great as 1 part in 4,000,000 when the direction of the discharge was reversed. The pressure in the tube was varied from a few millimetres to a vacuum so high that there was but little luminosity.

(2) The passage of Röntgen rays through the tube did not alter the wave-length nor the width of the mercury lines to an extent sufficient to affect the visibility of interference fringes formed with a difference of path of 400,000 waves. When the luminous column was viewed at right angles to the direction of the discharge no polarisation effects in the radiation from it, due to the passage of the Röntgen rays, could be detected by a sensitive Savart plate and Nicol prism.

(3) When the discharge passed in air between electrodes formed of an amalgam of cadmium and mercury, no variation of the wave-lengths of the strong Cd, Hg, lines greater than 0·002 tenth-metre was obtained by changing the line of sight from a direction along the discharge to one at right angles to that direction. Approximately the same result held good when a small capacity was inserted in the circuit, but in this case the discrepancies in the readings were larger.

This result shows that the luminous particles do not acquire a velocity in the direction of the discharge greater than 150 metres per second. Hence the curving of the image of the discharge produced by a rotating mirror, as in the Feddersen experiment, and as recently studied by Schuster and Hemsalech for individual spectral lines, appears to be due, not so much to motion of luminous particles as to the propagation along those particles of a condition of luminosity.

(4) Doppler effects in the canal rays, as announced by Stark during the course of the present investigations, were found for the strong hydrogen lines. In some cases they appeared also in mercury lines. The velocities represented by the displacements of the lines were of the order of 4×10^5 metres per second for the hydrogen particles and $2·5\times10^4$ metres per second for those of mercury. But it was found that, in general, the luminous mercury particles in the canal rays did not move (with a velocity greater than 100 metres per second). In these cases the canal rays appear to be due to non-luminous particles streaming through the mercury vapour and producing luminescence in the latter, probably by bombardment.

(5) A glass tube was sealed on to a canal-ray tube at right angles to the direction of the rays. This tube was covered by a piece of optical glass as free as possible from strain. A very sensitive combination of Savart plate and Nicol prism was used to detect, if possible, any polarisation that might exist in the light from the rays in hydrogen. After eliminating reflections from the walls of the tube no polarisation could be recognised.

(6) The light produced by electrical discharge, in uniform tubes 3 cm. or 4 cm. in diameter, was examined at right angles to the direction of discharge, at various points between the electrodes, and also behind the perforated kathode. It was found that the principal hydrogen lines were greatly broadened in those parts where the electric

field is known to be of great intensity. For example, the luminous layer covering the kathode (the dark space being 0·5 cm. to 4 cm.) gave hydrogen lines 0·4 Angström unit in width, but the lines of the second hydrogen spectrum and certain air lines were not appreciably broadened. This broadening seems to be due mainly to motion of the particles rather than change of free periods, for it is found to the same extent behind the kathode in the canal rays. The broadening is so great that it is not possible with the instruments at the author's disposal to determine the shift of these lines except to fix a superior limit of 0·1 Angström unit to its possible magnitude. The amount is probably considerably less than this. On the other hand, the shift of the lines of the second spectrum of hydrogen is so small as to approach the limits of error, viz. 0·005 Angström unit. The mercury lines show no shift but a slight broadening.

The experiments thus show that any electrical analogue of the Zeeman effect is, under the above conditions, largely masked by a widening of the lines.

"The Alcoholic Ferment of Yeast-juice. Part II.—The Coferment of Yeast-juice." By Dr. A. **Harden** and W. J. **Young**.

Summary. I.—(1) Photolytic decomposition of aqueous carbon dioxide can take place in the presence of chlorophyll, independently of vital or enzymic activity, provided that the necessary physical and chemical conditions are strictly adhered to.

(2) The products of the decomposition are formaldehyde and hydrogen peroxide, formic acid being an intermediate product.

(3) It is possible to reconstruct the process of photosynthesis outside the green plant, (*a*) as far as the production of formaldehyde and oxygen, by introducing a suitable catalysing enzyme into the system, and (*b*) as far as the production of oxygen and starch, by introducing, in addition to the enzyme, certain kinds of non-chlorophyllous living protoplasm.

II.—(1) There is direct experimental proof that formic acid is a product of the photolytic decomposition of carbon dioxide in the presence of an inorganic uranium salt.

(2) Formaldehyde has not been isolated and identified, in the case of an inorganic uranium salt, but a study of the reactions involved favours the view that it is formed as a transitory intermediate product.

MANCHESTER.

Literary and Philosophical Society, October 2.—Dr. W. E. Hoyle in the chair.—An account of *Eucommia ulmoides*, a Chinese tree yielding gutta-percha: Prof. F. E. **Weiss**. The author exhibited a young specimen of the tree, and mentioned that he had two larger ones growing in the open in his garden at Withington. The special interest in this tree lies in the fact that it is the only known plant yielding gutta-percha which can be grown outside the tropics.—A preliminary account of the life-history of the common house-fly (*Musca domestica*, L.): C. Gordon **Hewitt**. The female fly lays her eggs in the crevices of horse excrement, which for this purpose must be fresh. Despite the difficulty met with in getting the flies to lay their eggs in confinement, five lots of larvæ were reared, each batch experiencing different conditions of temperature. A rise in temperature produced an acceleration of the rate of development at any stage. In the larval state three stages are recognisable. The shortest period for the egg state was twenty-four hours, and remained constant. Those for the larval stages were two, two, and four days respectively, whilst that of the pupal state was six days. If these times be taken, the whole period from the deposition of the egg to the exclusion of the imago would last about fifteen days. In the actual experiments the total period varied from twenty to thirty days.

DIARY OF SOCIETIES.

WEDNESDAY, OCTOBER 17.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Some Rotifera of the Sikkim Himalaya: J. Murray.—*Cornuvia serpula*; a Species of Mycetozoa new to Britain: J. M. Coon.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, OCTOBER 18.

CHEMICAL SOCIETY, at 8.30.—Presentation of the Longstaff Medal to Prof. W. Noel Hartley.—The Amino-dicarboxylic Acid derived from Pinene: W. A. Tilden and D. F. Blyther.—The Preparation and Properties of Dihydropinylamine (Pinocamphylamine): W. A. Tilden and F. G. Shepheard.—Determination of Nitrates: F. S. Sinnatt.—The Nature of Ammoniacal Copper Solutions: H. N. Dawson.—Malacone, a Silicate of Zirconium containing Argon and Helium: S. Kitchen and W. G. Winterson.—The Relationship of Colour and Fluorescence to Constitution, Part i., The Condensation Products of Mellitic and Pyromellitic Acids with Resorcinol: O. Silberrad.—The Colouring Matters of the Stilbene Group, Part. iii.: A. G. Green and P. F. Crosland.—(1) Separation of *αα*- and *ββ'*-Dimethyladipic Acids; (2) Action of Alcoholic Potassium Hydroxide on 3-Bromo-1 : 1-Dimethyl-hexahydrobenzene: A. W. Crossley and N. Renouf.—(1) The Compounds of Pyridine with Dichromates; (2) The Normal Chromates and the Unsaturated Character of the Chromate Radical: S. H. C. Briggs.—(1) Interaction of Succinic Acid and Potassium Dichromate, Note on a Black Modification of Chromium Sesquioxide; (2) Derivatives of Polyvalent Iodine; the Action of Chlorine on Organic Iodo-derivatives, including the Sulphonium and Tetra-substituted Ammonium Iodides: E. A. Werner.—(1) New Derivatives of Diphenol (4·4·Dihydroxydiphenyl); (2) The so-called "Benzidine Chromate" and Allied Substances: J. Moir.—The Interaction of the Alkyl Sulphates with the Nitrites of the Alkali Metals and Metals of the Alkaline Earths: P. C. Rây and P. Neogi.

INSTITUTION OF MINING AND METALLURGY, at 8.—The Auriferous Rocks of India, Western Australia, and South Africa; M. Maclaren.—Sand Sampling in Cyanide Works: D. Simpson.—Treatment of the Precipitate and Manipulation of the Tilting Furnaces at the Redjang-Lebong Mine, Sumatra: S. J. Truscott.—A Combined Air and Water Spray: T. White.

FRIDAY, OCTOBER 19.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—*Discussion*: Railway-motor-car Traffic: T. H. Riches and S. B. Haslam.—*Paper*: Some Notes on the Mechanical Equipment of Collieries: E. M. Hann.

CONTENTS.

THURSDAY, OCTOBER 18, 1906.

FLORAL BIOLOGY.

Handbook of Flower Pollination based upon Hermann Müller's work "The Fertilisation of Flowers by Insects." By Dr. Paul Knuth. Translated by J. R. Ainsworth Davis, M.A. Vol. i. Introduction and Literature. Pp. xix+382; illustrated. (Oxford: At the Clarendon Press, 1906.) Price 18*s*. net.

THE Clarendon Press is to be congratulated on the appearance of the first volume of what is a serious undertaking—the translation of a German book in five volumes and nearly 3000 pages.

Hermann Müller's book "Die Befruchtung der Blumen" appeared thirty-three years ago, and D'Arcy Thompson's translation, published in 1883, has long been out of print. English readers will therefore welcome the present work, incorporating as it does the great mass of research on floral biology which has been carried out in recent years.

The book appears under favourable conditions, since the author—a recognised authority on the subject—has been able to come to an arrangement with H. Müller's representatives by which he is allowed to make use of all that naturalist's writings and admirable illustrations.

The chief feature in which it differs from Müller's books is the prominence given to the statistical method of studying the visits of insects. This subject has received especial attention of late from MacLeod, Verhoeff, Loew, Willis, Burkill, and others. It was a department of study to which the author devoted much time, and in consequence his book contains perhaps more on this subject than most readers require.

It is, as Prof. Balfour says in his preface, an encyclopædic work, and it has some of the defects of its qualities. It is admirable as a book of reference, and will be of great value to anyone desirous of extending his knowledge of the subject; but we confess to missing what we expect in the introductory volume of a handbook, namely, a broad treatment of the subject such as is needed to introduce a student to a detailed account of flower-pollination. There is no effective discussion of what lies at the root of the whole science of floral biology, namely, that fertilisation at any price is the primary necessity, while cross-fertilisation is a secondary need. From this standpoint the arrangements of the sexes in plants become comprehensible as compromises between the extreme cases of cleistogamy and diœciousness. In one case fertilisation is assured, while cross-fertilisation is impossible; in the other fertilisation is not a certainty, but if it occurs it implies of necessity a cross between two individuals. Nor, again, is the point of geitonogamy made clear, namely, that if pollen is brought from a separate flower there is at least a chance that it may come from another plant.

In referring to Darwin's "Cross- and Self-Fertilisation," Knuth speaks of the paucity of the experiments on crosses between flowers on the same plant, but he neglects to mention what Darwin thought the chief outcome of his work—the fact that crosses between individuals grown under identical conditions fail to give vigour to the offspring; and this is a result that includes the effect of crosses between flowers on the same plant.

The need of a more generalised introduction to floral biology was not so obvious to us in reading Knuth's book in German, but those who read it as an English text-book, presumably intended for university students, and who know the standard of knowledge which such readers bring to the study, will probably form a similar opinion.

In the pages devoted to the history of the subject a full account is given of the various ways of classifying flowers from a biological point of view. Here we find Hildebrand's and Axell's systems, of which the second is not generally accessible to English readers, being written in Swedish. Here, too, is Delpino's interesting arrangement of typical floral mechanisms into classes. Thus class iii., made up of flowers which are visited by insects crawling into the tubular corolla, contains the types named after the genera Datura, Digitalis, Campanula, &c. In class vii. we find one of the instances of the awkward translations which occur here and there in the English edition. The mechanism of Genista, Ulex, &c., is named by Delpino "Forma a scatto," and this is rendered by "tension form," which has none of the appropriateness of the original and does not direct attention to the explosion which is so characteristic of the type. In other cases the translator is a little too literal. What service is it to an English reader to find Hymenoptera described as membrane-winged insects, or Diptera as two-winged?

Under the heading "Autogamy" a list is given of all known instances of self-sterility; this, together with the corresponding lists of heterostyled and cleistogamic plants, forms a useful feature in the book. Again, in relation to cleistogamy, we are glad to see a refutation of some of the supposed instances of perpetual and unavoidable self-fertilisation, such as the case of *Juncus bufonius* and of *Salvia cleistogama*.

A good deal of space is given to the various classifications of flowers according to their mode of fertilisation and the type of insect visitors. The best-known system is that of H. Müller, who divided them into flowers visited for pollen only, flowers with exposed nectar, with concealed nectar, those adapted to the visits of bees, Lepidoptera, &c. These classes are known by the symbols Po, A, B, H, F, &c. Knuth propounded a more elaborate classification for which he had good reasons; but why the translator has altered the symbols so as to suggest the English equivalents of the class-names we cannot understand. Thus, instead of keeping Kl for "small-insect flowers," he gives Sm as the symbol. This, except on general principles, is no great matter; but when we find the familiar F which stood for lepidopterid flowers applied to those fitted to the visits of Diptera we have ground for complaint. The same is true of the introduction of new symbols for the well-known A, AB, and B. Surely English standards are sufficiently different from those in use on the Continent without our needlessly multiplying instances.

The discussion which follows on the different classes of flowers forms one of the most interesting parts of the volume. Thus we get Knuth's curious observations on the proportion of anemophilous plants on the wind-beaten Halligen Islands in the North Sea, where they form 47 per cent. of the flora, whereas on the mainland the percentage is 21·5—a case which may remind us of the wingless insects of Madeira. Then, again, we have details of flowers fertilised by bats, birds, slugs, and snails which we think are here put together for the first time in English. There is also a discussion of some interest on flowers which to our eyes are inconspicuous, but which nevertheless attract many visitors. Further on is a good account of the well-known methods of fertilisation in the yucca and the fig.

Under pollen flowers, *i.e.* those visited for the sake of their pollen, the author makes what seems to us an unnecessary blot in his system of classification. Thus *Sarothamnus scoparius*, *Genista tinctoria*, &c., though devoid of nectar and visited solely for pollen, "are not regarded as pollen-flowers but as well marked bee-flowers." Even here he is not consistent, since *Cassia chamaecrista* and *Solanum rostratum* are described as pollen flowers, though they too are adapted for bees.

H. Müller's important work on the specialisation of insects in relation to flowers is fully given, and this is a subject often neglected for the converse instances of floral adaptations. Here too is an interesting account of differences in habits according as the visitors are of the social or solitary bees. The social class, having to work hard for a living, is forced to visit flowers which the luxurious solitary bee neglects. Near the end of the book is a good account of the statistical method of treating the visits of insects, as illustrated chiefly from MacLeod's researches. The volume concludes with a valuable bibliography comprising 3748 entries, and occupying 160 pages.

The translator has done his work well on the whole. We must, however, direct attention to a few instances of faulty rendering. Thus "Blumenblätter" is translated by "floral leaves," "Saft" (nectar) by "sap." But the few slips in translation that occur are not serious; we have no objection to H. Müller being described as a "genial" author (p. 25), or to the incorrect statement that Darwin inherited his house at Down (p. 8*n*), except that they are due to the translator, not to the author.

But these are trifles in comparison to the fact that his English is thoroughly readable, and this is a standard by no means easy of attainment in translating from German.

F. D.

SINGLE-PHASE COMMUTATOR MOTORS.

Single-phase Commutator Motors. By F. Punga. Translated from the German by R. F. Looser. Pp. xvi+187. (London: Whittaker and Co., 1906.) Price 4*s.* 6*d.* net.

RECENT advances in the application of single-phase alternating currents to electric traction have given rise to a large volume of literature dealing chiefly with the motors employed. The possibility of working direct-current motors with alternating currents is by no means new, but it is only within the last few years that the principles of good design have become sufficiently well known to enable such working to be made a commercial success.

It was perhaps inevitable that a large part of the literature devoted to this subject should be somewhat academic; in any new departure of this kind the experimental work which forms the basis of progress is in the hands of manufacturers, to whose interest it is that the information so obtained should not be made public. It is, therefore, all the more interesting to examine a book which is evidently written for the practical man. In such a book circle diagrams should occupy a subordinate position, and attention should be directed to the question of proportions that may be assumed in practice.

The course adopted in this book is to set out as clearly as possible what may be called the practical theory of the motors, and to follow this up by applications of the theory to the design of actual examples. This is no doubt the right course, for however valuable a knowledge of the fundamental theory may be, there are many points of equal importance which can only be brought out in the calculation of an actual motor.

The setting out of the theory of single-phase commutator motors has been made very clear, and although circle diagrams are referred to, the author states very truly that they are of little practical value, and that it is better to calculate the current for a few points from first principles. Particular attention has been paid to the question of sparking, and its dependence on the "transformer voltage," the "reactance voltage," and the "rotation voltage" in the coils short-circuited by the brushes. The effect the transformer voltage has on the general design is also clearly explained, but hardly sufficient reference is made to the magnetising action of the circulating current produced.

Turning now to the calculation of typical motors, a series motor of 60 h.p. is worked out, and also a repulsion motor of 48 h.p. It is unfortunate that practically no indication is given as to how these motors are rated. At present, single-phase commutator motors are inevitably associated with traction work, in which it is customary to speak of the one-hour rating. Supposing this to be the intention of the author, it must be confessed that the size of the motors is rather large for their output, chiefly on account of the low speed chosen. Another objection, which is perhaps more serious, is that the windings have been made suitable for very low voltages in the armatures. For instance, the input of the 60 h.p. motor is about 620 amperes at 100 volts. This choice of voltage no doubt greatly facilitates the design from the point of view of a low transformer voltage, but such a choice would be almost impossible for traction work, owing to size of the controlling gear. At this voltage the current required by four 100 h.p. motors in parallel would be approximately 4000 amperes; and even, if connected two series two parallel, the control of 2000 amperes would involve very heavy cables and switches.

If, on the other hand, a higher voltage had been chosen, a higher value of the transformer voltage would have resulted; but this is precisely the difficulty which has to be met in practice. For railway work, voltages less than 220 are practically unknown.

The book concludes with two appendices, the first of which deals with the theory of the repulsion motor, taking account of magnetic saturation, and the shifting of the brushes; and the second gives some oscillograph tests dealing with the commutation of a small motor operating with alternating currents.

Mr. R. F. Looser, in translating this book from the German, has accomplished his task with excellent results.

VOLCANIC HISTORY OF AUVERGNE.

L'Age des derniers Volcans de la France. By Marcellin Boule. *La Géographie* (Mars, Mai, 1906.) Pp. 64; illustrated. (Paris: Masson et Cie.)

THE volcanic outbursts of Auvergne are to a certain extent disconnected locally and different in age. The western group is the more linear in arrangement, the eastern the more sporadic. In the one, the broad mass of the Cantal sends off a short spur—Aubrac—to the south-east, and a long one to the north, which extends through the famous Mont Dore district and terminates in the chain of Puys west of Clermont-Ferrand; in the other group we have the noted chain of the Velay and the outlier of Mezenc, Megal, and Coirons. The eruptions, apparently, were the latest to begin in the first of these districts, and the latest to cease in the region of the northern Puys. The tuffs and other sedimentary deposits, which are associated with the lava flows and masses of coarser scoria, have furnished palæontological data which fix the age of some of the volcanic outbursts, and make it possible by a comparative study of the ejecta to synchronise the discharges in different districts. The materials oscillate from basalts to andesites, with fairly abundant phonolites in two areas, and occasional rhyolites and trachytes among some of the older rocks. The earliest outbursts occurred in the Upper Miocene. Volcanic activity ceased in one of the southern extremities with the Lower Pliocene, in another with the Middle, in the Cantal itself with the Upper. It was prolonged in four districts well into the Quaternary, the date of its cessation being still far from certain.

In the neighbourhood of Le Puy, eruptions, as the discovery at Denise showed in 1844, were contemporaneous with Palæolithic man. The evidence of the Gravenoire skeleton (found in 1891) is doubtful, as it is from one or two other places, while that from Pranal, Blanzat, St. Saturnin, and Neschers is negative. There is none anywhere to show that eruptions were contemporary with Neolithic man; but an awakening, as Vesuvius once proved, is possible after a long slumber. Has this been the case in Auvergne? For that, according to some authorities, we have historical evidence. Here Prof. Boule's title and preface led us to hope for some additional information, but we have been disappointed. In fact, his discussion of the evidence is hardly so full as that which it received in the *Geological Magazine* so long ago as 1865. As was then stated, several earthquakes occurred about the year 451 A.D., and the wild deer became so terrified as to take refuge in Vienne. A third "portent" happened, but whether this was a volcanic eruption depends on the translation of certain Latin words in two letters written by bishops. If these refer to severe fires—possibly the consequences of the earthquakes—the language is extraordinarily bombastic; if to an isolated volcanic outbreak, this could not be in the "Puy" district, and there is much difficulty in locating it nearer Vienne. We do not find that the uncertainty has been diminished by Prof. Boule's researches; but, notwithstanding this disappointment, and though most of the information has been already published, we welcome as a boon to students this clearly written summary of the volcanic history of Auvergne from one who has taken such a leading part in its elucidation. T. G. Bonney.

OUR BOOK SHELF.

The Birds of the British Islands. In twenty parts. By Charles Stonham, C.M.G. With illustrations by L. M. Medland. Part i. Pp. 40 and plates. (London: E. Grant Richards, 1906.) Price 7*s.* 6*d.* net.

To use the language of sport, Mr. Stonham may claim to have established a new record. He has aimed at a colourless book, and colourless it is, both in the plates and in the text, though whether it is "far in advance of anything of the kind which has so far been attempted" must be left to the individual judgment of the reader.

In saying this, however, we are far from implying, or wishing to imply, that the work is without merit; it gives a careful and pleasing description of the species and their habits, and shows considerable acquaintance on the author's part with most of them; but nothing strikes us as impressive, nothing as an addition to our knowledge, nothing, in short, as unlike what may be found without much trouble elsewhere.

All this may, of course, be altered when families other than the Turdidæ come under discussion, but in this part—and it is this part that we are called upon to notice—we can see no sufficient reason for the publication of the work. Nevertheless, we infinitely prefer it to many other books treating of British birds, and hope, for the author's sake, that it may meet with more success than we anticipate. We can hardly believe, however, that the considerations of fine paper, brilliant ink, and so forth, advanced in the prospectus, will outweigh those of comparative cost. 6*l.* 15*s.* is no small price for a publication of this kind with black plates, especially when it is proposed to relegate the rare and occasional visitors—often of the utmost interest—to a future supplement, which will enhance the expense.

To the eye of an artist the plates will doubtless appeal as admirable specimens of the process employed, but to that of an ornithologist they lack the life and vigour which in many cases compensate for an absence of coloration.

Finally, we quite agree with Mr. Stonham that in many species the female and young are well worth depicting, and that it is quite useless to attempt to represent the songs of most birds by a set of syllables which each reader would in all probability mouth differently.

The Manufacture of Concrete Blocks, and their Use in Building Construction. By H. H. Rice and W. M. Torrance. Pp. 122. (London: Archibald Constable and Co., Ltd., 1906.) Price 8s. net.

THIS work is a reprint in full of the two prize papers on concrete block construction in connection with a competition instituted by the *Engineering News* and the *Cement Age*, and, in addition, abstracts are given of the papers of ten other competitors, which contain data not given in the prize papers.

Mr. Rice in his paper deals fully with the raw materials—cement, sand and gravel, or crushed stone; with the mixing and manufacture of the blocks; and with the important questions of curing and facing the blocks with a finer quality of the material, and he briefly discusses the principles underlying the use of this material in building construction.

Mr. Torrance deals more fully with the form of the blocks, illustrations being given of many of the moulds for which patents have been granted, and with the relative cost of buildings of concrete and other material; finally, he states that from an artistic standpoint the best success so far obtained has been where the process of casting in sand has been adopted, and several reproductions of photographs are given to illustrate this point.

The abstracts of the other ten papers give much useful information on many points of detail not dealt with by the authors of the two prize papers, with regard both to the manufacture of the blocks and also to their employment in building construction.

In an appendix are the rules and regulations governing the use of this material and the testing of the blocks in Philadelphia. There has been quite a flood of literature during the past year on reinforced concrete, but until this book appeared little had been written in reference to the use of concrete by itself for building purposes.

Elementary Electrical Calculations. By W. H. N. James and D. L. Sands. Pp. 216. (London: Longmans, Green and Co., 1905.) Price 3s. 6d. net.

THIS book is based upon a series of lectures given by the authors to first- and second-year students of electrical engineering, and can be confidently recommended to those for whom it is written. So far as it goes, it is well arranged and perfectly clear; the only criticism that can be suggested is that it does not go far enough. The range of a subject which should be studied by first- and second-year students is, however, a matter for individual teachers to settle.

It will suffice, therefore, to state that the book begins with an account of the fundamental units, proceeds to discuss Ohm's law very fully, and devotes brief chapters to power and work, conversion of energy, transmission and distribution treated quite simply, electrochemistry and photometry. Each chapter contains numerous examples fully worked out, and a large number of exercises for the student.

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.*]

Biometry and Biology: A Rejoinder.

I SHOULD like to preface my remarks on Mr. Lister's reply by relieving his mind from any anxiety about Dr. Pearl's feelings. Dr. Pearl is in America, and I cannot, of course, communicate with him, but I know him intimately, and am convinced that he is far too good a man of science to feel aggrieved by any criticism of his writings. He might well feel aggrieved that Mr. Lister supposes him desirous that his paper should remain uncriticised, because the criticism should affect his reputation. I am inclined to think that, as a fellow biometrician, he will rejoice with me that Mr. Lister's vague charge—made at a singularly unfitting moment—has been brought to a definite issue, and can be tried *coram judice*.

Had a first-year biometrical student in my laboratory sought advice from a biological freshman about the nature of *Paramaecium caudatum*, I should have anticipated that he would receive much the information with which Mr. Lister provides us. His remarks could only be made by one who (*a*) had either not studied the memoir he criticises, or had failed to perceive the significance of the constants calculated by the author, and (*b*) had never attempted accurate measurements on infusoria, or previously to such attempt been trained to that caution and accuracy in measurement which it is the function of biometry to inculcate.

I challenged Mr. Lister to substantiate the charge he made in August, when, presumably, the grounds of his insinuation at York were fresh in his mind. He then considered that Dr. Pearl's position was traversed by the objection that the conjugants individually are possibly or probably differentiated gametes.

What was the author's position? He expresses it exactly by quotations from Huxley and Romanes:—

"In my earliest criticisms of the 'Origin' I ventured to point out that its logical foundation was insecure so long as experiments in selective breeding had not produced varieties which were more or less infertile, and that insecurity remains up to the present time" (Huxley, "Life and Letters of Darwin," vol. i., p. 170).

"To state the case in the most general terms we may say that if the two basal principles are given in heredity and variability, the whole theory of organic evolution becomes neither more nor less than a theory of homogamy—that is a theory of the causes which lead to discriminate isolation, or the breeding of like with like to the exclusion of unlike" (Romanes, "Physiological Selection").

This problem of the divergence of individuals into varieties is the one selected by Dr. Pearl, and according to Mr. Lister is the best example by which he can illustrate his statement that biometricians do not select a sound biological problem "before bringing a formidable mathematical apparatus into action for its investigation." This is the "hare cooked before it was caught," to cite again Mr. Lister's phrase. Dr. Pearl shows that such homogamy exists in an extraordinarily high degree in *Paramaecium caudatum*. In other words, he has broken entirely novel ground, which, to say the least of it, renders Huxley's position no longer tenable. This is now admitted, albeit in a niggardly fashion, by Mr. Lister himself. In August he considered that Dr. Pearl's position was traversed by his omission to consider the differentiation of gametes which was possible or probable. He does not now even endeavour to show that it is traversed by this, but says that I have claimed for Dr. Pearl the *first* demonstration of the existence of this differentiation. In other words, he now admits that Dr. Pearl has fully considered the problem of differentiation. In fact, more than half Dr. Pearl's memoir is devoted to it. He further twits Dr. Pearl and myself with not distinguishing between a man and his gamete!

I turn to the last point first. I venture to think that the problem of homogamy is essentially the same in relation to both Metazoan and Protozoan, when we are considering its effect on the possible differentiation of species, and endeavouring to surmount Huxley's difficulty. Having shown myself that homogamy certainly does exist in one type of Metazoa, it was necessary that it should be shown to exist in the Protozoa, and for one type this is what Dr. Pearl has achieved.

Mr. Lister only obscures Dr. Pearl's statement as to the persistency of type in conjugant Paramæcia. Had he understood the constants dealt with by Dr. Pearl in this part of his paper he would have seen that they were what in biometry are termed *intra-racial* and not *inter-racial* values. The conclusions of Dr. Pearl have nothing to do with the inter-racial differentiation of gametes. Dr. Pearl grew Paramæcia under much variety of environment, and found that the non-conjugant type was highly correlated with the environment and the conjugant type singularly little affected by the environment. The whole inquiry was, of course, undertaken to illustrate Weismann's position, that while acquired characters are not inherited, the environment can influence inheritance where one cell is both soma and germ. In biology it has become almost axiomatic to assume that the Protozoa can inherit acquired characters on account of this identity, while in the Metazoa the acquired character of the soma is at the very least not usually inherited. Dr. Pearl brings out the all-important point that the gamete in Paramæcium is not, like the non-conjugant cell, markedly influenced by the environment. If Mr. Lister assumes that the characters *acquired* by the somatic cells are handed over to the gametic cells, this is, of course, to sweep away entirely the Weismannian hypothesis, and we may reasonably ask him for the quantitative proof of this assumption. The proof will at any rate go to the basis of the current hypothesis of "gametic purity." Mr. Lister asks for evidence of any relation between external characters in man and his gamete. The problem is not this, but the relation between the external characters in two phases of a cell which can be watched in passing from its conjugant to non-conjugant conditions, and that is an entirely different matter. Even here biometricians will shortly be prepared with an answer to the thus restated question,[1] although it has no relation whatever to Dr. Pearl's main point.

The remainder of Mr. Lister's letter would never have been written had he studied Dr. Pearl's paper or measured, as the latter has done, five or six thousand Paramæcia. The passage in Maupas was sufficiently familiar to me, and is actually referred to, together with the previous work of Hertwig, Gruber, and others on differentiation by Dr. Pearl *himself* in his paper. But the differentiation of two populations can only be *demonstrated* by an accurate quantitative investigation of the means, *variabilities, and correlations* of those populations. It may be rendered "possible or probable," as Mr. Lister held in August by a statement conveyed without detailed measurements in *seven* lines of print. In fact, Maupas says he has never found conjugants to exceed 225 μ, while Dr. Pearl, measuring immensely larger numbers, has found individuals up to 285 μ, a value considerably in excess of what was reached by the largest non-conjugant in his measurements, 275 μ. It will be clear in the face of such results that *demonstration* can only follow a study of large numbers and their proper statistical treatment.

Mr. Lister next proceeds to state that "every practical biologist knows" that specimens which have been preserved and fixed will be distorted. Will the reader credit the fact that pages of Dr. Pearl's memoir are devoted to a discussion of the methods needful to avoid distortion? Mr. Lister's statement only amounts to the confession that he himself cannot prepare undistorted specimens. The "practical biometrician" knows that the distortion can be almost entirely avoided by instantaneous killing of the Paramæcia and the avoidance of diffusion currents in changing to the higher grades of alcohol. The method of attaining these results is amply discussed by Dr. Pearl, but their application depends, as in all such matters, on long practice, on training and on technique. It is open to Mr. Lister to assert that the methods adopted by Prof. Worcester and Dr. Pearl failed in their object; it is not open to him to insinuate that they have overlooked a distortion the danger of which is obvious to the merest tyro in biology. But as he has not seen the preparations he can only defend his assertion on the ground that the measurements show marked evidences of the irregularities which would be produced by such distortion; and here we see at once the absence of thorough examination of Dr. Pearl's paper by Mr. Lister. Only *three* of the fourteen series discussed by Dr. Pearl were from *preserved* specimens. The methods employed in the other cases were *different*, but the many series were not mixed, as might be inferred from Mr. Lister's statement. Even including Dr. Simpson's measurements, made in a wholly different manner, there is striking general agreement which is absolutely inconsistent with the amount of variation which would arise in the case of largely distorted forms. As Dr. Pearl himself says, "The good agreement is something . . . which probably no biologist would have predicted before the measurements were made. One has been accustomed to think of Paramæcium as a soft-bodied creature likely to show great and altogether irregular fluctuations." He then points out that Paramæcium is less variable than Arcella, *Eupagurus prideauxi*, or *Ophiocoma nigra*, all of which organisms have a more or less firm exo-skeleton. So much for the question of the influence of distortion.

Mr. Lister next proceeds to the assertion that Paramæcium being a "slipper-shaped" (!) animal, there would be difficulty in measuring the breadth of the non-conjugant as compared with the conjugant. He would never have made this statement had he read Dr. Pearl's paper, where the relative weight of length and breadth measurements is considered at great length. The statement is further mere hypothesis, and not the experience of one who has learnt to measure Paramæcia. *The difficulty of measuring the breadth lies with the conjugating individuals and not with the non-conjugating individuals*, for reasons amply set forth by Dr. Pearl. In the next place, Dr. Pearl's main argument is drawn, not from the breadth, but from the length measurements, and, lastly, had Mr. Lister followed the significance of biometric constants he would at once have seen that his hypothesis was invalid. If the measurement of the breadth were affected by a large source of error due to diversity of aspect when the Paramæcium is measured after death, there would be little or no *organic* correlation between length and breadth. Dr. Pearl shows that the actual correlation is markedly higher for the non-conjugants than for the conjugants, and is of an intensity which we might reasonably expect from previous investigations of similar organic correlations.

Lastly, Mr. Lister proceeds gravely to inform us of another source of error which he supposes to exist. He says that Dr. Pearl's non-conjugant population consists of heterogeneous material, in which the variability would be increased by the fact that it contained all stages of individuals in process of differentiation into gametes. It seems astonishing to have to state it, but as a matter of fact no less than six control series of Paramæcia, in which no conjugation at all took place, and which each numbered 500 individuals, are dealt with by Dr. Pearl in his paper and compared with the series of conjugant Paramæcia. The comparison between conjugants in a preparation and the nearest non-conjugants was made primarily to ascertain whether the cultures were in any state of *local* heterogeneity, so that a spurious correlation between conjugants would necessarily arise from their being drawn from the same part of the culture. It was precisely of the nature of the test used by Prof. Weldon and myself to ascertain if *locality* influenced the value found for assortative mating in man.

Further, the slightest examination of Dr. Pearl's diagrams would have shown Mr. Lister that the so-called non-conjugant population is widely separated in distribution

[1] I will venture on a prophecy, rash as it may seem, but based upon a general experience of cell division where the mother and daughter cells have not been measured under like phases, that the correlation will not be found to be less than 0·5 or more than 0·7.

from the conjugant, and only in the first days of the conjugating fit is there an approach to a very slight secondary mode at the conjugating type value. This may correspond in the first days to a very small percentage of individuals in a "conjugating mood" among the non-conjugants. The skewness, however, as measured by Dr. Pearl's numbers, although slight, is the *other* way, showing that the non-conjugant population might best be conceived as a distribution *wanting* a portion about the conjugant type, and not as a population with an addition on that side, as it must be in the case of a mixture of non-conjugants and potential conjugants. Taking the variability of (*a*) all populations in which there were no conjugants, (*b*) populations of non-conjugants in which conjugants appear, and (*c*) populations entirely consisting of conjugants, we have the three numbers 8·7, 8·6, and 7·9, which suffice to show that non-conjugants in a conjugating population are practically identical in variability with non-conjugants in a non-conjugating population, *i.e.* the potential conjugate is a very small proportion of the population, conjugation taking place rapidly after the conjugating phase is reached.

I am sorry to have to reply to Mr. Lister in this fashion. I fear, to use his own phrase, he will still "go away unedified" from "the biometric side of the church." But the time has come when vague insinuations based on no complete study of biometry must be replaced by some attempt to understand before criticism is passed. Above all, in a case like the present, a total disregard of the contents of Dr. Pearl's memoir and a suggestion that he has made errors and overlooked difficulties, which he has actually dealt with at every turn, is not to the credit of the critic. A man who has spent years in studying Paramæcia, and made thousands of measurements after much consideration of the difficulties, may reasonably expect a different type of criticism from another who clearly has attempted no such series of measurements, and whose authority for *ex cathedra* utterances may therefore be well called into question. Dr. Pearl's full paper is now in type, and I do not think his reputation will suffer when the paper is tested against the *a priori* criticisms which Mr. Lister has passed upon it. KARL PEARSON.

Biometric Laboratory, University College, London, October 12.

Radium and Geology.

IN NATURE of October 11 (p. 585) two letters appear on this subject, in reply to which a few words may perhaps usefully be said. Mr. Fisher's principal point is that if the earth's internal heat is maintained by radium, there is no room left for that shrinkage of the globe by cooling which some geological theories require. I think that the difficulty is only apparent. The duration of radium, it is generally agreed, is limited to a few thousand years. The supply must be in some way maintained, or there could be no radium on the earth now. Writers on radioactivity are generally agreed that the radium supply is kept up by the spontaneous change of uranium into radium.

Since radium is found in ordinary rocks, we must, on the received theory, suppose that uranium also exists in these rocks. It may be objected that uranium is never entered as one of the constituents found by chemical analysis. But, since the quantity to be expected is only of the order of 1/1000th of 1 per cent., this is not surprising. It might be possible, by very special methods, to detect uranium in granite, but I think in any case we may feel confident that it is there.

Everything depends on this initial supply of uranium. It gradually passes into radium, and, after that, into some inert form. The supply of uranium cannot last for ever. Its gradual diminution must involve the cooling and shrinkage of the globe.

It may perhaps be thought in these circumstances illegitimate to equate the escape of heat per second from the earth to the supply generated by radium in that time. There is reason, however, to feel pretty sure that thermal equilibrium is practically established in a time small in comparison with the duration of uranium, so that the rate of change in the amount of the latter can have no appreciable influence on the distribution of temperature in the globe at any moment.

Mr. Palmer suggests that if the earth's internal heat is due to radium, the moon ought to be internally hot too, and its volcanoes should be active. I discussed the question of the moon's internal heat in my first paper (Proc. Roy. Soc., A, vol. lxxvii., p. 472). I quote from that paper:—"It has generally been supposed that the lunar volcanoes are extinct. But that view seems to rest chiefly on an *a priori* conviction that the moon has no internal heat. As Prof. W. H. Pickering has pointed out, all those observers who have made a special study of the moon have believed in the reality of changes occurring there."

Even if there were good reason to be sure that the lunar volcanoes were extinct, that would still be inconclusive. For it is believed by many geologists that volcanic action is due to the penetration of surface water to the hot interior of the globe. Thus volcanic inertness may be due, not to the absence of internal heat, but to the absence of surface water. R. J. STRUTT.

The Rusting of Iron.

IN my remarks on "The Rusting of Iron," published in NATURE of September 27, I directed attention to the fact that pure hydrogen peroxide solution was rapidly decomposed by cast-iron, the latter becoming covered with rust. This, I stated, "was, no doubt, due to catalytic action."

In his friendly criticism of my remarks, Dr. Gerald T. Moody writes, in NATURE of October 4, "that the metal becomes covered with rust in a few minutes, is not, however, to be referred to catalytic action, as Mr. Friend suggests, but is a consequence of the formation of acids by the oxidation of some of the impurities present in the iron, and of the subsequent electrolytic action."

That acids are formed in the above manner may be regarded as certain. These attack the iron, forming minute quantities of salts, which are decomposed by the oxygen of the peroxide, yielding rust, and liberating the acid, which can now attack more iron. In this way a small quantity of acid may be instrumental in oxidising a large quantity of iron. In other words, the acid is a catalyser, and the reaction is analogous to the rusting of pure iron in the presence of carbonic acid, oxygen, and water. The particular acid or acids which will cause this catalytic action must depend, of course, on the sample of iron used.

For the same reason "the intensity of action will be determined by the amount of acid formed on the surface of each particular sample of metal, when in contact with the peroxide." It is thus unnecessary to assume an electrolytic action, as Dr. Moody suggests. This is supported by the fact that the same result may be obtained by employing pure iron, and commercial hydrogen peroxide, which invariably contains hydrochloric acid and other impurities, as Dr. Moody has himself pointed out.

Würzburg, October 9. J. NEWTON FRIEND.

Optical Illusions.

IN your issue for September 27 a description of some optical illusions furnished by revolving fans recalled to my mind a very powerful illusion which I noticed some time ago, but for which I have not been able to furnish a satisfactory explanation.

A thaumatrope card (*i.e.* a card having a cage pictured on its one side and a bird on its other side) was mounted so as to turn round a vertical median axis at a speed of about two revolutions a second.

When an observer, viewing the rotating card from a distance of 5 feet or more, shuts one of his eyes, the card appears instantly to reverse its direction of rotation. (At the same time the axis of rotation appears to tilt a little away from the vertical.) On reopening the closed eye the illusion vanishes, and the card again appears to assume its true direction of rotation.

I showed the illusion to several friends, who all agreed as to its striking perfection. DOUGLAS CARNEGIE.

Newcastle-on-Tyne, October 10.

ETHNOLOGY OF SOUTHERN INDIA.[1]

THIS book is a reproduction, with some additions and quotations from published materials, of the useful bulletins which the author, as curator of the Madras Museum and director of the Provincial Ethnographical Survey, has issued during recent years. The arrangement of the book might be much improved; full references to the authorities should have been given, while a bibliography would assist the student in investigating a mass of unfamiliar literature. Even as it stands, the volume, with its useful collection of photographs, supplies much interesting material. The greater part of it is devoted to notes on marriage and death customs, and to a miscellaneous group of notes on omens, charms, magic, and the like. It is, as Mr. Thurston calls it, "a farrago," with which we can only deal by gleaning some of the interesting facts which abound in its pages.

FIG. 1.—Sorcery Figure. From "Ethnographic Notes in Southern India," by E. Thurston.

Thus in the notes on marriage we find the rite of *confarreatio* adopted by the Kammalans of Malabar in the case of polyandrous unions, a fact which we believe to be new to Indian ethnologists. The bride and her prospective bridegrooms, who are all brothers, are seated in a row, the eldest on the right, the others in order of seniority, and last of all the bride. The tribal priest solemnises the union by pouring milk into the mouths of all the parties to the contract. Much evidence on the subject of fraternal polyandry is here collected, but for a scientific treatment of the subject we must await the forthcoming book on the Todas by Dr. Rivers. Numerous cases, again, are given of actual or feigned resistance offered by the friends of the bride to the bridegroom and his party. These are accepted *en bloc* as evidence of marriage by capture, which seems unscientific in view of the evidence collected by Mr. J. G. Frazer to show that many of these mock combats are really intended to promote the fertility of the soil, and are thus by analogy appropriated in the marriage rites. The hill people of Vizagapatam practise a curious method of selecting the bride. Near their houses is a pit in which the children are placed at night to keep them warm in the cold season. In spring all the marriageable girls are shut up in one of these pits, and a young man who has already selected his bride with the consent of his parents comes to the brink and sings out her name. If she likes him she comes out, a fire is lighted, and a dance solemnises the union. If she sings back that she will not have him he immediately tries the name of another girl, and goes on doing so until he is successful.

[1] "Ethnographic Notes in Southern India." By E. Thurston. Pp. viii+580; 40 plates. (Madras: Government Press, 1906.)

The chapter on death rites, though badly arranged, abounds in useful information. Madras supplies an admirable field for such investigations, because prehistoric interments are numerous, and it would be interesting to compare the usages of the earlier people with those of the present forest tribes. This Mr. Thurston has not attempted to do, but his collection of facts will help European students to undertake the inquiry.

A good illustration of the theory propounded by Mr. E. S. Hartland at the York meeting of the British Association—that both magic and religion, in their earliest forms, are based on the conception of a transmissible personality, the Mana of the Melanesian races—is found in the belief that from the eye of a man of low caste a subtle matter proceeds which contaminates food and other things upon which it falls. The most remarkable example of black magic is found in the nude figure of a woman, with her feet turned backwards, a large square hole cut above the navel, and the whole body covered with long iron nails and Arabic inscriptions, which was washed ashore at Calicut in 1903. This figure, of which the illustration is here reproduced (Fig. 1), Mr. Thurston supposes to be that of a woman of the Laccadive Islands who was possessed by an evil spirit, "which was nailed to it before it was cast into the sea." The fact that the feet are turned backwards certainly indicates its demoniacal character, and it seems more probable that it represents some notorious witch; that the nails were driven into it and the mutilation made in order to injure her, and the spells added to destroy her magical power; finally, that the image was cast into the sea as a means of getting rid of the sorceress.

FIG. 2.—Meriah Sacrifice Post. From "Ethnographic Notes in Southern India," by E. Thurston.

The chapter on fire walking supplies many facts, but does not help us much to understand the methods and significance of the rite. The question has been discussed by Mr. J. G. Frazer in his recent book on "Adonis, Attis, and Osiris," with the result that it seems to be a survival of a rite of actual fire sacrifice. In some cases the juice of the *Aloe indica* is said to be used as a protective, but Mr. Thurston seems to believe that the indurated skin on the soles of men who habitually walk barefoot over the roughest ground accounts for many cases of immunity. A recent description by Mr. D'Penha of the rite as it is performed at Travancore indicates that the length of time which is allowed to expire between the lighting of the fire and the actual walking makes it an operation of little danger. Mr. Partridge, who witnessed the ceremony at Ganjam, describes the priest as going to the fire-pits, "which were a mass of red-hot ashes; he sprinkled not more than a handful of incense on to them; dipped his feet in a mixture of rice-water and milk; and walked across one pit, leading another man. He then dipped his feet again in the fluid mixture, and returned by the other pit. The time he took in walking across one pit was not more than four seconds, and he took about four steps on the ashes. At least fifty persons in the crowd walked over the pits afterwards, but they went a little faster than the priest, and some of them only took two steps on the ashes. Their feet were not hurt, and they did not wash them in any mixture before or after they went over the ashes. I infer from the way in which the performance was conducted that anyone can easily walk over the ashes, but that, if he goes like the priest, he must dip his feet in the mixture both before and after walking across them." Mr. Risley, on the evidence from Bengal, came to the conclusion that when a narrow trench is used in the rite, it is possible for an active man to place his feet so rapidly on the edges of the trench that he does not actually touch the burning cinders, and escapes injury. Probably many performances of the rite may be explained in this way.

The chief ethnological curiosity of the museum is the Meriah sacrificial post from Ganjam, used in the blood sacrifices of the Khonds, of which the illustration is here reproduced (Fig. 2). It has suffered much damage from white ants, and its original form is not easily recognisable. It seems to represent the proboscis of an elephant to which the victim was bound. This, according to General Campbell, was one of the most common forms.

Mr. Thurston's book is arranged without any method, but it contains a mass of curious information which will make it welcome to European ethnologists.

MEDICAL SCIENCE AND ARMY EFFICIENCY.

In spite of the natural interest which the nation takes in the Army, few people realise completely what is the work that the Royal Army Medical Corps has to do, how vast are the responsibilities committed to it, and how dependent army efficiency is upon medical science. It is difficult to explain this want of interest and knowledge, but it arises probably from the fact that much of the work which the medical service does in the Army, both in peace and war, is of an unostentatious nature, and lacks the pomp and glamour which appeal so strongly to a public when associating itself with the military organisation of the country. Apart from this, the medical service suffered for many years under grave official disabilities, being systematically snubbed, and its professional and military pride injured. Such an attitude on the part of highly-placed persons in the military bureaucracy could not fail to dishearten its *personnel* and lessen any general enthusiasm or interest in its work by the general public. To a large extent these mistakes of the past have been rectified, and the army medical service desires now, as it ever has done, to do its duty and to deserve well of the country; but it recognises that to do this it must advance and utilise fully the progress of science and the increasing knowledge of the profession of medicine which it represents in the military machine. Before attempting to explain these aspirations, it may not be uninteresting to readers of Nature to sketch briefly the evolution of the army medical service from less enlightened times to the present day.

The need of medical attendance with an army in the field seems to have been always more or less recognised. In the days of the early Edwards, physicians and surgeons are recorded as having formed part of the levies which were taken into the field; but until the sixteenth century the proportion of such men to the whole force was very small, and even in the time of James I. we find no allowance or provision in the estimates for medicines or hospital appliances; these details were supposed to be found by the surgeons themselves, for the cost of which a weekly stoppage of 2*d.* was made from the pay of the private soldier. It is not until the time of Marlborough that we find any sign of prominence being given to the medical service of the Army, but it was nearly fifty years later that the first reforms in military medicine and sanitation were introduced by Sir John Pringle, when physician-general to the forces in Flanders. The long series of wars in which England was engaged at the end of the eighteenth and the beginning of the nineteenth centuries produced many able men who left their mark on the organisation of the Army; not the least remarkable among them was Sir James M'Grigor, who, beginning his career as a military surgeon in 1793, became principal medical officer in Portugal and the Peninsula under Wellington, and finished his official career as medical director-general after the time of the great war. To him it was due that, in the service of which he was head, order was evolved out of chaos, and that the army medical service became an organised body, uniting in itself the best traditions of two professions.

In the long peace that followed Waterloo, our military machinery rusted from disuse or decay, notably the supplementary services which are necessary to form an army. The arrangements which had been made and the materials which had been collected in the old war-time for the care of the sick and wounded disappeared with nothing to replace them, and, when the Crimean War came, the best endeavours of the best men were powerless to grapple with the problems which were to be faced. The lessons of old experience had been forgotten, and the army medical service found itself helpless, without means to carry out even an antiquated system of professional duty. At that time the army medical service consisted only of officers, divided into two classes, staff surgeons and regimental surgeons, though the whole were borne on one list, and, up to a certain rank, were interchangeable. After a regimental surgeon had attained a certain seniority he was promoted to be a staff surgeon of the first class, and was employed thenceforth in superintendence and administration rather than in regimental or personal professional practice. Practically all the officers of the medical staff had at one time or another been regimental surgeons, and presented in varying degree the merits or demerits of that training. The system of gazetting medical officers to individual corps had many advantages, both socially and professionally, but it had undoubted drawbacks. The first and most important of these was that there was a constant difficulty in utilising them elsewhere than with their own corps, hence, if the public service was to be carried out, the total number of surgeons to be maintained was excessive. Putting aside this question of economy and distribution of *personnel*, the system was extravagant owing to the hospitals being regimental also; this involved an unnecessary duplication of equipment, while, too, in many instances the regimental surgeons, by this limitation of their sphere of duty, had a tendency to drift into a quasi-routine method of professional practice.

In 1858, following the close of the Crimean War, came the Royal Commission under the presidency of Sidney Herbert. The immediate result of its report was the formation of the Army Medical School at Netley for the training of medical officers in military technical duties, also the re-modelling of the service and the initiation of practical reforms in the administration of military medical affairs, as well as the creation for hospital duties of the Army Hospital Corps, a body of men possessing a complete military organisation. In 1873 the system of regimental surgeons, except in the Guards, was abolished finally, and all medical officers were consolidated into one staff; at the same time disappeared also the regimental hospitals, their places being taken by general hospitals and station or field hospitals. From this date all regimental organisation ceased to exist, the arrangements for medical affairs passing into the hands of the medical officers alone. In 1877 authority was given to medical officers to command the whole of the Army Hospital Corps, and also all patients in military hospitals, as well as other soldiers attached to them for hospital duty. From this date the medical officers became invested with the responsibilities as to discipline, training, supply, payment, and movement of their own subordinates, similar to the responsibilities resting upon a commissioned officer in any other branch of the service. In 1885 the appellation of the Army Hospital Corps was changed to Medical Staff Corps, and in 1898 the Medical Staff and the Medical Staff Corps were further consolidated into an autonomous whole as the Royal Army Medical Corps of the present time. As a necessary sequel to the functions and responsibilities of the Corps in its new organisation, its officers were given full army rank and title, thus completing the evolution of the medical service from the chaotic state when its *personnel* were mere camp followers endowed with neither official status nor responsibility to the completely autonomous and purely military organisation of to-day. These recent reforms have embraced the granting of good pay, liberal terms of service and study, with the abolition of the archaic school of instruction at Netley and the substitution of a Royal Army Medical College in London, where the officers of the Corps are brought into intimate touch with the newest theories and practice of medicine. In a word, the liberal and far-seeing policy of those responsible for the reforms of 1899 to 1902 has revolutionised the position and *moral* of the Corps, with the result that its 1002 officers and 4189 non-commissioned officers and men constitute a contented and thoroughly efficient body of technically trained men, equipped and able to meet the needs of the sick and the wounded.

Is the task ended? it may be asked, and have we reached finality in our efforts to build up a medical corps at once worthy of the country and the Army of which it is an integral unit? Unfortunately no; there is much yet to be done. Military history has, up to to-day, been a history of the battle only, of brave deeds done and suffering bravely borne; but what of the history of the means by which armies were rendered numerically efficient and placed in a condition to fight? We have faced the problem of how to treat and provide for the sick and wounded, and unhesitatingly compel our commanders to encumber their fighting force with *impedimenta* and medical provision for 10 per cent. of sick; but need this be? The two great scourges of armies in the field are enteric and dysentery. During the late war in South Africa, these two diseases alone caused 74,000 admissions to hospital and 9200 deaths. Yet both diseases are largely preventable. It is no exaggeration to say that for every man wounded in war twenty sick men are brought to hospital, largely from preventable causes. The unopposed crossing of the Modder River lost us more men from enteric than the battle of Colenso lost us from wounds. Surely if this enormous waste of fighting strength is avoidable, the prevention of sickness and disease in a field force is of more importance than the mere treatment of its victims. Thanks to the evolution in its organisation and perfection of equipment which the Royal Army Medical Corps now presents, the soldier of to-day has a better chance of recovery than the sick or wounded man of the Peninsular or Crimean Wars; but the same cannot be said of the soldier's chances of contracting preventable disease, for the organisation and equipment of the British Army as to disease prevention remain little better than they were a hundred years ago. The reason of this is, that army administration (medical) has not kept pace with the advance of science, and has neglected to note early the influence of Pasteur's work upon the problem of war. This, then, is the task still before the army medical service—how to translate scientific knowledge into an administrative system for the efficient prevention of disease among troops in the field. This would be easy enough if no regard were paid to the necessities of mobility and supplies, but those are points which we cannot ignore; in fact, the whole object and aim of sanitary effort is to increase fighting efficiency and lessen transport; therefore, in our campaign to reduce the incidence of preventable disease, we need to be careful not to add *impedimenta* to the Army with one hand even though we take some away with the other.

It is to the solution of this problem that the medical corps of the Army is now devoting itself, and the principles on which it is working are briefly these:—(1) the Army at large, from highest to lowest, must be educated to appreciate the need of radical reforms in the direction of preventing disease, and to understand that these cannot be secured "by order" only, but require personal effort on the part of each individual and the recognition by officers of their own direct responsibility for the health of their men; (2) the elaboration of an organised system for providing safe and potable water for all troops when in camp or on field service. The practical application of the first principle has taken the form of systematic instruction in the various garrisons of all ranks in elementary sanitation. These classes are conducted by officers of the Royal Army Medical Corps, whereby the importance of personal effort on the part of both officers and men is enforced and the special training of a certain number of men in practical sanitation secured, so that each unit may have its own sanitary squad for these special duties. Having these trained men at their disposal, it is hoped that commanding officers will find no future difficulty in the maintenance of their own lines and camps in conditions of sanitary efficiency. For the provision of safe and approved water to each unit in the field the Royal Army Medical Corps proposes to take full responsibility, and to this end every water-cart, every filter, every heat steriliser, and all chemical reagents for the routine purification of water will be in the charge of, and worked by, trained men of the Medical Corps.

Experience has shown that to hand this kind of equipment over to other than specially trained men is certain to end in failure. For the training of these men in methods of water purification the new School of Army Sanitation has been established at Aldershot, where special provision is provided for practical instruction in every method and the working or trial of any new apparatus or chemical technique adapted for army needs. The success of this effort has been already remarkable, demonstrating not only the feasibility of purifying water for soldiers under field conditions, either by means of special filters, by heat exchange sterilisers or by chemical reagents, but also showing the fitness of the men of the Royal Army Medical Corps for this special work. The school is utilised also for instruction of men from every branch of the service in general sanitary duties, and in this twofold way constitutes a centre for the dissemination of practical sanitary knowledge and work to the whole Army.

It is early yet to say what will be the final result of this attempt, but everything points to the conclusion that the incidence of preventable disease in time of war must and will be reduced thereby. It is gratifying, further, to record the sympathetic support which the movement is receiving from a large number of general officers, commanding officers, and others outside the medical corps; but there is much leeway to be made up and much apathy and inertia to be overcome. This will be done only by the support of public opinion and interest, particularly of the scientific public. Possibly this outline of the present position may appeal to them to see that the scheme of work here sketched out has free scope and opportunity to evolve itself; in other words, that medical science is applied logically to the attainment of army efficiency, and that disease prevention is regarded as much a function of the medical corps as disease or wound treatment.

R. H. FIRTH.

THE METRIC SYSTEM OF WEIGHTS AND MEASURES IN THE COLONIES.[1]

THE question of the introduction of the metric system of weights and measures into the United Kingdom has been before the public for more than forty years. An important step in this direction was taken in 1897, when the Weights and Measures (Metric System) Act was passed which rendered it lawful to use metric weights and measures in this country for the general purposes of trade. The trading community as a whole has not, however, manifested any eagerness to take advantage of this permissive legislation, and, so far as retail trade is concerned, the use of the metric system appears to be restricted to dispensing chemists and a few vendors of lager beer. It is true that for some years past the system has been allowed to appear in the official syllabus of our public elementary schools, but no stress is laid upon it there, and its chief recommendation is represented as being "the advantage to be gained from uniformity in the method of forming multiples and sub-multiples of the unit."

But although the metric system has made little progress in this country, and has met with scant official encouragement, the importance of its universal adoption is becoming every year more fully recognised in our colonies. The report which forms the subject of this article is a very clear indication of the strong current of public opinion in the Transvaal in favour of the general adoption of the system. The commissioners, of whom Mr. R. T. A. Innes, the well-known Government meteorologist, was chairman, recommend that the kilogram, the metre, and the litre be adopted as the basis of the standards of weight and measure in the colony. An important resolution, which will go far towards making the public familiar with metric weights and measures, is that it shall be compulsory to use the system in land surveying and in the retail sale of drugs. The opinion is expressed that it will not be practicable to insist upon the exclusive use of the metric system in general trade in the colony until the system is made compulsory in the United Kingdom, unless the other South African colonies consider it feasible to combine for the purpose.

The commissioners have made a careful survey of the question of weights and measures legislation, and their recommendations are embodied in a final draft ordinance the provisions of which are in many respects a distinct advance on the enactments in force in this country. Thus the definition of "trade" explicitly includes contracts for land, and so renders surveyors' measures liable to official verification. In the United Kingdom, surveyors generally test their own measures as best they can. The definition of "measuring instrument" includes instruments for the measurement of area. A similar provision in this country would be most beneficial to the leather trade in preventing disputes, now of frequent occurrence, especially in the sale of hides. Short weight and measure, and the practice of weighing the wrappers with goods sold, are made distinctly penal. People defrauded by these practices in the United Kingdom have to seek their remedy in the county court, or in a prosecution for false pretences.

It appears from the minutes of evidence appended to the report that much difficulty is experienced in the Transvaal in getting assay weights standardised with accuracy, especially weights from 10 mg. downwards. Certificates obtained some years ago from official institutions in Austria, England, Germany, and the United States were found to give very different values for the same set of proportional assay weights. So far at least as England and the United States are concerned, it is probable that at the period in question the standardising institutions had had but little experience in the verification of metric assay weights. Within the last few years, however, both these departments have been materially strengthened. The recent report of the newly-constituted Bureau of Standards at Washington sufficiently attests the high calibre of the scientific members of the present staff, whilst a corresponding improvement has been effected in this country by the appointment of Major P. A. MacMahon, F.R.S., to take charge of the Standards Department of the Board of Trade.

At the forthcoming colonial conference the importance to our colonies of the adoption of the metric system of weights and measures throughout the Empire will be urgently impressed upon the Secretary of State, and it is hoped that the Home authorities will be induced to take a greater interest in this question than they have hitherto evinced. The introduction of the metric system into the United Kingdom is not indeed a task to be lightly undertaken. It would involve much hardship to small traders, and would derange the habits of the whole trading community. Centuries of instruction in the "advantages of uniform multiples of the unit" would not prepare the nation for so great a sacrifice. When so little has been done by the authorities to familiarise the public with the real significance of the question, it is not surprising that public opinion is on the whole unripe for

[1] "Report of the Commission appointed to consider and report upon a Draft Ordinance to consolidate and amend the Law relating to Weights and Measures." (Pretoria: Government Printing Office, 1906.)

a change of such magnitude. These considerations are well understood in the colonies. Thus on p. 64 of the report now under consideration we find the statement:—"The United Kingdom is conservative and unless this is forced upon them it will never be adopted."

The question of the adoption of the metric system has not been brought forward in our colonies merely from considerations of relative practical utility or of relative scientific perfection, but owing to difficulties experienced in commerce with foreign countries, and to the prospect of continual loss of trade. Until the United Kingdom, their very good customer, takes the lead, they cannot afford to make the change. If their loyalty in respect of weights and measures is thus in great measure enforced upon them, it is none the less pathetic. Every day it is more effectually shutting them out from the new markets which are of vital importance to their commercial prosperity. So long as the public at home are taught that the claims of the metric system are based chiefly on its decimal notation, so long will they remain unconvinced of the necessity for adopting it. On the other hand, if the true issues are placed before them, they are not likely to be inconsiderate in a matter which involves the interests of their most important colonies.

NOTES.

The following is the text of the address presented by Sir Arch. Geikie for the Royal Society at the recent celebration of the quatercentenary of the University of Aberdeen:—The Royal Society of London for Promoting Natural Knowledge sends cordial greetings to the University of Aberdeen on the auspicious occasion of the celebration of the four hundredth anniversary of its foundation. The Royal Society would more specially desire to record its sense of the importance of the services which the University has rendered to the progress of science. From its infancy the society has been privileged to count among its fellows distinguished professors and graduates of Aberdeen, and this close and valuable association still continues. It is a gratification to recall that the illustrious family of the Gregorys, which for some two centuries shed so much fame upon the University and upon Scotland, were from the beginning intimately linked with the Royal Society. James Gregory early reached such eminence in mathematical and astronomical research that in 1668, when he was only thirty years of age, he was elected a fellow, six years after the incorporation of the society. His invention of a reflecting telescope, of which he had first conceived the idea, prompted Newton to proceed in a similar direction in order to evade the difficulties of chromatic dispersion, and led to mutual regard and friendly cooperation. To his brother David Gregory, who had the distinction of being one of the earliest effective promoters of the Newtonian philosophy, the society is also indebted for important communications published in early volumes of the Philosophical Transactions. The obligations of physical science to Aberdeen did not end with the lives of the masters of the seventeenth century, for within living memory the University has numbered among its professors the world-renowned pathfinder James Clerk Maxwell. To the progress of the study of medicine the same remarkable family of Gregory continued during successive generations to make important contributions, while the fame of the medical school was in more recent years extended by Allen Thomson. In natural science the well-remembered names of John Fleming, William MacGillivray, and James Nicol appear among those who have sustained the scientific reputation of Aberdeen. But it is not only with the scientific side of culture in the University that the Royal Society has had interesting links. It is a pleasure to remember that Thomas Reid, the father of Scottish philosophy, whose fame is one of the fairest pearls in the chaplet of the northern University, contributed to the Royal Society in 1748 an essay upon quantity. In remembrance of these varied associations of the past, and with sincere wishes for their continuance in the future, the Royal Society gladly adds its felicitations to those which will this year come from all civilised countries to the University of Aberdeen.

We regret to learn of the death on Wednesday, October 10, at the age of fifty-five, of Mr. Herbert Rix, assistant secretary of the Royal Society from 1885 to 1896. Mr. Rix resigned his post ten years ago, finding that his strength would no longer sustain the greatly increased anxiety and burden of his office. He was already suffering from a weakness of the heart, which gradually developed during the following years. A year ago he was obliged to relinquish nearly all active work, and the shock of his wife's death last August, as the result of an accident, had a disastrous effect upon him. Mr. Rix entered the service of the Royal Society in 1879, as clerk under the late Mr. Walter White, then assistant secretary, whom he succeeded six years later, his service to the society thus extending over seventeen years. During this period a great extension of the activity of the society occurred, entailing a large increase in the responsibilities of the executive and in the amount of work thrown upon the office. Mr. Rix's bent was in the direction of the moral rather than of the exact sciences, but he gave the best energies of a well-trained mind to the arduous duties of his position, and the simple directness of his character, his high principles, and his kindly nature made him popular with all who came in contact with him. After retiring from the assistant secretaryship he retained for some years the position of clerk to the Government Grant Committee, and continued up to the time of his death to act as secretary to the Lawes Trust Committee. He devoted much of his latter years to the study of comparative religion, and was a frequent lecturer on ethical subjects. He was a graduate of London University.

The board of directors of the great manufacturing firm of Kynoch (Ltd.) has decided to introduce the metric system of weights and measures into all their works. A small committee has been appointed to consider the details of the change and to provide the necessary instruments, and as soon as the committee reports the change will be made. All the weights and measures used by the firm, whether lineal, square, or cubic, will be metric. For money calculations the pound sterling will be adopted as the unit, and this will be subdivided decimally.

A Reuter telegram of October 11 from Basse-Terre, Guadeloupe, reports that a violent eruption of Mont Pelée has caused a shower of ashes to fall over the south-east of Guadeloupe.

A New Zealand international exhibition is to be held, under the auspices of the New Zealand Government, at Christchurch, Canterbury. The exhibition will be opened on November 1, and will be terminated in April, 1907. A special feature is to be made of the representation of Maori life, and Poi dances and hakas will be arranged from time to time.

The annual meeting of the Yorkshire Naturalists' Union will be held at York on Saturday, December 15. Mr. W. Eagle Clarke, of the Royal Scottish Museum, will deliver his presidential address, entitled "Antarctic Bird-life," which will be illustrated by a series of lantern-slides from photographs taken during the National and Scottish expeditions. Further details can be obtained from Mr. T. Sheppard, the honorary secretary of the society, at the Museum, Hull.

A fruit growers' conference will be held at the South-Eastern Agricultural College, Wye, on Wednesday, November 7. The chair will be taken by Mr. Laurence Hardy, M.P., and an introductory address will be given by the principal of the college. The subjects to be considered at the conference will be:—Methods of planting, S. U. Pickering, F.R.S.; strawberry culture, W. P. Wright; treatment of American blight, F. V. Theobald; and some fungus diseases of orchards and plantations, E. S. Salmon.

We learn from the *Times* that unavoidable delay in the completion of the latest addition to the Carnegie Institute building at Pittsburg, Pa., has made it necessary to change the date for opening the annual international exhibition from November 1 of this year to April 11, 1907. This change has been made because the trustees desire the exhibition to be held in conjunction with the opening and dedication of the building, which has been enlarged during the past two years to about six times its original size. A number of eminent men, representing the scientific, artistic, and literary organisations and institutions of the world, will be present at the dedication.

The new session of the Royal Geographical Society will be opened on November 12, when a paper will be read on North-Eastern Rhodesia by Mr. L. A. Wallace. On November 19 Mr. J. Stanley Gardiner will deal with the subject of the Seychelle Islands, and on December 10 an account of irrigation in the United States will be given by Major John H. Beacom. Other provisional arrangements are as follows:—Polar problems, Dr. Fridtjof Nansen; through Central Africa from the west coast to the Nile, Lieut. Boyd Alexander; nine years' survey work in northern China and Mongolia, Colonel A. W. S. Wingate; a journey through Central Asia to northern China, Major C. D. Bruce; the north magnetic pole and the north-west passage, Captain Amundsen; aboriginal India, Colonel Sir T. H. Holdich, K.C.M.G.; a journey from Yunnan to Assam, E. C. Young; the story of London maps, Laurence Gomme; the evolution of the map of Africa, Edward Heawood; inland waterways, G. G. Chisholm; the Taupo volcanic region, New Zealand, J. Mackintosh Bell. At one of the meetings in the early part of next year an authoritative account will be given of H.R.H. the Duke of the Abruzzi's expedition to Mount Ruwenzori.

In 1904 an advisory committee was appointed by the Secretary of State for India to inquire into some of the problems concerning plague, and the first function of the advisory committee was to appoint a working commission which has been investigating the disease in India ever since. A series of reports on the work already accomplished has just been published in a special number of the *Journal of Hygiene* (vi., No. 4). The first half of this contains the results of experiments on the transmission of plague by fleas. Guinea-pigs allowed to run free in plague houses in 29 per cent. of cases contracted plague, but if the animals were kept screened by fine gauze, so that fleas had no access, they remained healthy. Fleas caught on rats dying of plague and transferred to healthy animals transmitted the disease. The Hon. N. C. Rothschild contributes a paper on the species of flea found on rats. Experiments on the infectivity of native floors grossly contaminated with *B. pestis* seem to show that they do not remain infective for more than twenty-four hours. In plague-infected rats as many as 100,000,000 bacilli may be present in 1 c.c. of blood, and a few in the urine and fæces. Chronic plague in rats was noted in six instances at a season of the year when neither human nor rat plague existed, suggesting that this possibly is the means by which the infection is propagated from season to season.

The contents of the first part of the nineteenth volume of the Proceedings of the Royal Society of Victoria comprise descriptions of new and little-known marine molluscs from the adjacent sea, by Mr. J. H. Gatliff, and of decapod crustaceans from the same, by Messrs. S. W. Fulton and F. E. Grant, together with the first instalment of a census of the Victorian representatives of the last-named group by the same writers.

The papers in the September issue of the *American Naturalist* are chiefly interesting to histologists and specialists. In the first Prof. A. W. Weysse and Mr. W. S. Burgess contribute an elaborate account of the histogenesis of the retina, summarising their conclusions at considerable length in tabular form. The marine copepod crustaceans of Rhode Island receive attention at the hands of Mr. L. W. Williams, while Mr. R. H. Howe discusses the lichens of Mount Monadnock, New Hampshire.

Another of those emendations in nomenclature which are rapidly tending to make zoology an impossible science to all save the specialists in particular branches appears in a paper on the "digger-wasps" of North America and the West Indies, forming No. 1487 of the Proceedings of the U.S. National Museum. According to the author, Mr. H. T. Fernald, none of the insects which have been included in the genus Sphex during the past century properly belongs to it. Consequently the species and subgenera so long included under that generic designation now appear under the title Chlorion, while Sphex is made to include those hitherto known as Ammophila, a further change being the substitution of the subfamily Chlorioninæ for the original Spheginæ, and the transference of the latter, under the altered form of Sphecinæ, to the old Ammophilinæ. Fortunately (under its amended form of Sphecidæ) the family name of Sphegidæ is retained for the whole group. The author appears to have made an exhaustive study of that section of the group he classifies as Chlorioninæ, having examined, and when necessary re-described, all the type-specimens in American collections.

To the June issue of the Proceedings of the Philadelphia Academy Mr. H. W. Fowler contributes the first part of a paper on American fresh-water "heterognathous" fishes, or those usually classified under the family name Characinidæ. In the author's opinion they should form two families, for which the titles Erythrinidæ and Characidæ are adopted. Apparently, however, there is no justification for the use of the name Characinidæ (or Characidæ), since there is no such genus as Characinus or Characus. If but one family is recognised the name Erythrinidæ may be employed, but if two groups are recognised a new title (such as Citharinidæ) is required. It may also be noticed that the author does not recognise the preoccupation of Chirodon (or Cheirodon) by Chirodus. The author has had access to all Cope's type-specimens, and proposes a number of new names, and he is of opinion that the information he conveys with regard to rare or nominal species will be appreciated by naturalists.

Museum technique is the leading feature of the five articles (four of which were read at the recent Bristol conference) in the September issue of the *Museums Journal*. In the first, and perhaps most generally interesting, Dr. Sorby discusses the mode of forming a collection to illustrate the origin and structure of rocks. The material of rocks, such as sands and clays, should form the starting point. This should be followed by illustrations of different modes of deposition and sorting, while the consolidation of deposits by infiltration, or by removal and replacement of material, claims the next place. The formation of concretions, and various mechanical changes, culminating in slaty-cleavage, complete the illustration of the genesis of aqueous rocks, after which come illustrations of the formation of the igneous series. The next three articles deal respectively with the exhibition of coins, models of Protozoa, and the hanging and care of pictures. In the fifth Dr. J. E. Duerden describes a new method of preserving entire tortoises which deserves the best attention of museum curators, the specimens treated by this method having, it is stated, a remarkably life-like appearance.

The report of the working of the Government Museum at Madras for the past year is a record of steady progress. The great collection of prehistoric antiquities recovered from interments in the Nilgiri Hills by Mr. J. W. Breeks and others has now been increased by a splendid series of bronzes, iron weapons and implements, pottery, and human bones from the excavations at Aditanallur, in the Tinnevelly district, conducted by Mr. A. Rea, and these have been arranged in a new gallery built for their reception. Mr. Thurston, who usefully combines the duties of curator with those of director of the Ethnographical Survey, has made his usual tours among the jungle tribes, and has collected many curious implements, skulls, and other specimens. He has made a special anthropometric survey of that little-known tribe, the Chenchus of the Nallamalai Hills. His materials now enable him to establish the correlation, so far as the type of head is concerned, between the people of the Canarese, Maratha, and Telugu area, that is to say, the north-west and north-east of the province, as compared with the Malayalim and Tamil dwellers in the south. This is interesting in connection with Mr. Risley's speculations on the brachycephalic Marathas. During these expeditions he used for the first time an Edison's phonograph, by which he was able to secure records of tribal songs and music. Duplicates of these are to be sent to Mr. C. S. Myers for the Museum of Comparative Music at Cambridge. Mr. Thurston finds the phonograph an admirable means of conciliating timid and suspicious jungle folk, who fear the ordinary anthropometric methods. No travelling anthropologist, he says, should be without it.

A collection of diagnoses of new Philippine ferns, prepared by Mr. E. B. Copeland, forms the second supplement to vol. i. of the *Philippine Journal of Science*. The most striking novelty is an epiphytic plant of the nature of a Drynaria, receiving the name of *Thayeria cornucopia*, that is said to have a unique humus-collecting structure; each leaf forms a complete receptacle, enclosing the humus on all sides. New species are described for a number of genera, including Alsophila, Cyathea, Trichomanes, Nephrolepis, Plagiogyria, &c. The writer revives the genus Schizostege, assigned to Cheilanthes by Baker and to Pteris by Christ and Diels, for two new species.

Owing to the want of knowledge of the complete life-histories of many of the Uredinales, the classification of the group is a matter of some difficulty. Prof. J. C. Arthur presented an outline of a system of classification to the International Scientific Congress of Botanists at Vienna in 1905, that is published in their "Resultats Scientifiques." Three orders, Coleosporiaceæ, Uredinaceæ, and Æcidiaceæ, are defined according to the nature of the teleutospores and their germination. Suborders are determined by the position which the spores occupy in the tissues of the host plant. Finally, the genera in each suborder are grouped according to the development of one or more of the æcidio-, uredo-, and teleuto-spore stages.

In the annual report for 1905–6 of the botanic station, agricultural school and experiment plots in St. Lucia, the superintendent, Mr. J. C. Moore, refers to tapping trials made on trees of *Castilloa elastica* that point to a yield of 2 lb. of cured rubber for mature trees. The agricultural instructor, Mr. G. S. Hudson, devotes a considerable portion of his report to the subject of cacao, detailing the results obtained on experiment plots. A new hybrid plant has been produced by crossing *Theobroma pentagona* with *Theobroma cacao*. On the debated question of shade or no shade for cacao, Mr. Hudson says that shade and shelter are obviated partly in Grenada by close planting, but he recommends for St. Lucia a light shade of Para rubber trees or *Erythrina indica*, and wind belts of *Inga vera*.

We have received several of the recent issues of the *Boletin del Ministerio de Fomento* of Peru, a well-edited journal issued by the Department of Public Works. It contains much valuable information regarding the railways of the Republic.

An admirable coloured geological map of Queensland (Publication No. 206), on a scale of forty miles to the inch, has been received from the Geological Survey of Queensland. It has been compiled under the supervision of Mr. B. Dunstan, acting Government geologist, by Mr. H. W. Fox, and shows the mineral localities clearly marked in red.

The Transactions of the Institution of Engineers and Shipbuilders in Scotland (vol. xlix., part vii.) contains a valuable paper on equimomental systems and their use in applied mechanics, by Mr. R. F. Muirhead. The value of this principle has hitherto been regarded by engineers as of academic interest, and in developing the principle and in reducing the results to a form suitable for practical application the author has done much to reduce the time and labour of engineering calculators.

The annual memorandum issued by the chief engineer of the Manchester Steam Users' Association deals with several subjects of importance to engineers, such as steam-pipe explosions, the brittleness of steel plates, and boiler tests. Many steam pipes are badly designed, and may explode at any time. They could, however, be made safe without much expense; and in order to encourage those dealing with these matters to study the subject, a sketch is given of a glass model which clearly shows the hammering action of water when confined in steam pipes. In the section dealing with boiler tests, particular stress is laid on the carrying out of gas analysis with the greatest possible care. If this is done, it will be possible to utilise the gas analysis for determining the chemical composition of the fuel, and for ascertaining at any instant what is the efficiency of the heating surface.

In *Engineering* (vol. lxxxii., No. 2126) an abstract is given of a paper by Mr. A. R. Ledoux, presented to the American Institute of Mining Engineers, describing a new method of mining kaolin. Deposits in the Housatonic River district in Connecticut were being worked at a loss, owing to transport difficulties and to increase in expenses caused by the dip of the vein, which ran at an angle of about 50 degrees from the vertical, between gneiss and hornblende schist, and a footwall of rock. The material is therefore now mined by well, by which method the crude material is obtained with but little of the overburden, &c. The wells are from 50 feet to 198 feet deep, and contain a 4-inch, and, inside this, a 2-inch pipe. These go down gradually into the clay. Water at a pressure of about 40 lb. per square inch is forced through the smaller pipe, and on its passage upward carries with it about 5 per cent. of solid matter, of which 75 per cent. is pure kaolin.

Much valuable information regarding the mineral resources of Peru continues to be got together in the admirable series of monographs issued by the Government Corps of Mining Engineers. In *Boletin* No. 29 Mr. Federico G. Fuchs describes the copper-bearing region in the vicinity of Ica and Nazca. His detailed description, covering 100 pages, and his geological map show the importance of a mining centre that has long been neglected. In *Boletin* No. 35 Mr. Enrique I. Dueñas reviews the mineral resources of Jauja and Huancayo. At the present time no mines are being worked in these provinces, but the author shows that they are rich in coal, asphalt, copper, silver, gold, molybdenum, and iron. In *Boletin* No. 36 Mr. Luis Pflücker describes the iron-ore deposits of Aija and Calleycancha. The ore, which occurs in veins, is of great purity and richness, but the absence of fuel is, in the case of the Aija deposits, unfavourable to their development. The Calleycancha veins are more promising owing to their proximity to the Mancos coalfield.

The address delivered by Mr. James Adamson, hon. secretary to the Institute of Marine Engineers, on October 1, dealt in a scholarly manner with the advantages of a technical society. To the individual member, the advantages are in the direction of mental exercise, and consequent strengthening of the faculties of the mind; in the direction of finding out, in the course of discussions with fellow-craftsmen, how troubles in connection with details have been met and difficulties overcome; in the direction of social intercourse, and in exchanging experiences for mutual benefit. The advantages to the community of which the members of the society are units are in tending to improve the conditions of life and work all round; in tending to bring to the front, for the benefit of all, the latest improvements and developments; in tending to educate the general public in respect to the various aspects of the world of science, and to give the people a better understanding of things within the domain of science. The advantages to the nation are in tending to improve the trade of the country by improving methods of manufacture; in tending to improve material and minimise risk of failure; in tending to lessen insurance premiums by lessening risk of breakages, stoppages, and disablements; in tending to the adoption of improved methods, material and appliances, with better conditions of upkeep and improved views in respect to upkeep and expenditure, to get the best results in immediate running and prospective life average, thus minimising costs and economising capital outlay, with consequent advantages in competing for the traffic of the world; and in tending to reduce the cost of material and running expenses and repairs, enabling employers to lessen the cost of output, and make improvements in their plant to enable them to keep up to date in their works and factories with all competitors.

During the past few years several theories have been advanced connecting the fluorescence of organic substances with their chemical constitution. A new hypothesis is now suggested by Profs. Luigi Francesconi and G. Bargellini, based on the examination of a very large number of substances by a very sensitive method which they have devised for detecting fluorescence (*Atti dei Lincei*, series 5, vol. xv., No. 3). When a beam of sunlight is concentrated by a lens on a solution of the substance contained in a test-tube in a darkened box, and the liquid is examined from above, the cone of light appears, in the case of fluorescent substances, of a different colour from that of the solution. The striking fact has been elicited that aliphatic substances do not show fluorescence, and the same holds true of alicyclic compounds in which fatty groups predominate. It is contended that all aromatic substances are potentially fluorescent, and that a greater or less degree of fluorescence is to be attributed to the presence of certain groups or radicals which enhance or diminish the effect, each group possessing a specific influence.

The chemical and electrical effects induced by ultraviolet light in the case of certain elements have recently attracted attention, and explanations have been advanced based on the electronic theory of matter. In this connection an investigation of the photoelectric properties of anthracene, by A. Pochettino (*Atti dei Lincei*, series 5, vol. xv., ii., p. 171), has a special significance. It has long been recognised that anthracene is highly fluorescent, and the author has recently proved that this fluorescence is accompanied by "ionisation" of the air in the neighbourhood of the anthracene. In the paper cited it is shown that the photoelectric effect of anthracene is very nearly the same as that of zinc, and that, as with zinc, the activity decays with time. This decay is, however, observed only when the layer of anthracene exceeds a certain thickness (0·02 mm.), and is attributed to the high dielectric properties of the material, which, by allowing the accumulation of a positive charge on the anthracene, arrests the ionisation effect. The original activity of anthracene which has completely lost its photoelectric properties can be restored, not only by leaving the material in darkness, but by exposing it during a few minutes to the radiation of radium, which serves to neutralise the positive charge. The decay of the activity with time is capable of being expressed by an exponential curve. Similar results are noticed in the case of phenanthrene. The resemblance of the phenomena described to those characteristic of radio-activity again raises the question, suggested by Armstrong and Lowry in 1903, of the relationship of radio-activity and fluorescence. In the case of anthracene, atomic degradation is hardly probable; the fluorescence of anthracene is, indeed, generally attributed to molecular transformation involving the change of one structure into another under the influence of light. Whether radio-activity is not also a molecular, as distinguished from an atomic, change, caused by an external stimulus, similar to, if not identical with, light, is a question which naturally arises from the analogy presented by the two cases.

An elaborate work on salt and salt mines is in course of publication by Mr. W. Engelmann, Leipzig, for the Vienna Academy of Sciences, under the title "Das Salz: dessen Vorkommen und Verwertung in sämtlichen Staaten der Erde." The second volume, dealing with salt in Asia, Africa, America, and Oceania, appeared recently, and the first volume, which will be concerned with Europe, is in the press.

THE prominence now given to geometrical and machine drawing in the curricula of schools and colleges has led to an increased demand for trustworthy mathematical drawing instruments. The recent catalogue, with its numerous illustrations, published by Mr. W. H. Harling, of Finsbury Pavement, London, showing the instruments he is prepared to supply, may be commended to the attention of teachers and students. In it they will find particulars concerning a great variety of instruments designed to meet every want.

OUR ASTRONOMICAL COLUMN.

COMET 1906*e* (KOPFF).—In addition to those published by Herr M. Ebell, elliptic elements have been calculated for the orbit of Kopff's comet by Messrs. Crawford and Champreux, and are published in No. 100 of the Lick Observatory Bulletins. They are as follows:—

Elements.

T = 1906 May 2·0877 G.M.T.
Epoch = 1906 Sept. 5·67091 ,,

$$\left.\begin{array}{l} M = 18^\circ\ 41'\ 54''.6 \\ \omega = 19\ 28\ 44.9 \\ \Omega = 263\ 45\ 23.6 \\ i = 8\ 44\ 09.8 \end{array}\right\} 1906.0 \qquad \begin{array}{l} \log q = 0.230114 \\ \log e = 9.716356 \\ \log a = 0.549258 \\ \mu = 532''.255 \\ \text{Period} = 6.66633 \text{ years} \end{array}$$

The first decimal place of the period is determinate, and as this agrees with Herr Ebell's, who gave 6·617 years, it may be taken as fairly established. An ephemeris which accompanies the elements gives the following positions for the remainder of this month:—

Ephemeris (12h. G.M.T.).

1906	α (true) h. m.	δ (true) ° ′	1906	α (true) h. m.	δ (true) ° ′
Oct. 17·5	22 28	5 3	Oct. 25·5	22 30	4 30
21·5	22 29	4 45	29·5	22 32	4 17

JUPITER'S SEVENTH SATELLITE.—From a telegram from Prof. Pickering to the Kiel Centralstelle, published in No. 4123 of the *Astronomische Nachrichten*, we learn that Jupiter's seventh satellite was re-observed by Prof. Perrine at the Lick Observatory on September 25. The position-angle and distance at 1906 September 25·9962 were 110°·1 and 2578″ respectively.

OBSERVATIONS OF VARIABLE STARS.—Bulletin No. 8 of the Laws Observatory, University of Missouri, contains the results of some variable-star observations made at the observatory during 1905–6. A grant of five hundred dollars from the Gould fund of the National Academy of Sciences has enabled the director, Prof. F. H. Seares, to engage an assistant observer, Mr. E. S. Haynes, for this work with gratifying results.

The star B.D. + 55°·2817 has been shown to be a variable of the continuous variation type, with a range of 0·4 magnitude and a period of 5·4 days. Observations of V Lacertæ, V Vulpeculæ, and 108.1905 Capricorni are also recorded. In the case of the last-named, the rise to maximum is very rapid, an increase of 1·5 magnitudes taking place in 1¾ hours, and the observations show that this star is probably not of the Algol type.

SUN-SPOT SPECTRA OBSERVATIONS.—In No. 2, vol. xxiv., of the *Astrophysical Journal*, Mr. W. M. Mitchell, of Princeton Observatory, records the results of his sun-spot spectra observations made during the period October, 1905, to May, 1906. Mr. Mitchell found that during the more recent observations the number of "weakened" lines in the spot spectra has increased considerably; many lines previously recorded as "reversed" are now "weakened," and new lines of the latter type are recorded. A suggestion that this change may be a result of the passing of the sun-spot maximum awaits the confirmation of further observations. Numerous cases of abnormal "reversals" are referred to in the paper. From the observations of reversed lines Mr. Mitchell deduces a temperature for the gases producing these lines of 4700°, and a further deduction gives 0·38 as the ratio of the sun-spot radiation to the radiation from the unaffected photosphere. The spectrum and construction of the chromosphere are also discussed at some length.

CONDENSATION NUCLEI.[1]

PROF. Barus has written more upon the subject of condensation nuclei than any other physicist. In the present memoir, as in those which have preceded it, he arrives at conclusions which are not in agreement with the work of others who have investigated the properties of ions and nuclei. If his investigations are to be trusted, the determinations which have hitherto been made of the charge carried by the ions by means of the condensation method must be regarded as quite untrustworthy. The matter is of sufficient importance, therefore, to justify an examination of Prof. Barus's methods.

The first three chapters, and the greater part of the sixth and concluding chapter, are concerned with experiments upon the production of clouds by the sudden expansion of dust-free air initially saturated with water vapour, the air in most cases being exposed to the action of X-rays or radium. As described by Prof. Barus, the phenomena are exceedingly complicated and irregular. This is not surprising, however, being largely a result of complication in the experimental conditions.

The expansion was brought about by suddenly opening communication between the "fog chamber" and another much larger, partially exhausted vessel, a measured fall of pressure being thus produced. By means of the coronas formed, an estimate was obtained of the size, and hence indirectly of the number of the drops; filtered air was then re-admitted to bring the pressure back to that of the atmosphere. This method of effecting the expansion is not a suitable one for investigations of the kind attempted. For the rate of fall of pressure must diminish as the expansion approaches completion; it is probable that with a suitable width of connecting tube no great error will be introduced into the measurement of the least expansion required to produce a cloud (*i.e.* that the expansion may be made practically adiabatic), but it is unlikely that the maximum degree of supersaturation resulting from expansions greater than this approaches at all closely to that calculated from the pressure fall. For the condensation on the nuclei which first come into action will, by reducing the amount of vapour remaining uncondensed and by the heat set free, prevent the full supersaturation corresponding to the pressure fall from being attained. The larger the number of easily caught nuclei, the more will the maximum supersaturation attained fall short of the theoretical. The method is thus not a suitable one for obtaining information about the number of nuclei corresponding to various degrees of efficiency.

If we produce a cloud in dust-free air upon nuclei which require a high degree of supersaturation to make water condense upon them, the drops which are formed, if caused to evaporate by compression of the air, appear to leave behind nuclei requiring only a slight supersaturation to make water condense upon them. Unless these are removed before expansions large enough to catch the original nuclei are again attempted confusion is sure to follow. The result of neglecting this precaution is not merely that these residual nuclei give rise to drops as well as those under investigation, but unless the apparatus is such as gives exceedingly efficient expansion the supersaturation necessary for the capture of the nuclei under investigation may not be attained, the number of drops produced being thus too small in contrast to what might at first sight be expected. The experiments of Prof. Barus's investigation were performed under conditions which made this effect

[1] "The Nucleation of the Uncontaminated Atmosphere." By Prof. Carl Barus. Pp. 152. (Published by the Carnegie Institution of Washington January, 1906.)

conspicuous, the result in many cases being a remarkable alternation of larger and smaller coronas, corresponding to variations in the number of the drops, for successive expansions of equal amount. It is easily seen how, under the appropriate conditions, such an alternation may arise, for the second expansion may remove the greater number of the residual nuclei due to the first, so that the third takes place under conditions similar to those of the first expansion. A large amount of space is given to the study of these alternations, and they are finally traced to their true source after many hypotheses have been suggested for their explanation, "the solutional enlargement" of the nucleus, as the author calls it, being then apparently regarded as a new discovery. Besides incidental references to these residual nuclei in earlier papers, he would have found them described in Thomson's "Conduction of Electricity through Gases," p. 139, or in a review of the subject of condensation nuclei presented to the International Electrical Congress of St. Louis in 1904, and a great deal of labour might have been saved. That small drops of pure water might be expected to cease to evaporate, even in an unsaturated atmosphere, beyond a certain minimum size (related to the thickness of minimum surface tension of thin films) is pointed out by Thomson in the same chapter, p. 153; and a theory (having a similar basis), which explains the permanence of certain slow-moving ions requiring a negligible degree of supersaturation to make water condense upon them, has been given by Langevin and Bloch.

By exposing to intense X-rays the moist air in a "rectangular condensation chamber of wood impregnated with resinous cement," the front and rear faces being of plate glass, persistent nuclei requiring only a very slight expansion to cause water to condense upon them were obtained. The only nuclei hitherto observed in dust-free air exposed to X-rays require large expansions to capture them. That such nuclei should, under the appropriate conditions (the occurrence of chemical action giving rise to soluble products), grow into larger bodies is what might be expected; such a growth has, for example, been observed in the case of the ions arising from a point discharge. It is quite likely that sufficiently intense X-rays or radium rays might bring about in moist air the chemical action necessary for such a growth of the nuclei, as intense ultraviolet light certainly does; but results, obtained with a chamber of wood impregnated with resinous cement and not rigorously shielded from all possible direct electrical effects from an X-ray bulb placed a few cm. from it, are not free from ambiguity.

Apart from this effect of very intense radiation, the conclusions arrived at by the study of the effect of X-rays and radium rays appear to differ from those of other observers. Prof. Barus holds original views, not only upon the relation of "nucleation" to ionisation, but as to the nature of the radiation from an X-ray tube. These are best given in his own words:—

Chapter vi., p. 133: "Let the X-radiation to which the dust-free air is exposed be relatively weak, so that the density of ionisation may remain below a certain critical value. The nuclei observed on condensation are then very small, and they require a high order of exhaustion, approaching but always below the fog limit of non-energised air. They are usually instantaneously generated (within a second) by the radiation, so that their number is definite independent of the time of exposure. They decay in a few seconds after the radiation ceases, *i.e.*, roughly, to one-half their number in 2 seconds to one-fifth in 20 seconds, in the usual way. I fancy that these nuclei are what most physicists would call ions; but nevertheless the particles are not of a size, the dimensions depending on the intensity of the penetrating radiation to which they are usually due, and they pass continuously into the persistent nuclei, as shown in the next paragraph, where decay of ionisation and of nucleation are very different things. They are abundantly produced by the γ rays, which though weak ionisers, become from this point of view strong nucleators."

Chapter vi., p. 142: "While the phosphorescent, photographic, and electric effects of X-radiation decrease rapidly with the distance, D, from the tube, the nucleating effect (N, nuclei generated per cubic centimetre, instantly) is nearly constant over relatively enormous distances. Thus to give two examples among many ($\partial p = 25$ cm.):—

D =	... 6	... 200	... 600	... 6	... 200	... 600 cm.
$N > 10^{-3}$	88	... 83	... 83	... 79	... 79	... 79 ,,

The law of inverse squares would predicate a reduction of 10,000 to 1 between these limits; and in fact, at 6 cm. the phosphorescent screen is intensely luminous, at 200 cm. very dim, at 600 cm. quite dark as in the case of any ordinary illumination. The leaves of an electroscope within a glass bell jar collapse in a time which is directly as the square of the distance from the energised X-ray bulb. The result obtained with nuclei is astonishing; the nuclei-producing radiation would, at first sight, seem to be of an extremely penetrating kind, akin to the gamma rays of radium, and distinct from the ordinary phosphorescence-producing X-rays."

Chapter vi., p. 144: "To the eye of the fog chamber therefore the walls of the room are aglow with radiation, and no matter in what position the bulb may be placed (observationally from 6 cm. to 6 m. between bulb and chamber) the X-illumination as derived from primary and secondary sources is constant everywhere. It is to be understood that the X-illumination here referred to may be corpuscular. In fact, so far as I see, the primary and secondary radiation here in question may be identical; for the corpuscles may come from the circumambient air molecules shattered by the shock of gamma rays."

Chapter vi., p. 145: "It has been shown that for very short exposures (sections 101 and 102) the nucleation is the same, whether the bulb is placed at 6 cm. or 6 m. from the fog chamber. But only in the former case (D = 6 cm.) is the effect cumulative; only for very short distances will persistent or very large nuclei appear if the exposure is prolonged several minutes. I have therefore suspected that the radiation from the X-ray bulb is twofold in character; that the instantaneous effect (fleeting nuclei) is due to a gamma-like ray, quick moving enough to penetrate several millimetres of iron plate appreciably even for D = 6 metres; furthermore that the cumulative effect (persistent nuclei) is due to X light, properly so called, which produces the usual effects subject to the laws of inverse squares; but it is noteworthy that while the penetration of X-rays is relatively small, and the distance effect negligible (section 101), they are both large for the radiation from radium (section 104)."

The conclusion that the nucleus-producing radiation from an X-ray bulb is constant over distances varying from 6 cm. to 6 m. (or as elsewhere expressed that "the whole medium within the room is almost equally energised throughout") is somewhat startling. One would not expect the number of nuclei present at a given moment in any case to fall off inversely as the square of the distance; the number of ions might under suitable conditions be expected to vary inversely as the distance; but the fact that there is no falling off at once suggests that there is something wrong with the experiments or the interpretation put upon them. Possibly the observed constancy is partly due to the failure of the method to deal with more than a limited number of nuclei. Some of the results, however, suggest that it may have been partly due to the failure to shield off the rapidly changing electric field produced by the working of the coil.

There is more danger of the statements of the first paragraph quoted above leading to confusion. The expression "fog-limit" apparently indicates the smallest pressure fall which produces a sufficiently large number of drops to admit of a corona being observed. Previous expansion experiments, in which a sudden definite volume change was produced, have shown three critical or limiting values of the expansion (measured by the ratio of the final to the initial volume). These are 1·38, beyond which dense fogs begin to be produced in dust-free air under normal conditions; 1·25, the least expansion required for the capture of negative ions; and an intermediate one in the neighbourhood of 1·31, the least expansion required for the capture of positive ions. Certain apparently uncharged nuclei require an expansion of about the same amount as do the positive ions. Ions of both kinds are always present in small numbers in the air of a closed vessel unless an electric field is present to remove them as they are set free; an expansion exceeding 1·25 gives, in the absence of such a field, fog or rain, according as the air is exposed to external ionising agents or not. The above three limits would correspond to adiabatic pressure falls of 27·7, 20·5, and 24·1 cm. of mercury respectively, if the initial pressure was 76 cm., and would vary with the initial pressure. The fog limit obtained by Prof. Barus for air exposed to X-rays or radium rays, except under conditions such that persistent nuclei resulted, generally lay between 19 and 21 cm., except when the radiation was exceedingly weak, when the limit approached that which he obtained for "non-energised" air, about 24 cm., which may be compared with the intermediate critical expansion mentioned above. The results of Prof. Barus are accounted for if we suppose that his method failed to detect the comparatively small number of drops formed on the spontaneously produced negative ions; such variation of the limit as was observed in air exposed to external radiation, as the intensity was varied within moderate limits, being what might be expected with a method in which the "fog limit" is only reached when a certain minimum number of drops is exceeded. It is true that the ions are not at any one moment all in an equally favourable condition for helping condensation, a certain range of expansions (not very wide, however) being required, for example, to catch all the negative ions; but there is no evidence that the efficiency of the ions as nuclei increases with the intensity of the ionising rays, if we leave out of consideration the possible effect of exceedingly intense rays; for the weakest radiation (that responsible for the "spontaneous" ionisation), as well as for radiation of very considerable intensity, the efficiency of the most favourably situated ions remains the same. Prof. Barus has apparently failed to notice that the limits found by him are, if properly interpreted, in fairly good agreement with those of previous observers—quite as good agreement as could be expected from the comparative roughness of his methods. Possibly some explanation of this omission is afforded by a passage on p. 50, where the volume change corresponding to a given pressure fall has been wrongly calculated, as if the expansion were isothermal instead of being nearly adiabatic.

It is a matter of some difficulty to know what views Prof. Barus really holds upon the relation of the ionisation as determined by electrometer measurements and the "fleeting nuclei" which "most physicists would call ions." That he does not regard such nuclei as identical with the ions is plain from the statement that the gamma rays, though weak ionisers, are strong nucleators, as well as from the suggestion that the fleeting nuclei produced by an X-ray bulb may be due to "a gamma-like ray," and only the persistent nuclei to the "X-light properly so called, which produces the well-known effects subject to the law of inverse squares" (the ionisation as determined by electrometer measurements being one of these, as another of the passages quoted seems to indicate). Prof. Barus seems to have entirely failed to realise how complete is the evidence of the identity of the nuclei produced, in the investigations of previous observers, by X-rays or any of the various types of Becquerel rays with the ions the existence of which has to be postulated to explain the phenomena of the conduction of electricity through the air exposed to such rays. Not only has it been shown by direct experiments that the nuclei are positively and negatively charged bodies having properties such as have to be assigned to the ions to explain the phenomena of conduction through gases, but a still more direct proof of the identity is furnished by the agreement of the two methods by which the charge on the ions was determined, that of J. J. Thomson and that of H. A. Wilson. For the former gives the ratio of the ionisation (the product of the number of the ions per c.c. and the charge carried by each), as determined by electrical methods, to the number of the nuclei, while the latter gives directly the actual charge of a single nucleus. Thus the number of nuclei, multiplied by the charge on each nucleus, is equal to the product of ionic charge and number of ions deduced from electrical measurements. The ionisation accounted for by the nuclei in question is thus equal to the ionisation determined by the electrical method.

Chapters iv. and v. contain an account of observations made at Providence and in the comparatively uncontaminated atmosphere of Block Island upon the variations in the number of nuclei in unfiltered atmospheric air. The nuclei are here such as may be caught with smaller expansions than are required by the ions; they are Aitken's "dust" particles. Their number was estimated, not by Aitken's method, but by observing the coronas seen through the fogs produced on expansion of the air in an apparatus of the same type as that used in the investigations already discussed. In the present case, where only easily caught nuclei are involved, the objections brought above against the method do not apply, and there can be no doubt about the importance of such investigations.

C. T. R. Wilson.

BOTANICAL CONGRESS AT HAMBURG.

The Society of Applied Botanists held its annual conference at Hamburg in September, and the Society of Systematic Botanists held its meeting there at the same time. Some 150 botanists in all, mostly interested in applied botany, attended. The choice of place of meeting was a happy one, as in Hamburg, the chief Continental port, the closest connection can be seen between commercial and scientific activities.

All the botanical institutions are under the direction of Prof. Zacharias, and while the educational requirements are well cared for, everything that the botanical scientific staff can do to foster the trade of the city is done. The seed-testing station is under the direct charge of Prof. Voigt, who, with six assistants, tests some 1500 samples of seed, oil-cake, &c., each year. An important export seed trade with the Argentine Republic is carried on, the certificates required by the Republic being supplied from the station. Another important institution is the Station for Plant Protection, founded some seven years ago as a means of protection for the vineyards and orchards of Germany against the San José scale insect and other pests liable to be imported into Germany on American apples, fruit-trees, &c. This station is in charge of Dr. Brick, who, armed with the necessary staff, library, and apparatus, must report on every barrel of apples coming into port. The rejected apples, dangerous to Germany, find a ready market in England and elsewhere.

In the Botanical Museum the collections are arranged in two sections. One part follows the usual lines—the specimens are arranged in systematic order, according to their natural affinities, and serve more especially for educational purposes. The other part of the collection appeals to commercial interests. The fibres of commerce, the chief rubbers, gums, resins, cereals, &c., are in each class grouped together, regardless of natural affinities, and solely for trade purposes. A new and more commodious museum in the Botanic Gardens is just reaching completion. The museum is regularly visited by schools and their teachers, and a large piece of ground is set apart in the suburbs to supply the specimens required in the schools for teaching purposes.

Everything that could be was done by the local botanical staff and others to make the meetings of the societies a success. The Hamburg Government granted a sum of 4000 marks toward expenses, and in other different ways showed a practical interest in the proceedings. One important feature was the first International Conference on Seed Testing. Most of the seed stations in the world were represented, and attempts to establish a uniform system of testing, applicable in different countries, were discussed. It was generally felt that it would be premature to seek to go further at present than simple discussion. Many valuable papers were contributed. Dr. Stebler gave the results of twenty years' investigation in the station at Zürich as to the country of origin of the seeds of commerce, judged sometimes from the particles of soil found in the impurities (!), but more usually from the weed-seeds present. This paper was fully illustrated by dried plants and seeds. Dr. von Weinzierl, of Vienna, dealt with sugar-beet and mangel seeds; Dr. Degen, of Budapest, with dodder in clover; Prof. Rodewald, of Kiel, with the sources of error in seed-testing; while Prof. Voigt, of Hamburg had prepared a comparative report embodying the rules governing seed-testing in Germany, Russia, Scandinavia, and the United States of America. Surprise was expressed that there was only one Government seed station in the United Kingdom—that in the present writer's charge in Dublin, where during the past year 1476 samples were examined.

A paper which aroused considerable interest was that by Prof. Warburg urging the claims of tropical agriculture on behalf of the German colonies, and the conference adopted resolutions urging the necessity of :—(1) The erection of a central imperial institute in connection with the Biological Institute at Dahlem, for the study of tropical agriculture and forestry. (2) Conversion of the botanical garden in Victoria, in the Cameroons, into an agricultural institute of the first order. (3) Foundation of similar institutes in Togo and the South Sea Islands. Prof. Warburg thought that a banana trade in German West Africa could be developed, that rubber could be made available in increasing quantities by cultivation of rubber trees, and that mistakes had been made by attempts to apply to tropical countries the crops and methods of cultivation found to succeed in Germany.

Many important papers on other subjects by Profs. Drude, Zacharias, Aderhold, Appel, Vañha, &c., were read, but limitations of space prevent further mention here. A detailed official report is in course of preparation. The systematists, with Dr. Engler as president, devoted one day to the Heide near Wintermoor, where, under Dr. Graebner's guidance, fine specimens of native Juniperus, and many other features, wild and cultivated, of the moor, which is of enormous extent, were seen. While attempts are being made to restore to profitable cultivation land which is now in possession of heather, and was formerly covered with oak and beech, one portion, some fifty acres in extent, near Totengrund, has been bought by Prof. Thomsen, of Münster, and presented by him to the nation as a permanent "nature memorial."

T. J.

METEOROLOGICAL OBSERVATIONS.

Terrestrial Physics in Messina.—The *Annuario* of the Messina Observatory for the year 1905 shows that Prof. G. B. Rizzo has made a good beginning in the important task recently imposed upon him by the faculty of the university. The climate of Sicily is fairly well known so far as the principal towns are concerned, thanks to the efforts of the directors of the large observatories of Palermo and Catania and others, but, as Prof. Rizzo points out, little or nothing is known about the conditions of the other parts of the island. To remedy this want a number of rainfall and temperature stations have been established during the last year in the province of Messina, and have recorded observations from the beginning of 1906. On the initiative of the International Meteorological Committee, the Solar Committee of which Sir Norman Lockyer is president is carrying out an important study of the connection of solar and terrestrial phenomena; for Italy, Prof. Riccò at Catania and Prof. Rizzo at Messina are actively engaged in the investigation on the general plan laid down by the committee. For the study of earthquake phenomena one of Vicentini's microseismographs has been erected; in connection with this subject Prof. Rizzo is investigating the facts relating to the terrible Italian earthquake of September, 1905, with the cooperation of more than eighty observatories in various parts of the world. The seismograms show that the disturbance was felt from Norway to the Cape of Good Hope, and from California to New Zealand. The complete results will shortly be published.

Meteorology in the United States.—The report of the U.S. Weather Bureau for the fiscal year 1904–5 (pp. xxiv+384) gives a brief survey of the development of the weather service during ten years' administration of the present chief (Prof. W. L. Moore). The magnitude of the work now performed by it is almost astounding; indeed, Prof. Moore claims that in the results accomplished for the benefit of the farmer, the sailor, the seeker after health or pleasure, and others, there is no weather service in the world comparable with it. The estimated amount of the expenditure for the year exceeded 278,000*l.*, and the appropriation for the following year, including the support of Mount Weather Observatory (Virginia), an institution devoted purely to meteorological research, exceeded 290,000*l.* The supervising director of that observatory is Dr. W. J. Humphreys, late professor of physics in the University of Virginia, and Prof. Moore states that Mount Weather may be expected to do as much for the science of meteorology as the service has already done for the material interests of the United States. It is stated that the daily distribution of weather forecasts and charts has increased to nearly 623,000, of which 158,000 represent printed reports. Weather maps are printed at nearly 100 local stations, and daily telegraphic reports are received from the Azores and west coasts of Europe, and the Bureau has developed one of the best wireless systems now in use. The Navy Department has instructed its wireless stations to receive and promptly transmit to the ocean or other places where the information can be made useful the storm warnings of the Weather Bureau, and has requested vessels having the use of its wireless stations to take observations and to transmit them to the Bureau, *without charge against the Department of Agriculture.* With a further extension of wireless telegraphy, it is thought that the reports will render possible a storm-warning service for the western coasts of Europe and for vessels in mid-ocean. Arrangements have been made for aërial research by liberating unmanned balloons from many stations, in cooperation with those at Mount Weather.

The last semi-annual Bulletin of the Colorado College Observatory contains the annual meteorological summary for 1905. The present observatory, erected in 1894, is about 6040 feet above sea-level, and was the gift of Mr. H. R. Wolcott, of Denver; the director is Dr. F. H. Loud. It is well equipped with astronomical and self-recording meteorological instruments; the college became a voluntary station of the U.S. Signal Service in 1878. The mean temperature of the year 1905 was 46°·1, mean maximum 58°·8, minimum 33·5, absolute maximum 91°, in June and August, minimum −22°, in February. The yearly rainfall was 15·9 inches, number of rain-days 70. The Bulletin also contains monthly summaries of weather records at Colorado Springs between 1872 and 1903, which have been collected from various sources with considerable labour by Mr. C. M. Angeli, and prepared for press by Mr. C. D. Child; their present publication is merely preliminary, in view of numerous demands for historical information, and is subject to later revision.

Observations in Mauritius.—The annual report of the director of the Royal Alfred Observatory, Mauritius, for 1905, shows that the rainfall there was much above the average of the last thirty years, viz. 67·90 inches as compared with 48·27 inches; in January the fall was 21·16 inches, or 12·77 inches above the normal, and is the greatest on record. The maximum shade temperature was 89°·0, in November, and the minimum 52°·3, in August; the highest temperature in the sun's rays was 156°·4, in January, the highest on record being 165°·5, in February, 1898. From observations obtained from ships' logs, the tracks of seven cyclones in the Indian Ocean were laid down; 474 photographs of the sun were sent during the year to the Solar Physics Committee. Fifty-three earthquakes were recorded. The registered velocity of the wind was below the average in every month except April; Mr. Claxton remarks that a comparison of the records of the Robinson and Dines anemometers in use at the observatory in the years 1904–5 indicates that one or both are untrustworthy as standard instruments.

Rainfall in German South-West Africa in 1904–5.—Notwithstanding the considerable damage and loss of records due to the rebellion of several tribes, complete results from twenty-eight stations are published in *Wissenschaftliche Beihefte zum deutschen Kolonialblatte*, Band xix., 2 Heft. The total number of stations which have suffered during the last two years amounts to forty, but steps are being taken to replace the instruments as soon as practicable. The rainfall of the year in question was, on the average, only about three-fourths of that in the previous year—in the central and southern parts only about one-half. The principal rains fall between January and March; the greater part of the annual amount is sometimes made up in the course of a few days. At Okombahe, for instance, two-thirds of the annual amount of $11\frac{1}{2}$ inches fell in the course of four days (January 27–30), and of this amount 5 inches fell on January 28. Generally speaking, little or no rain falls between May and September, inclusive.

Report of the Liverpool Observatory, 1905.—This observatory, maintained at Bidston by the Mersey Docks and Harbour Board, is one of the oldest and best equipped in the United Kingdom, and it transmits daily telegraphic reports to the Meteorological Office. Under the head of automatic instruments are included anemometers of the forms designed by Dines, Osler, and Robinson. We give the comparative maximum records of these during two of the heaviest gales of the year:—

	Dines. miles	Osler. lbs. on sq. ft.	Robinson. miles per hour	Direction
1905, Jan. 8	73·3	32	55	S.W.
,, Nov. 26	70·1	40·5	68	W.
,, ,, 27	77·0	33·2	61	W.

The gusts recorded by the Dines and Osler anemometers were not exactly at the same time; the figures seem to show that the force of the gusts differs considerably at different points of the same locality. With respect to observations with Milne's seismograph, Mr. Plummer makes the interesting remark that during the time of the recent Antarctic expedition many earthquakes recorded by the exploring party were registered on the instrument at Bidston, although intermediate stations did not in all instances record the tremor. The average number of astronomical observations made with the transit instrument has been practically maintained during the year.

South African Meteorology.—Under the title "South Africa as seen by a Meteorologist," Dr. H. R. Mill gave a lecture before the Royal Meteorological Society on March 21, and an abstract has now been published. The address contains much instructive matter, but Dr. Mill's meteorological notes naturally refer chiefly to rainfall. Table Bay was reached on August 15, 1905, the minimum temperature at Cape Town being only 38°. The most unusual part of the meteorological equipment at the Royal Observatory was the size of the standard rain-gauge, having a diameter of about $11\frac{1}{4}$ inches; at other stations in the colony the size is 8 inches. The usual exposure of the gauges in South Africa is 4 feet high, a fact, as Dr. Mill observes, that must be borne in mind when comparing readings with gauges in this country, where they are usually placed at a height of 1 foot. Meteorology in Cape Colony suffers, the author states, by the excessively small annual grant available, and the opinion is expressed that the good work done at Kenilworth (Kimberley) makes it desirable that the institution should be placed on a permanent footing. The Transvaal Government spends a comparatively large sum on meteorological observations; at Johannesburg the observatory is admirably fitted up, and the site offers peculiar advantages for anemometer work. The rain gauges here and in the Orange River Colony are 5 inches in diameter. The site of the observatory at Grey Town is not a very good one, and is shortly to be changed. Meteorology at Bulawayo is under the charge of Father Goetz, to whose work we recently referred; he has constructed an ingenious electrical recording rain gauge which is apparently very efficient. On the homeward journey a visit was made to the Portuguese station at Beira; with regard to this observatory, Dr. Mill remarks that it is "an imposing structure and the rain gauge is of heroic dimensions." This interesting paper is embellished by many photographic illustrations.

Report of the Observatory Department of the National Physical Laboratory for the Year 1905.—As this branch is in many respects complete in itself, and its work appeals to a different class from that interested in the other departments, the director thinks it desirable to issue the report separately. The magnetographs have been in constant operation throughout the year, and the curves have again been free from any very large disturbances; the most interesting movements were those of November 12 and 15. On the latter date an auroral display was generally observed (NATURE, November 30, 1905, p. 101). The mean declination during the year was 16° 32′·9 W., mean inclination 67° 3′·8 N. Owing to the disturbance of the vertical force produced by electric trams, it was found impossible to tabulate the curves for this element satisfactorily. The meteorological traces and tabulations have been, as usual, sent to the Meteorological Office for publication, therefore only the results are given as an appendix to the report in question. The maximum shade temperature was 81°·5, on July 8, and the minimum 22°·4, on November 22 (23°·4 on January 19). The rainfall was 22·61 inches, and the number of rain days 154, including five days on which snow was recorded. The number of instruments verified (exclusive of watches and chronometers) amounted to 26,058, being a considerable increase as compared with the previous year; about 60 per cent. of these instruments were clinical thermometers.

The Warm Air Current at the Height of 10–12 *Kilometres*.—In the *Meteorologische Zeitschrift* for June, Dr. R. Nimführ discusses the question of one of the most interesting results of the international balloon ascents, viz. the "inversion of temperature" at an altitude of 8–13 km. pointed out by M. L. Teisserenc de Bort (*Comptes rendus*, April 28, 1902), and by Dr. Assmann at an altitude of 10–15 km. (*Sitzb. Akad.*, Berlin, May 1, 1902). Dr. Nimführ states that the French experiments were made with paper balloons, that in about half the ascents the maximum height of the balloon was at the critical altitude of 11–12 km., and that consequently the instruments were affected by solar radiation owing to decrease of ventilation; also that Dr. Assmann's experiments were probably similarly affected, although to a less extent, as he used closed rubber balloons. Dr. Nimführ thinks that the lifting power of the balloons was decreased in the higher regions owing to the rubber becoming porous by expansion; further, that the bimetallic thermometer used in some ascents is subject to a fundamental error, now under further investigation, which possibly affects some of the results obtained. We offer no comments on the questions raised; they will no doubt receive full consideration by those engaged in this important branch of meteorological inquiry.

Rainfall in the Philippines.—The Bulletin for December last, issued by the Weather Bureau of Manila, under the direction of the Rev. Father Algué, contains a table of the monthly and annual distribution of rainfall in 1905 at fifty-three stations scattered over the different islands of the archipelago. It is shown that the stations may be arranged in three groups:—(1) where the fall is uniform in the various months; (2) where the rainfall is scarce from December to March inclusive; (3) stations with abundant rains from June to October, and little in the rest of the year. At some stations the amounts are large, *e.g.* Baguio, an elevated plateau, more than 165 inches, while eighteen of the other stations have falls varying from 79 inches to 115 inches. From the results of the last five years' observations at Baguio we note that the mean annual temperature there is 65°·3; the lowest monthly mean is 61°·3, in February, and the highest 67°·1, in April and May. The absolute maximum was 84°·7, in April, and the minimum 42°·8, in February. Rain falls on an average on 171 days, mostly between May and October.

DISEASES OF SHEEP.

PROBABLY few persons, unless they have had reason to study the matter, have any idea of the immense economic importance of the diseases of animals. As a matter of fact, our flocks and herds are every year stricken down to an extent representing a value of hundreds of thousands of pounds!

In 1901 a committee, consisting of Prof. Hamilton, Mr. J. McCall, and Mr. E. G. Wheeler, with Mr. R. B. Greig as secretary, was appointed by the Board of Agriculture to investigate and report on the diseases of sheep known as louping-ill and braxy, and the findings of this committee have lately been published in a voluminous and interesting report.

Louping-ill is a disease which shows itself in the form of nervous spasms of the limbs and neck, or rigidity, followed by more or less complete paralysis; sometimes, however, there is a general dazed condition with speedy collapse. It does not seem to be known in foreign countries, but in the British Isles is met with particularly on the west coasts of Ireland and Scotland, in Cumberland and Westmorland, and in small, scattered areas throughout the country. Sheep of all ages may be attacked, and the mortality may amount to 20 per cent. or even more.

Braxy is often a rapidly fatal disease. The animal goes off its feed, is restless, the belly swells, it falls on its side, becomes semi-comatose, and death soon ensues, the carcase having a characteristic odour. The disease prevails in several countries of northern Europe, and in the British Isles on the west coasts of Ireland and Scotland, central Wales, Westmorland and Northumberland, Cornwall, Wilts, and Gloucester. Sheep under one year are the chief sufferers.

A remarkable feature of both these (and certain other) diseases of the sheep is their seasonal prevalence; thus louping-ill and braxy are not met with during July and August, and the former is most prevalent from April to June, the latter from November to February.

In the case of louping-ill, for a long time the specific cause remained a mystery, carcase after carcase examined showing no lesions, and inoculations of the blood, &c., failed to convey the disease from one sheep to another. At last, examination of the fluid in the peritoneal cavity revealed the presence of a large sporing anærobic bacillus (Fig. 1), which, on inoculation into healthy sheep, conveyed the disease again and again. It was for a long time an enigma how this bacillus reached the peritoneal cavity, the blood and tissues being free from it. Eventually, however, in a diseased lamb the intestine was found to be swarming with the bacillus, and a long series of experiments proved that the organisms or their spores are taken in with the food, and if at the susceptible period of the year induce the disease in a large proportion of cases. The organism, being passed with the dejecta, fouls the pasture, and so the disease is propagated. Precisely the same holds good for braxy, which, however, is caused by an organism different from the louping-ill bacillus, the braxy organism being also an anærobic sporing bacillus, but being much smaller and more delicate than the louping-ill bacillus (Fig. 2).

Attempts to immunise by means of injections of attenuated organisms or by chemical products of the organisms proved not only failures, but dangerous on account of the mortality. Taking into account the fact that the organisms are intestinal, the happy idea of drenching the animals with cultures during the insusceptible period was adopted, and proved a decided success on the large scale. Thus, with louping-ill, 1340 sheep were treated in this manner, and a single doubtful death from the disease occurred; with braxy, 1545 sheep were treated, and there were nine possible (three being doubtful) deaths from braxy among them.

A remarkable discovery was made with regard to the seasonal susceptibility and immunity. It was found that during the period of immunity the blood of the sheep proved highly bactericidal towards the louping-ill and braxy bacilli, while during the susceptible period the bacilli were not only not destroyed by, but grew well in, the sheep's blood.

As already indicated, the diseases are mostly communicated by the fouling of the pastures by the dejecta. It has been held by some that the sheep-tick plays a part in their transmission, but experiments showed that this could only be to a very insignificant extent.

The report, which is illustrated with a number of figures and maps, is highly suggestive in many directions; the researches made promise to throw new light on the pathology of many of the contagious and infectious maladies of man and the lower animals, and we congratulate Prof. Hamilton and his collaborators on the valuable work they have done.

R. T. HEWLETT.

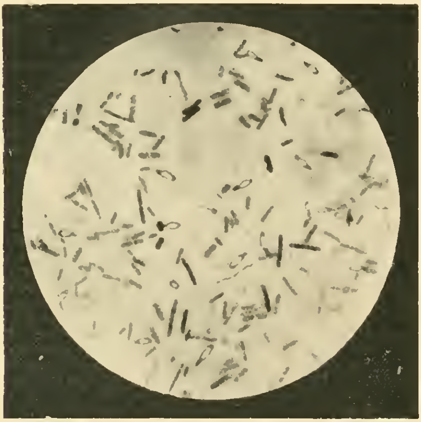


FIG. 1.—Bacillus of Louping ill in peritoneal liquid of sheep, showing the rods, some without spores, others with spores in their interior. × 1000 diameters.

FIG. 2.—Bacillus of Braxy, peritoneal liquid of sheep, showing the comparatively delicate rods, some sporing, others not; those sporing have an oval or lanceolate form. × 1000 diameters.

THE NEW MUSPRATT LABORATORY OF PHYSICAL AND ELECTROCHEMISTRY AT THE UNIVERSITY OF LIVERPOOL.

THE laboratory of physical and electrochemistry, which the University of Liverpool owes to the munificent generosity of Mr. E. K. Muspratt, president of the council of the University, was formally opened by Sir William Ramsay, K.C.B., F.R.S., on Saturday, October 13. The distinguished company which assembled in Liverpool for the occasion included, amongst others, the following well-known men of science from abroad:—Prof. Ostwald (Leipzig), Prof. R. Abegg (Breslau), Prof. Ernst Cohen (Utrecht), Prof. H. Goldschmidt (Christiania), Prof. Lash Miller (Toronto), and Prof. Macallum (Toronto).

On Saturday forenoon the guests inspected the new laboratory privately, and were afterwards entertained to lunch by Sir John Brunner, Bart., M.P., at the University Club, many other prominent men of science and letters in

Liverpool being also present. At 3 o'clock the opening ceremony took place in the arts theatre of the University, a large and distinguished company being present. Mr. E. K. Muspratt formally presented the new laboratory to the University, and in a very interesting speech expressed his conviction that physical chemistry was that branch of chemistry which was most likely to advance knowledge at the present time. Sir John Brunner had founded the chair of physical chemistry at Liverpool. In order to complete this valuable gift a laboratory was necessary, and so he (Mr. Muspratt) had resolved to build and equip a laboratory of physical and electrochemistry. He was glad to see that a considerable number of rooms had been reserved for research work in the new building. He wished to emphasise in the strongest manner the necessity of research being most actively carried out in the University. He was convinced of the importance of electrochemistry, and so he had taken care that the new laboratory should have an adequate electrical equipment.

Vice-Chancellor A. W. W. Dale formally received Mr. Muspratt's gift on behalf of the University, the Earl of Derby, Chancellor of the University, not being able to be present. The Vice-Chancellor referred in glowing terms to the liberality and generosity of Mr. E. K. Muspratt, who had already increased his original gift of 10,000*l.* to something like 14,000*l.* Sir W. Ramsay, in an interesting address, dealt with the paramount necessity of cultivating the "troublesome habit of thinking," as against the subconscious or semi-unconscious processes of brain action. It was the duty of the University to strive with all its power to induce young men to cultivate independent thought. A man might be a walking dictionary, but, if he was, he had all the defects of a dictionary—the words were there, but they formed disconnected and desultory reading. The power to be desired was not specially to remember the words, but to build them up into living sentences. The chief duty of a chair of physical chemistry was to teach men to think for themselves. He would advise that as soon as might be the student of that fascinating subject should be induced by example, precept, sympathy, exhortation, and by all means whereby young human minds could be influenced, to extend the bounds of their subject.

After Sir John Brunner had moved a vote of thanks to Sir W. Ramsay for his very interesting address, which was seconded by Prof. Donnan, the company adjourned to inspect the new laboratory. At five o'clock Prof. Ostwald delivered a highly original and interesting address on the fundamental principles of chemistry, in which he showed that the phases occurring in nature are all solutions, and that the concepts of pure substances are only ideal limiting cases. In fact, a "pure" substance was simply a phase which, within certain limits, boiled or froze at a constant temperature. It was an artificial product. In the evening the guests of the University were entertained to dinner at the University Club by the Liverpool section of the Society of Chemical Industry.

The following brief description of the new laboratory may be of interest to the readers of Nature. The building, which is connected with the main chemical institute, contains a basement, ground, first, and second floors. The basement includes a dynamo room, battery room, furnace room, store, and a research room for six students. The generating plant consists of motor-generators driven off the city mains at 460 volts, and comprises a 30-kilowatt direct-current generator supplying current at 80–100 volts, a 10-kilowatt charging set consisting of two machines on the same axis each giving 250 amperes at 20 volts, and an 80-kilowatt alternator with two windings to give 1000 amperes at 80 volts or 500 amperes at 150 volts. The charging set is employed to charge in sections a battery of thirty-six Tudor cells, divided up into six sets of six cells, so that different floors or rooms may have the use of separate sets. Vertical cables carry the current from the machines and accumulators to four distributing exchange-boards (one on each floor), whence run circuits (to carry 50 amperes) to the working benches. It is possible by means of flexible connections to connect up on the exchange-board the terminals at each working bench with the required voltage. From the battery switch-board three wires run to each of three exchange-boards, the arrangement being such that each of the latter is supplied with current at 4, 8 and 12 volts from a different set of cells. Specially heavy cables and terminals are arranged to permit of employing 1000 amperes (direct or alternating) in the basement furnace room. The ground floor contains a lecture room with accommodation for about ninety students, a preparation room, library, workshop, and photographic room. The second floor contains a junior labnratory to hold twenty-one students, a balance and switch room, an optical room, a room for three advanced students, research room for a member of the staff, and an instrument store room. The second floor comprises a senior laboratory for eight students, a balance and switch room, and four research rooms. On the roof there is a lavatory, a distillation room, and arrangements for carrying out work in the open air.

All working benches are supplied with gas, water, and electricity. The current is carried by uninsulated wire run on the walls and ceilings by means of wooden battens and porcelain insulators, and terminating in slate panels fixed on wooden battens above the working benches. Close to each bench is a fire-proof slab constructed of compressed red Ruabon tiles set in cement. Each centre bench carries a sink at one end and a thermostat at the other.

The architects of the building are Messrs. Willink and Thicknesse, Castle Street, Liverpool.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—Prof. Somerville, Sibthorpian professor of rural economy, has been elected to a fellowship at St. John's College.

Mr. J. E. Marsh, F.R.S., Balliol College, has been elected to a fellowship at Merton College.

Scholarship examinations in natural science have been announced for the following dates:—December 4, Balliol, Christ Church, and Trinity Colleges; December 11, University, Magdalen, and Lincoln Colleges; January 15, 1907, Jesus College.

Cambridge. Dr. G. H. F. Nuttall, F.R.S., fellow of Christ's College, and university lecturer in hygiene, has been appointed the first Quick professor of biology; until the Senate shall otherwise determine, "to devote himself to the study of the Protozoa, especially such as cause disease, and generally to promote that branch of study." Owing to the terms of the will of the late Frederick James Quick, the professorship is not tenable for more than three years without re-election.

The voting on the proposed changes in the mathematical tripos will take place at 2 p.m. on Thursday, October 25.

The Government of India has awarded Mr. A. R. Brown, "Anthony Wilkin" student in ethnology and archæology, the sum of 300*l.* to assist him in carrying on his researches amongst the natives of Andaman and Nicobar Islands.

Mr. H. Yule Oldham, the reader in geography, will give a course of public lectures this term on the history of geographical discovery, on Thursdays at 5 p.m., beginning to-day, in the Sedgwick Museum.

The Clerk Maxwell scholarship is vacant by the resignation of Mr. O. W. Richardson, who has accepted a professorship at Princeton, New Jersey. Candidates for the scholarship should send their applications to Prof. J. J. Thomson.

Mr. J. W. McBain has been appointed lecturer in chemistry at University College, Bristol. Mr. McBain is a graduate of the University of Toronto, and has also studied for several years in Germany.

New physical and engineering laboratories were opened at Edinburgh University on Tuesday. Mr. Balfour presided over the ceremony, and an address on the progress of scientific research was given by Mr. Andrew Carnegie.

The *British Medical Journal* states that the authorities of the Victoria University, Manchester, have received a sum of 5000*l.* from the trustees appointed under the will of the late Miss Middleton, and have allocated this amount towards the endowment of the chair of anatomy.

The year-book of the Michigan College of Mines, a pamphlet of 132 pages, accompanied by an atlas of views showing the methods pursued and the facilities for practical instruction afforded by the immediate surroundings, has been received. Established in 1885, and situated in the centre of the Lake Superior mining district, the college furnishes an excellent practical and theoretical training in mining and kindred subjects.

A course of eight lectures on "The Carbohydrates and their Relations to Living Organisms" will be given in the physiology department of University College, University of London, by Dr. S. B. Schryver, on Wednesdays at 5 p.m., beginning on Wednesday, October 24. These lectures are open to all students of the University of London, also to qualified medical men on presentation of their cards, and to such other persons as are specially admitted.

A course of four lectures on the "Phylogeny of the Higher Crustacea" will be given in the zoological lecture room of University College, London, by Dr. W. T. Calman, at 5 p.m., on Wednesdays during October and November, beginning on October 24. The lectures are for advanced students of the University and others interested in zoology. There is no fee for the course; cards of admission may be obtained on application to Mr. P. J. Hartog, academic registrar of the University.

At the opening of the winter session at St. Andrews University on October 12, Principal Donaldson announced that the Lord Rector, Mr. Carnegie, has offered 10,000*l.* to build such an addition to the University library as will provide ample space for all the books of the University, and a room where students can read with perfect quiet and with easy access to whatever they may require. Mr. Carnegie has also promised a donation of 11,500*l.* for a physical laboratory at University College, Dundee.

According to *Science*, improvements have been made during the summer at Cornell University which will greatly strengthen the scientific work. New and enlarged quarters have been provided for the engineering department and the departments of geology, physics, and biology. Quantitative and organic laboratories have been provided for the chemical department. A large amount of apparatus has been secured for the different subjects. By the death of the sister of the late Mr. W. W. Guiteau, the University will receive the legacy left by him, said to amount to between 20,000*l.* and 40,000*l.*

The Board of Education, South Kensington, has issued the following list of candidates successful in the competition for the Whitworth scholarships and exhibitions, 1906:—(1) *Scholarships* (*tenable for three years*), 125*l. a year each*:—Frederick G. Turner, London; William E. Hogg, London; Sidney G. Winn, London; Samuel Lees, Manchester.—(2) *Exhibitions* (*tenable for one year*), *value* 50*l.*:—William F. Cobbett, Gosport; William H. Mead, Southsea; Arthur Williams, Brymbo, Wrexham; James Bradley, Hollinwood, Lancs; George E. Morgan, Portsmouth; Albert C. H. Connor, Gillingham, Kent; Edgar J. Mitchell, Devonport; George O. Dawe, Devonport; Ernest Bate, London; Henry W. Turner, Portsmouth; William H. C. Coombe, Devonport; Edwin M. Vigers, London; Ronald E. Widdecombe, Saltash; Frederick R. Rogers, Devonport; Frank H. Cothay, Sunderland; Sidney Vernon, Abbey Wood, Kent; Frank R. Bloor, Gillingham, Kent; George W. Burley, Meersbrook, Sheffield; Robert James, Pembroke Dock; Sidney C. Gladwyn, London; Frederick C. Worton, London; John Airey, Bradford, Yorks; Charles A. Wright, Preston; William G. Weaver, Brighton; William E. Stokes, London; Thomas B. Bardo, Sheerness; Alfred Bailey, Oldham; John S. Buchanan, Cambuslang, Glasgow; Albert E. Palmer, Sunderland; Henry W. Maskell, London.

The following list of successful candidates for Royal exhibitions, national scholarships, and free studentships (science) has just been issued by the Board of Education, South Kensington:—*Royal Exhibitions:* Walter H. Stock, Swindon; John M. Robertson, Pembroke Dock; John C. Nixon, Southsea; Thomas W. Page, Ipplepen, Newton Abbot; Charles A. Brearley, Halifax; William F. Cobbett, Gosport; Herbert Schofield, Halifax. *National Scholarships for Mechanics*:—Henry S. Rowell, West Benwell, Newcastle-on-Tyne; Joseph J. Brooks, Devonport; Albert C. H. Connor, Gillingham, Kent; Frederick Hickey, Southsea; William H. Mead, Southsea. *Free Studentships for Mechanics*:—Arthur C. Lowe, Harrogate; Frank R. Bloor, Gillingham, Kent; John Airey, Bradford, Yorks. *National Scholarships for Physics*:—Douglas V. Plumbridge, Isleworth; Andrew McCance, Glasgow; Thomas Royds, Oldham; Henry J. Lomax, Darwen; John N. Brown, London. *Free Studentship for Physics*:—Edward F. Pattenden, Whitstable. *National Scholarships for Chemistry*:—Arthur Bramley, Elland, Yorks; Harold W. Atkinson, New Mills, Stockport; Fred Bridge, Burnley; William A. Naish, Handsworth, Birmingham; Norman M. Comber, Brighton; Percy G. Ward, Brighton. *Free Studentship for Chemistry*:—Henry V. A. Briscoe, London. *National Scholarships for Biology*:—Rowland M. Richards, Manningham, Bradford; James H. Orton, Bradford, Yorks; Katie Barratt, Swanley, Kent. *Free Studentship for Biology*:—James L. Thompson, London. *National Scholarships for Geology*:—Abraham Haworth, Burnley; Arthur T. Cundy, Redruth; Ernest Lee, Burnley.

At the distribution of prizes at the Royal Technical Institute, Salford, on October 11, Mr. H. B. Knowles, the principal, read an encouraging report. Speaking of the value of the training given in day technical schools, he said:—"It may be that a youth who has left school at the earliest moment allowed by the law will at the age of seventeen or eighteen have secured a position better paid than the one a student obtains immediately on leaving technical day classes, although in many cases the training received has given immediate access to a career which would otherwise have been inaccessible. The proper time for such a comparison would, however, be some half-dozen years after; and I have weighty reasons for my confidence that then it would be found that the two or three years spent in technical departments had been in every respect a most profitable investment." The principal also directed attention to two important developments in connection with the Salford arrangements for the current session. First, the correlation between the work at the institute and the work in evening schools has been made more real by the stipulation that all applicants for admission to the institute under sixteen years of age shall, before admission, pass an examination in English and mathematics. Secondly, courses of instruction suitable for students occupied in the various trades, and extending over four or five years, have been arranged on the basis of attendance at classes on three evenings per week. An added inducement to take these courses has been offered by making the fee for a course small as compared with the fees for the individual classes constituting the course. A great improvement in the quality of much of the work is expected as a result of this arrangement.

SOCIETIES AND ACADEMIES.

London.

Royal Society, February 15.—"Observations on the Labyrinth of Certain Animals." By Dr. Albert A. **Gray.**

The labyrinths of six animals were examined, and the conditions found may be summarised as follows:—The labyrinth of the lion presents the usual features of the Carnivora. The cochlea is of the sharp-pointed type, and there is hardly any evidence of a perilymph space in the semicircular canals. The Indian gazelle has a cochlea of a flat type, and there is a trace of a perilymph space in the canals. In the three-toed sloth the cochlea is of a flat type. The canals are almost square, and the perilymph space is well marked. The labyrinth of the wallaby is like that of the ungulates, but two large otoliths are present in the vestibule.

Among the birds the ostrich is peculiar, owing to the fact that there is no communication between the posterior and superior canals at the point at which they cross. The cochlea is also very short. The crested screamer has a relatively long cochlea, and the superior canal droops somewhat backwards.

May 10.—"The Mechanism of Carbon Assimilation in Green Plants: the Photolytic Decomposition of Carbon Dioxide *in vitro*. By F. L. **Usher** and J. H. **Priestley**.

For summary of this paper see NATURE of October 11 (p. 604).

June 14.—"Studies on Enzyme Action. Lipase, II." By Prof. Henry E. **Armstrong**, F.R.S., and Dr. Ernest **Ormerod**.

Inasmuch as the ethereal salts which are hydrolysed under the influence of lipase are all compounds of the type R'.CO.OX', it cannot well be supposed, as R' and X' may be varied within wide limits, that the selective action of the enzyme is exercised with reference either to R' or to X': consequently the controlling influence must be attributed to the carboxyl radicle (CO.O); the enzyme must be so constituted that it can "fit itself to this group." The problem to be solved is—why should ethereal salts derived from the lower terms of the acetic series be so much less readily hydrolysed than the higher? The differences in stability do not account for the differences in behaviour of homologous salts; in fact, ordinary hydrolytic agents appear to act more readily on the lower terms. Nor can the difference be attributed to the destruction of the enzyme by the acid which is liberated from the salt, as this destructive effect can be avoided by diluting the solutions to the necessary extent. Their experiments have led the authors to form the provisional hypothesis that the hydrolysis of the ethereal salt by lipase involves the direct association of the enzyme with the carboxyl centre and that such association may be prevented by the "hydration" of this centre: consequently, that those salts which are the more attractive of water will be the less readily hydrolysed. The facts generally seem to be in accordance with this view, inasmuch as the solubility in water of ethereal salts diminishes as the series is ascended; salts such as ethylic formate and acetate undoubtedly tend to form hydrates (hydrols) in solution, such as

$$CH_3.CO\,OEt + OH_2 = CH_3.C(OEt)^{OH}_{OH}.$$

A noteworthy result in harmony with the view is the fact that ethylic malate is but slowly acted upon by lipase in comparison with ethylic succinate and that ethylic tartrate is practically unaffected. The explanation of the differences to be observed between animal and vegetable lipase is probably to be sought for rather in differences in their emulsifying power than in peculiarities inherent in the lipoclast. The main difficulty the investigation presents lies in securing uniform conditions; if an effective comparison is to be made between ethereal salts, it is an essential condition of success that the substances compared be in solution. Peculiar difficulties are encountered on this account in studying the action of lipase from various sources on fatty substances.

June 21.—"Ionic Velocities in Air at different Temperatures." By P. **Phillips**. Communicated by Prof. J. J. Thomson, F.R.S.

The object of this paper is to find at different temperatures the velocity in an electric field of the ions produced by Röntgen rays in air at atmospheric pressure. The method used for determining the velocities is that devised by Langevin in 1902, and published in his "Recherches sur les Gaz ionisées," Paris, 1902.

The general arrangement of the apparatus is very little different from that used by Langevin, the only serious difference being that the vessel containing the electrodes is made so that it may be immersed in baths at different temperatures.

The velocities have been found at temperatures ranging from $-179°$ C. to $+138°$ C., and the following are the values of k_1 and k_2, the velocities of the $+ve$ and $-ve$ ions under a field of one volt per centimetre:—

k_1	k_2	Temp., abs.
2·00	2·495	411
1·95	2·40	399
1·85	2·30	383
1·81	2·21	373
1·67	2·125	348
1·60	2·00	333
1·39	1·785	285
0·945	1·23	209
0·235	0·235	94

When k_1 and k_2 are plotted against the temperature we see that between the temperatures 209° and 411° k_1 and k_2 seem to be proportional to the absolute temperature, but at 94° k_1 and k_2 seem to be equal, and much smaller than would be given by this linear law.

Making use of the kinetic theory of gases, we can arrive at the following expression for k_1 and k_2:—

$$k = \tfrac{1}{2}X\frac{e\lambda}{mv}\left[\frac{4\sqrt{2}}{n\left(1+n^{\frac{1}{3}}\right)^2\left(1+\frac{1}{n}\right)^{\frac{1}{2}}}\right],$$

where X is the field in absolute units, e the charge on the ion, λ the mean free path of a molecule, m the mass of a molecule, v the mean molecular velocity of the molecule, and n the number of molecules in an ion. Making use of the values of k_1 and k_2 given above, we obtain the following values of n_1 and n_2:—

Temp., abs	n_1	n
94	4·63	4·63
209	2·12	1·82
285	1·76	1·43
348	1·64	1·34
411	1·52	1·25

When n_1 and n_2 are plotted against the temperature they show a very rapid increase as the temperature of liquefaction of air is approached. This is what might be expected, as the ions in a vapour near its liquefaction temperature are usually large. At the upper temperature the curve shows no very marked tendency, so that it is difficult to predict what might happen at a higher temperature.

The fact that n varies continuously, and not in jumps, would seem to show that there is a continual exchange going on between ions and uncharged molecules; at some collisions several molecules remain attached to the ion, while at others one or more of them is knocked off, and so a dynamical equilibrium is set up. As the temperature of the gas rises, the collisions are more violent, and, statistically, fewer molecules are attached to an ion; this gradual change would go on until the collisions became so violent that at times corpuscles would be shot off without even a single molecule attached to them. When this happened the velocity of the ion would very rapidly increase with the temperature, and so we might expect in flames those very rapidly moving ions which consist of single unloaded corpuscles for an appreciable fraction of their existence.

"Note on Opalescence in Fluids near the Critical Temperature." By Prof. Sydney **Young**, F.R.S.

The experiments described by Travers and Usher were mostly carried out at constant volume, the temperature being raised very slowly. In the author's experiments the substance was kept at its critical temperature, and the volume altered by equal stages. The tubes employed were much narrower. Where comparison is possible the observations confirm those of Travers and Usher, and the following generalisations may be deduced from them:—(1) When observations were made during compression no opalescence was visible until a definite volume was reached: opalescence then appeared at the bottom of the tube, that is to say, just over the mercury; on further compression the opalescence or mist became denser, and extended further up the tube; near the critical volume the mist was very dense, especially near the middle; continuing to compress, the mist disappeared below, but became dense above; the clear part extended upwards, and the mist finally disappeared at the top of the tube. When observations were made during expansion the phenomena were very similar, except that the mist was usually lower down in the tube. (2) The limits of volume between which mist was visible were much the same for the four paraffins examined, about 1·17 or 1·18 to 0·87 or 0·88 (critical volume = 1·00). (3) At slightly higher temperatures the mist was much less dense and the range of volume more restricted. It seems probable that the position of maximum opalescence depends on the volume, but further investigation is desirable.

June 28.—"The Alcoholic Ferment of Yeast-juice. Part ii.—The Coferment of Yeast-juice." By Dr. Arthur **Harden** and W. J. **Young**. Communicated by Dr. C. J. Martin, F.R.S.

Experiments have been made on the nature of the dialysable, thermostable substance contained in yeast-juice, upon the presence of which the fermentation of glucose by yeast-juice depends, and to which the name coferment is provisionally applied. The inactive residue, obtained by filtration of yeast-juice through a Martin gelatin filter, has been prepared in a solid form, which is quite inactive when dissolved in glucose solution, but is rendered active by the addition of filtrate or of boiled yeast-juice. This solid retains its potential activity for a considerable time. When a *small* quantity of boiled yeast-juice is added to a solution of this inactive residue in 10 per cent. glucose, fermentation commences, and continues for a period varying with the amount of boiled juice added. The cessation of fermentation appears to be due to a change in the coferment, since the addition of a further quantity causes a repetition of the phenomenon.

Paris.

Academy of Sciences, October 1.—M. H. Poincaré in the chair.—Remarks by M. **Berthelot** on his work entitled "Traité pratique de l'Analyse des Gaz."—Some new examples of Rosaceæ containing hydrocyanic acid: L. **Guignard.** In addition to the plants mentioned by the author in earlier papers on this subject, the names of twenty additional genera are given from which hydrocyanic acid has been obtained. The earlier experiments have also been made quantitative, and it has been found that the amounts of the acid obtainable depend on the age of the organs of the plant. The leaves nearly always furnish the highest proportion of prussic acid, and in certain cases the proportion is nearly as high as that given by the leaves of the cherry laurel.—The ravages of *Loxostega (Eurycreon) sticticalis* in the cultivation of beet-root of the Central Plateau: Alfred **Giard.** For some years this parasite has been well known in North America as a dangerous enemy of the beet. More recently it has caused great damage to beet culture in Russia, but France has hitherto escaped this pest. This year, possibly owing to the unusual dryness, it has taken firm hold of some regions of the Midi, in some districts more than 90 per cent. of the roots being affected. The author describes in detail the measures necessary to eradicate the parasite.—The periodic trajectories of electric corpuscles in space under the influence of terrestrial magnetism, with application to the magnetic perturbations: Carl **Störmer.**—The constituents of the alloys of manganese and molybdenum: G. **Arrivaut.** The preparation of alloys rich in molybdenum is difficult in the furnace, but easy when a suitable mixture of the oxides is reduced with aluminium. From the ingots thus obtained the compounds Mn_2Mo, $MnMo$, and $MnMo_2$ have been isolated.—Syntheses in the quinoline series. Dihydrophenylnaphthoquinoline dicarboxylic ester and its derivatives: L. J. **Simon** and Ch. **Mauguin.**—The existence of stable yeast forms in *Sterigmatocystis versicolor* and in *Aspergillus fumigatus*, and the pathogenic nature of the yeast derived from the latter type: G. **Odin.**—The "*fenêtre*" of the Plan-du-Nette and the geology of Haute-Tarentaise: W. **Kilian.**—A leakage between impermeable zones in calcareous subsoils: E. A. **Martel.**

DIARY OF SOCIETIES.

THURSDAY, October 18.

Chemical Society, at 8.30.—Presentation of the Longstaff Medal to Prof. W. Noel Hartley.—The Amino-dicarboxylic Acid derived from Pinene: W. A. Tilden and D. F Blyther.—The Preparation and Properties of Dihydropinylamine (Pinocamphylamine): W. A. Tilden and F. G Shepheard.—Determination of Nitrates: F. S. Sinnatt.—The Nature of Ammoniacal Copper Solutions: H. N. Dawson.—Malacone, a Silicate of Zirconium containing Argon and Helium: S. Kitchen and W G Winterson.—The Relationship of Colour and Fluorescence to Constitution, Part i., The Condensation Products of Mellitic and Pyromellitic Acids with Resorcinol: O. Silberrad.—The Colouring Matters of the Stilbene Group, Part. iii.: A. G. Green and P. F. Crosland.—(1) Separation of $\alpha\alpha$- and $\beta\beta'$-Dimethyladipic Acids; (2) Action of Alcoholic Potassium Hydroxide on 3-Bromo-1 : 1-Dimethyl-hexahydrobenzene: A. W. Crossley and N. Renouf.—(1) The Compounds of Pyridine with Dichromates; (2) The Normal Chromates and the Unsaturated Character of the Chromate Radical: S. H. C. Briggs.—(1) Interaction of Succinic Acid and Potassium Dichromate, Note on a Black Modification of Chromium Sesquioxide; (2) Derivatives of Polyvalent Iodine; the Action of Chlorine on Organic Iodo-derivatives, including the Sulphonium and Tetra-substituted Ammonium Iodides: E. A. Werner.—(1) New Derivatives of Diphenol (4-4'-Dihydroxydiphenyl); (2) The so-called "Benzidine Chromate" and Allied Substances: J. Moir.—The Interaction of the Alkyl Sulphates with the Nitrites of the Alkali Metals and Metals of the Alkaline Earths: P. C. Rây and P. Neogi

Institution of Mining and Metallurgy, at 8.—The Auriferous Rocks of India, Western Australia, and South Africa; M. Maclaren.—Sand Sampling in Cyanide Works: D. Simpson.—Treatment of the Precipitate and Manipulation of the Tilting Furnaces at the Redjang-Lebong Mine, Sumatra: S. J. Truscott.—A Combined Air and Water Spray: T. White.

FRIDAY, October 19.

Institution of Mechanical Engineers, at 8.—*Discussion:* Railway-motor-car Traffic: T. H. Riches and S. B. Haslam.—*Paper:* Some Notes on the Mechanical Equipment of Collieries: E. M. Hann.

SATURDAY, October 20.

Essex Field Club (at Epping).—Annual Fungus Foray—all day Meeting. —The Ecology of Fungi: George Massee.

CONTENTS.

THURSDAY, OCTOBER 25, 1906.

THE GEOLOGICAL HISTORY OF SEA-LEVEL.

The Face of the Earth (*Das Antlitz der Erde*). By Prof. Eduard Suess. Translated by Dr. Hertha B. C. Sollas, under the direction of Prof. W. J. Sollas. Vol. ii. Pp. vi + 556; illustrated. (Oxford: Clarendon Press, 1906.) Price 25s. net.

THE first volume of this translation has been previously reviewed in NATURE, and we can renew our congratulations to the translator on her admirable rendering of this great work. Prof. Suess's eloquence depends on his ideas and his poetical imagery, and thus his writings suffer less by translation than those of most men. Doubt may be felt whether some of the proposed equivalents of technical terms, and such words as quer-Andian, will be generally adopted in English. In reading the volume it is necessary to remember that the original was published eighteen years ago. The French translation, edited by M. de Margerie, was brought up to date and illustrated by additional maps; but this edition exactly follows the original, and does not even add the date of its first publication. We are, however, frequently reminded of its age by such statements as that the Arctic Ocean is "of very trifling depth," or that the author cannot hazard a guess as to the structure of the Celebes. In many cases the facts stated are now known to be incorrect; but later research has removed Prof. Suess's difficulties probably more often than it has added to them.

The main purpose of this volume is the statement of the evidence for Suess's contention that continents are never uplifted in mass, and that the occurrence of raised shore lines and horizontal sheets of marine rocks is due to the lowering of sea-level, and not to the raising of the land. Suess, therefore, returns to pre-Playfairian geology, for Playfair maintained that the level of the land is less stable than that of the sea. This apparently improbable conclusion became, owing to the brilliant advocacy of Lyell, the fundamental principle of the Uniformitarian school of geology.

The contrary view was dismissed by Herbert Spencer as one of the gratuitous assumptions of what he called "illogical geology." Nevertheless, it is now advocated by the geologist who has probably the widest general acquaintance with geological literature, and is gifted with a scientific insight that has materially advanced each of the many branches of geology to which he has given his attention.

Prof. Suess's argument is that a continental uplift is impossible. A continent may subside, but it cannot be uplifted in mass. Rocks may be raised locally when uptilted during the formation of a mountain chain; but he denies the possibility of the uniform uplift of widespread masses composed of irregular materials. The sea has certainly encroached at times upon the land, and has at others receded; but instead of these changes being due to the sinking and rising of the land, Suess maintains that they are due to variations in sea-level.

That the sea-level is not uniform is indisputable. It varies from causes which need only to be stated to be accepted. The water is heaped up in places by wind and rivers. Elsewhere it is lowered by rapid evaporation, and the surface is maintained at the lower level by the greater weight of the salter water. Thus the surface of the Mediterranean, according to Suess, is funnel-shaped, the lowest part of the funnel being in the area of especially salt water in the neighbourhood of Crete. Variations in wind and rainfall or in the course of rivers; the reduction in the lateral attraction of the land, in consequence of its denudation; the retardation of an on-shore current by increased friction due to shoaling, may all lead to a local retreat of the sea. Thus Suess attributes a raised beach near Bombay to sedimentation having checked the incoming tide, and thus caused a local depression of sea-level. The apparent effect of these causes on the shore-line would be the same as that produced by an actual uplift of the land. As the retreat or advance of the shore-line may be produced by the oscillation either of the land or of the sea, Suess objects to the usual terminology, which always speaks of the uplift or subsidence of the land. To avoid unproved assumptions he speaks of negative and positive movements, according as the sea-level falls or rises relatively to the adjacent land. Sir Archibald Geikie has suggested terms—the emergence and submergence of the land—which are equally noncommittal, and have the advantage of being self-explanatory. The encroachment or retreat of the sea may be a merely local incident or it may be a world-wide phenomenon; in the latter case, Suess speaks of it as a eustatic movement, and explains it as due to an increase or reduction in the capacity of the ocean basins. A negative movement, *i.e.* an emergence of the land, would be caused by an increase in the depth of the oceans by a subsidence of their floor, which lets the water fall away from the land.

This volume may be considered in two sections; in the first chapters Prof. Suess states his heterodox doctrine, and the mass of stratigraphical evidence in its support. In the second section he examines the leading cases relied on by the champions of secular elevation of the land. These two sections of the book appear of unequal value, for they deal with movements of probably different character and origin. The first part describes the great movements of emergence and submergence which are world-wide in their range; Suess's greatest service to geology has been his recognition of this fundamental fact and its consequences. It is a most helpful discovery, and Prof. Suess offers us the only reasonable explanation yet advanced. The evidence is summarised by Suess in chapters ii. to vi. of this volume. Therein he describes and compares in detail the coasts of the Atlantic and the Pacific, and gives a summary of the geological history of the oceans. The striking resemblance in the lithological succession in some of the geological systems in remote parts of the world can only be explained on the assumption that they are controlled by some world-wide agency; this, Suess's fundamental proposition, seems to be supported by the general evidence of stratigraphical geology.

The second division of the subject is the discussion of the leading cases which have been used to prove the actual uplift and subsidence of the land, such as the raised shore-lines of Norway and northern Europe, the bored pillars of the Temple of Serapis, near Naples, the raised beaches around the Baltic, and the submerged peat bogs and forests on the British coasts. Suess examines these cases in detail, and denies that they give any evidence of secular uplift. He rejects what are generally considered some of the best established of geological truths, such as the still progressive tilting of Scandinavia. Suess denies these popular conclusions, and during his argument claims that both Lyell and Darwin mistook kitchen middens for raised sea beaches. Suess examines the evidence in detail for each case, and maintains that the inferences based on it are invalid. The shore-lines of Norway he claims to have been formed along the shores of glacier-dammed lakes. The Temple of Serapis, he maintains, has no connection with secular movements, because it is actually in the breached crater of a volcano. Submerged forests, he points out, may be due to growth behind storm beaches, or on land along a low shore which has sunk by the shrinkage of an underlying water-logged bed. The raised beaches around the inner Baltic he explains by the gradual lowering of the water by the emptying of that sea. The slow emergence of the north Baltic shore is, therefore, according to Suess, the consequence of a climatic change, not of an earth movement; and Suess advances evidence to prove that the level of the southern Baltic has been constant throughout historic times.

The latter part of this volume is perhaps of most popular interest, but it is the least convincing part of the "Antlitz," and perhaps the least essential to Prof. Suess's main position. Suess admits some cases of uplift, as at the Temple of Serapis, and he admits that some of the lower Norwegian shore-lines are true sea beaches We may accept Dr. Günther's evidence showing that the uplift near Naples was somewhat wider than Suess admitted, or accept a slow uprise of the land near the great lakes of America, without rejecting the doctrine that the major changes in the range of the sea are due to changes in its level. Suess only briefly refers to the phenomenon of isostasy; and the work of Colonel Burrard in India shows that the plumb-line agrees with the pendulum as to the unequal density of the blocks in the earth's crust; and therefore some areas may have been uplifted to restore that hydrostatic equilibrium at which others are still upheld.

The second division of this volume shows that the easy inference that every submerged forest and every raised beach involves a movement of the land is not justified. Suess shows that they can be explained without any assumption of earth movements. Each case must be judged on its merits. We can accept either the explanation of a limited emergence or submergence of the land without rejecting Prof. Suess's main proposition that, in the geological past, the major changes in the range of the sea have been due to variations in its level.

J. W. G.

REFUSE DESTRUCTORS.

(1) *The Disposal of Municipal Refuse.* By H. de B. Parsons. Pp. x + 186. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1906.) Price 8s. 6d. net.

(2) *Garbage Crematories in America.* By W. M. Venable, M.S. Pp. x + 200. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1906.) Price 8s. 6d. net.

(1) THE author has not attempted in this book to produce a treatise dealing with the designing of the details for the final disposal of city refuse, but rather to set forth clearly the principles underlying the sanitary and economic handling and destruction of such material. The book owed its origin to certain designs which Mr. Parsons was engaged upon in connection with the disposal of the refuse of the city of New York, and as a result the bulk of the appliances and plant which the author describes are those which are employed in the Empire City, and there is a number of excellent reproductions of photographs of the methods adopted in that city both for collecting and for disposing of the refuse.

In chapter iii. it is shown that the general refuse for which a method of collection and disposal must be provided can be divided into five classes:—(1) ashes; (2) garbage; (3) rubbish; (4) street sweepings; and (5) snow; and tables are given to show the average composition of the first four of these, and the weight which has to be collected annually in a number of selected American cities; in New York the refuse varies from 2·6 lb. to 4·9 lb. per head per diem. The methods of collecting the various classes of refuse are then dealt with, and the author rightly lays stress on the absolute need of arranging the collections at regular intervals, and of the use of properly designed, covered, and water-tight carts; the important problem of cleansing streets crowded with vehicular traffic is also briefly discussed.

In the next two chapters the methods of disposal are taken up, and the various systems in use contrasted and compared; such processes as those of dumping on land or dumping in water should never be permitted; they are hopelessly insanitary; one of the illustrations—"Disfigurement of Beach by Dumping at Sea"—is a striking instance of the abominable results which may arise from such cheap and nasty methods. Mr. Parsons is evidently of opinion that the reduction process (only applicable when the garbage is separately collected), by which oil and grease are extracted and sold, can never be made a paying process, and it seems, therefore, highly undesirable to put up plants of this nature, when they are liable to produce such serious nuisance from foul smells. It is pointed out that the incineration process, which has been such a success in the cities of England and Germany, has so far not been adopted on a large scale in the United States, but the author considers that this method is bound to become more and more common in the States; where it has been a failure it is entirely due to faulty design of the destructors, and to the desire unduly to cheapen first cost.

Undoubtedly the form of civic government in

America, with its frequent changes of administration and its too often objectionable policy of the spoils to the victors, renders such problems as the economic and sanitary disposal of city refuse much more difficult to solve than in the case of the cities of Europe, where the municipal engineering and sanitary staff have much greater influence and powers of control.

(2) Called upon to remedy defects in existing crematories in the United States, Mr. Venable has made a complete study of the principles of design of every type of crematory so far built in the States, and this book is the result. In an introductory chapter the author points out that the crudity of the methods of disposal still in use in many cities is almost incredible, and he traces much of the slow progress of reform in this matter to the frequent changes in the administrative officials. In the second chapter tables are given as to the quantities which have to be collected, and the average composition of the refuse in a few large cities; in four cities in the States the weight per head per annum ranges from 1140 lb. to 1670 lb.

The problem of burning refuse without offence is then taken up, and Mr. Venable insists on the absolute importance of so designing the furnace that a temperature is reached which renders the discharge of odours from the chimney stack impossible. In chapter iv. the various types of crematories are divided up into classes, based on the fact that there is, or is not, some attempt at preliminary drying; each class is then described in some detail, and illustrations are given of a well-known example of each class, and lists of all the patents so far granted in the States for such crematories; the next chapter deals with the cost of working destructors, and the heat available from the products of combustion for steam raising.

In chapter vi. a complete history is given of the building of crematories in the States from 1887, the pioneer year, to the present date, and sectional drawings are reproduced of many of the furnaces which have been put up during that period. Mr. Venable is an advocate for the separate collection of garbage, refuse, and ashes, and, therefore, while quite ready to admit that the destruction of refuse in England, where usually the whole of the refuse is collected in one receptacle, is admirably carried out at the present day, he does not think that the British type of destructor is ever likely to come into extensive use in America; he, however, gives details of some of the tests carried out on Meldrum furnaces in Great Britain. In the last three chapters the materials and methods of construction likely to give the most satisfactory results are discussed, and, lastly, a draft specification is given.

These two books will be extremely interesting to English municipal authorities, because they deal fully with the methods of disposal of city refuse in the United States, methods which differ radically from those in use in our own country, and, while still convinced that we are ahead of our Transatlantic cousins in this important sanitary problem, nevertheless there is much we can learn from them.

SOME RECENT WORKS ON PHYSIOLOGY.

On Carbohydrate Metabolism, with an Appendix on the Assimilation of Carbohydrate into Proteid and Fat, followed by the Fundamental Principles and the Treatment of Diabetes, dialectically discussed. By Dr. F. W. Pavy, F.R.S. Pp. xi+138. (London: J. and A. Churchill, 1906.) Price 6s. net.

The Dynamics of Living Matter. By Prof. Jacques Loeb. (Columbia University Biological Series, No. 8.) Pp. xi+233. (New York: The Columbia University Press; London: Macmillan and Co., Ltd., 1906.) Price 12s. 6d. net.

Geschmack und Geruch. By Dr. Wilhelm Sternberg. Pp. viii+149. (Berlin: Julius Springer, 1906.) Price 4 marks.

DR. PAVY'S new book on carbohydrate metabolism deals with a subject to which he has devoted a long life of study and original research, and his opinions are therefore entitled to the most careful consideration and respect. He treats the subject partly from the physician's point of view, for the disease known as diabetes cannot be properly understood until the nature of the metabolism which the carbohydrates undergo in health is a matter of certain knowledge. Those acquainted with Dr. Pavy's previous writings will be aware that he has never accepted the glycogenic theory of Claude Bernard, and in the present brochure he brings forward fresh evidence of what he regards as its incorrectness. Dr. Pavy also was the first to direct attention to the glucoside nature of the proteids, and this view is also amplified. Most attention, however, will be centred on the new doctrine of absorption he puts forward, and to the important *rôle* in this process which he assigns to the lymphocytes. He supposes that what first occurs is that these cells assimilate nutrient matter and incorporate it in their protoplasm, and subsequently carry it to the tissues. Among other facts in support of this view he directs attention to the great increase in the lymphocytes of the blood after a meal. One imagines this view will not be immediately accepted, partly because it is doubtful whether the lymphocytes are sufficiently numerous, or capable of sufficiently rapid integration and disintegration to bear the burden of the large amount of material which has to be transported, and partly because the acceptance of such a theory will involve the rejection of much recent physiological work in which it has been shown that the food-proteids are broken down during digestion into the small molecules of the amino-acids of which they are composed. Dr. Pavy has produced an interesting and suggestive book, but he has made no experimental attempt to disprove the new ideas of complete hydrolysis of proteids in the intestine which are rapidly gaining credence.

Prof. Jacques Loeb's book is the outcome of a series of lectures he gave at Columbia University in 1902. He has entitled it the "Dynamics of Living Matter," and it is an attempt to explain the phenomena of life on the basis of physical chemistry. Prof. Loeb has been an arduous worker at this branch of science, and it will be convenient to have in a compact form the outcome of his numerous fuller publications, which it is the object of this book to present. Prof. Loeb's name is best known in connection with the parthenogenesis which he has artificially produced in unfertilised marine eggs, by altering the saline constituents and other physical conditions of the surrounding water. This subject is here given in its most recent developments, but the book naturally contains a good deal in addition. We may regard the work as a useful counterblast to those who term themselves neo-vitalists. It can hardly be considered the last word on the subject. Physical chemistry in relation to inorganic material is in a state of flux, one theory displacing others with startling rapidity. It is, therefore, a little early to apply it to organic and living substances with any hope of obtaining universal acceptance of the theories put forward. The speculations indulged in are interesting, and the facts will settle down into their proper places later on.

The third book in this physiological batch relates to a small corner of physiological inquiry, namely, taste and smell, and mainly the former. Dr. Sternberg has devoted attention to this sub-branch of a branch of physiology, and has produced a readable pamphlet. It is, however, a little difficult to understand why books should be written with such limited scope, and it is doubtful if they are really needed.

MATTER AND RADIO-ACTIVITY.

The Electrical Nature of Matter and Radio-activity. By Prof. Harry C. Jones. Pp. ix+212. (London: Archibald Constable and Co., Ltd., 1906.) Price 7s. 6d. net.

THIS book consists of a series of articles, written in semi-popular style, reprinted from the *Electrical Review.* The first third of the book is occupied with the electronic theory of matter, and follows the usual popular lines. The subject is treated only from what may be called the Cavendish Laboratory point of view, and, in fact, we read that we owe the whole electronic conception to Prof. J. J. Thomson. The optical and spectroscopic foundations for the theory are omitted, and the names of Larmor, H. A. Lorentz, and Zeeman are not mentioned.

It is difficult to attempt to review this part of the book, for if the reviewer has interpreted a recent paper by Prof. J. J. Thomson aright, the view that the constituent electrons of an atom are present in sufficient numbers to contribute any appreciable part of its mass appears to have been disproved. Here, however, we read:—

"There is one point at least brought out so clearly that there can scarcely be any question about it, and that is that matter is a pure hypothesis."

And again:—

"The atom according to this theory is *very complex.* Take, for example, the atom of mercury. This contains somewhat more than 150,000 electrons, and some of the heavier atoms are even more complex."

The author, by thus presenting so dogmatically and literally the speculations which have centred around the electron as the basis of matter, has directed attention away from the solid experimental work on which our knowledge of the nature of electrons rests. It is this work, and not the sweeping electronic hypothesis, which is connected with radio-activity. But for the pioneer work on the ionisation of gases done in the Cavendish Laboratory and elsewhere, the electrical method of radio-active measurement could not have reached its present perfection, and it is safe to say that, deprived of this method, radio-activity would have advanced but slowly. But whether the atom of mercury has 200 or 150,000 electrons is a question which fortunately has nothing to do with the very fundamental and independent conclusions of the nature of matter formed from radio-active evidence.

Radio-activity, the second topic, is started in chapter v., and with the remainder of the work and the mode of treatment no exception can be taken, except that it is not very up-to-date. The last chapter, which is entitled "Most Recent Work in Radio-activity," attempts, however, to accomplish this.

The book as a whole gives a comprehensive and interesting survey of the radio-activity of matter as it is interpreted by the disintegration hypothesis. Perhaps the best chapters are those dealing with the reproduction of radio-active matter and the theory arising therefrom. Here the chemical training and point of view of the author are in evidence, and the significance of the continuous reappearance of the products of change after complete removal by chemical or other means is very clearly brought out.

Attention may be directed to some inaccuracies and errors of minor importance. The author does not seem very clear about the nature and properties of the γ rays. We learn that their power to affect the photographic plate is much greater than that of the β or even the α particles, an error which is frequently repeated. Their origin is ascribed to the *impact* of β rays on solid matter rather than to the acceleration of the β particle during *expulsion.* In the experiment of causing, by means of a glass tube containing radium, a discharge to pass between two points just so far apart that ordinarily the spark fails, most of the ionisation from the glass tube is ascribed to the γ rays. It is safe to say that if the glass were as thick as this the experiment would fail. The statement that the emanation can be condensed at low temperatures like an ordinary gas into a *liquid* is obviously a slip, for a little later we read that no liquid or even mist will be seen. Twice later, however, the statement is repeated, and liquid appears a loose word for non-gaseous. The β rays are ascribed little power of exciting phosphorescence, and the effect on a platino-cyanide screen is said to be greater for α than for β and γ rays.

F. S.

OUR BOOK SHELF.

Résistance, Inductance et Capacité. By M. J. Rodet. Pp. x+257. (Paris: Gauthier-Villars, 1905.)

This book is devoted entirely to the three subjects which form the title, and it has evidently been the author's aim to include everything within the limits mentioned likely to be of use to engineers or physicists.

As a whole the author has succeeded, and has produced a valuable book of reference. The subjects are treated in the order mentioned. Under the heading of resistance, in addition to the usual constants, information is given as to the conductivities of insulators, solid and liquid, and the insulation due to a film of oil between a rotating shaft and its bearings. An account is given of the various rectifiers, including the Cooper-Hewitt.

Under the heading of inductance a full and clear statement is given of the usual phenomena, and the various methods of calculating coefficients of self- and mutual inductance are explained, but no mention is made of a rectangular coil such as is used in certain instruments of the dynamometer style. The inductance of cables is also studied, and a reference is made to the apparent increase of resistance of conductors traversed by alternating currents, but no mention is made of the internal self-induction of an iron rail, which is an important factor in the application of alternating currents to electric traction.

The initial portions of that part of the book which is devoted to the study of capacity follow the ordinary methods of exposition. Tables of specific inductive capacity of various substances are given, and information is presented as to the variation of this property with temperature. Following this, the distribution of the potential in a compound condenser is described, as, for instance, in a condenser in which the dielectric is composed of two plates of glass separated by a layer of air. (This matter is of practical importance in the building of high-voltage machines, as brought out by Messrs. Hobart and Turner in their recent book on insulating materials.) A brief reference is made to the electrodynamic condenser proposed by Mr. Swinburne, and a section is devoted to the study of capacity effects due to cables and overhead transmission lines.

The book would have been more complete if the researches of the late Dr. John Hopkinson had been referred to as to the specific inductive capacity of materials at very low temperature. For practical men, however, this volume contains almost everything that they are likely to want, and to them it can be thoroughly recommended.

Natural Phenomena. A Collection of Descriptive and Speculative Essays on some of the By-paths of Nature. By F. A. Black. Pp. xiv+366. (London and Edinburgh: Gall and Inglis, n.d.)

In this book Mr. Black offers some essays which might well be of value to the student of physiography. Treatises on this subject are usually crammed very full of facts, and more interest might be awakened and a wider horizon opened to the student, if he reads such a work as this in connection with the ordinary text-books. There are ten essays altogether; four deal with some points connected with our own atmosphere, and four discuss problems of elementary astronomy, arising mainly from the motion of the earth on its axis. The remaining two treat of the Sargasso Sea and the Zodiacal Light with its allied phenomena. These seem to be highways rather than by-paths.

It would not be correct to say that Mr. Black is always exact in his descriptions; he is apt to be somewhat loose, and his book suggests that he has not consulted the most recent authorities. But he is never so far wrong as to be misleading. He may puzzle the student by apparent contradictions, due to the introduction or exclusion of circumstances which can exercise an important influence upon the point under consideration. Particularly would we caution the student to beware of those explanations for which the author himself is responsible, and in which he seeks to remove difficulties that have not yet received a satisfactory solution. An example will be found in the discussion on the semi-diurnal barometric inequality. The author seems, too, to have lost his way in the chapter on weather cycles; but the book is calculated to arouse interest, to stimulate curiosity, to promote further study, and on these grounds one may welcome its appearance. The illustrations are generally effective, and a very good index accompanies the book.

A Text-book of General Zoology. By Dr. Henry R. Linville and Dr. Henry A. Kelly. Pp. x+462; illustrated. (London and Boston: Ginn and Company, 1906.) Price 7s. 6d.

This addition to the long shelf of text-books of zoology has some fresh features. Practical experience has led the authors to begin with the Arthropods, work down to the Protozoa, and then ascend the vertebrate series. The study of insects has been found the best introduction to the broad problems of zoology, and in the earlier chapters a modified inductive method is pursued. About half-way through the book, after the student has become familiar with systems of organs, he is introduced to physiological principles, illustrated with special reference to the earthworm. Throughout the book prominence is given to the study of animal behaviour and the environmental conditions. Thus there is a feeling of fresh air through the chapters. The authors have reacted from the position of identifying zoology with comparative anatomy, and the introduction to the science which they have presented seems to us, not only interesting, but educationally wholesome. Most of the illustrations are original, and many of them are beautiful.

Science Readers. Book VII. By Vincent T. Murché. Pp. 299. (London: Macmillan and Co., Ltd., 1906.) Price 1s. 9d.

Object Lessons in Elementary Science. Stage VII. By Vincent T. Murché. New and revised edition. Pp. xvi+322. (London: Macmillan and Co., Ltd., 1906.) Price 2s.

These books deal with elementary physics. The first is intended for pupils to read in class, lesson by lesson, after they have attended an explanatory and experimental demonstration from the teacher on the subject in hand. The second book contains notes of lessons designed only for the use of teachers. The notes are accompanied by helpful advice, blackboard sketches, and many other evidences of the wide experience of the author. Both volumes are attractively illustrated and well printed, though it may well be doubted if the bewildering profusion of types in the second book adds to its helpfulness. The author is a master of simplicity of expression, and the information he supplies is, as a rule, trustworthy. The books deserve the careful consideration of teachers of very elementary classes.

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.*]

Absorption of the Radio-active Emanations by Charcoal.

The interesting property of certain kinds of charcoal, notably that of the cocoa-nut, of rapidly absorbing gases, except the inert gases belonging to the argon family, is now well known since the recent experiments of Sir James Dewar.

In a recent investigation I had occasion to pass the radium emanation through a tube filled with cocoa-nut charcoal, and was surprised to find that the emanation was completely absorbed by it. If a slow current of air, mixed with the emanation of radium, thorium, or actinium, is passed through a tube filled with charcoal, the issuing gas is completely deprived of emanation. This occurs at ordinary temperatures, and there is no necessity for initial cooling of the charcoal. This property of charcoal of absorbing the radium emanation can be shown by a very simple and striking experiment. If a side tube containing a fraction of a gram of charcoal is attached to a vessel containing the emanation released from several milligrams of radium bromide, in the course of time the emanation is absorbed by the charcoal. At ordinary temperatures, several hours or days, depending on the size of the vessel, are required to effect a complete absorption as the emanation diffuses slowly through the air. If some powdered willemite is added with the charcoal, the gradual absorption of the emanation is shown by the increasing brilliancy of the phosphorescence produced in the surrounding willemite.

It makes no difference whether the charcoal has been initially heated to get rid of the absorbed air or whether it has already absorbed its full quantity. At low pressures of the gas, using charcoal which has been previously heated, the removal of the emanation takes place rapidly. This is probably due to the rapid absorption of the gas which carries the emanation with it. The charcoal retains the emanation at ordinary temperatures, for I have found that the emanation retained in a charcoal tube open to the air loses its activity at the normal rate observed in sealed vessels.

The greater part of the emanation is released by heating the charcoal below a red heat. I have not yet settled whether the release of the emanation is due to an alteration in the absorptive power of the charcoal for the emanation at high temperatures, or whether the emanation is mechanically carried away by the rush of air which takes place when the charcoal is heated.

Since the emanations behave like inert gases of the argon family, it is somewhat surprising that charcoal should so readily absorb them. It must be remembered, however, that in ordinary experiments a very minute quantity of the emanation is present, and it is not unlikely that even the gases argon and helium are absorbed by charcoal to a small degree.

This property of charcoal of retaining the emanation promises to be of service in laboratories where radium is kept in a state of solution. It is dangerous to keep radium in the form of solution in sealed vessels, as the gradual production of hydrogen and oxygen in the solution raises the internal pressure, which would ultimately lead to the bursting of the vessel. At the same time, the escape of the emanation causes a radio-active contamination of the laboratory which renders delicate experiments on radio-activity or ionisation very difficult.

This problem will be solved by the use of a small tube containing cocoa-nut charcoal attached to the vessel, with one end open to the air. The air inside the radium vessel is kept at atmospheric pressure, while the emanation is completely stopped in the charcoal. The emanation mixed with a small quantity of gas can at any time be obtained from the charcoal by heating.

Experiments are in progress to test whether this property of charcoal can be utilised to determine quantitatively the amount of radium emanation existing in the air, and also the amount of emanation diffusing to the atmosphere from the soil.

E. Rutherford.

McGill University, Montreal, October 6.

The Recent Radium Controversy.

I was absent from Montreal during the time of the interesting discussion on radium which appeared in the *Times*, and it is only quite recently that I have had an opportunity of reading the correspondence in full. In the course of this discussion some weight has been attached to a remark in the second edition of my book "Radio-activity," viz. that radium is a compound of helium and lead. It is far from my intention to reopen this discussion, on which I think quite enough has already been said, but in the last issue of Nature (September 27) which I have just received, there appears a letter by Lord Kelvin in which this remark is still further emphasised.

Lord Kelvin quite correctly quotes my words, but I feel that the statement, apart from its context, is liable to leave an erroneous impression of my views on the question, especially in the minds of those who are not directly acquainted with my writings.

At the risk of being somewhat lengthy, I should like to quote fully some statements made in my book which, I think, clearly show my attitude on this question.

P. p. 482:—"In order to explain the presence of helium in radium on ordinary chemical lines, it has been suggested that radium is not a true element, but a molecular compound of helium with some substance known or unknown. The helium composed gradually breaks down, giving rise to the helium observed. It is at once obvious that this postulated helium compound is of a character entirely different from that of any other compound previously observed in chemistry. Weight for weight, it emits during its change an amount of energy at least one million times greater than any molecular compound known (see section 249). In addition it must be supposed that the rate of breaking up of the helium compound is independent of great ranges of temperature—a result never before observed in any molecular change. The helium compound in its breaking up must give rise to the peculiar radiations and also pass through the successive radio-active changes observed in radium.

"Thus in order to explain the production of helium and radio-activity on this view, a unique kind of molecule must be postulated—a molecule in fact which is endowed with every single property which on the disintegration theory is ascribed to the atom of the radio-elements. On the other hand, radium, as far as it has been examined, has fulfilled every test required for an element. It has a well marked and characteristic spectrum, and there is no reason to suppose that it is not an element in the ordinarily accepted sense of the term.

"On the theory that the radio-elements are undergoing atomic disintegration, the helium must be considered to be a constituent of the radium atom, or in other words, the radium atom is built up of parts, one of which, at least, is the atom of helium. . . ."

P. 483:—"Taking the view that the α particles are projected helium atoms, we must regard the atoms of the radio-elements as compounds of some known or unknown substance with helium. These compounds break up spontaneously, and at a very slow rate even in the case of radium. The disintegration takes place in successive stages, and at most of the stages a helium atom is projected with great velocity. This disintegration is accompanied by an enormous emission of energy. The liberation of such a large amount of energy in the radio-active changes at once explains the constancy of the rate of change under the action of any of the physical and chemical agencies at our command. On this view, uranium, thorium, and radium are in reality compounds of helium. The helium, however, is held in such strong combination that the compound cannot be broken up by chemical or physical forces, and, in consequence, these bodies behave as chemical elements in the ordinarily accepted chemical sense.

"It appears not unlikely that many of the so-called chemical elements may prove to be compounds of helium, or, in other words, that the helium atom is one of the secondary units with which the heavier atoms are built up. In this connection it is of interest to note that many of the elements differ in their atomic weight by four—the atomic weight of helium.

"If the α particle is a helium atom, at least three α particles must be expelled from uranium (238·5) to reduce its atomic weight to that of radium (225). It is known that five α particles are expelled from radium during its successive transformations. This would make the atomic weight of the final residue $225-20=205$. This is very nearly the atomic weight of lead, 206·5. I have for some time considered it probable that lead is the end or final product of radium. The same suggestion has recently been made by Boltwood."

Then follows a discussion of the evidence on which this suggestion is based.

I think that the above quotation makes my position clear on this subject. E. Rutherford.

McGill University, Montreal, October 11.

Radium and Geology.

The Hon. R. J. Strutt has advanced weighty reasons in favour of supposing radium to be confined to a certain shallow layer over the surface of the earth. To assume, however, that a heavy element is thus restricted in distribution appears to me to present difficulties. It would appear that an *a priori* probable reason why uranium should disintegrate more rapidly near the surface than at greater depths would bridge over the difficulty, and, if for that reason only, would deserve attention.

I think such a reconciliation of observational facts with the probabilities involved would be found in the view that the break up of uranium is not entirely spontaneous, but is partly secondary in character, *i.e.* that disruption of an α particle from an unstable atom may precipitate the failure of neighbouring atoms, as Prof. J. J. Thomson has suggested might happen in the case of radium. If this be the case, and we assume that the uranium is in general distributed in random aggregates throughout the earth, a reason is at once forthcoming for Mr. Strutt's results. The lighter constituents in the outer crust—aluminium, silicon, oxygen—exert a lesser screening action than the heavy metals deeper down. The conflagration is, as it were, isolated where the heavier metals interpose to absorb the energy of the α ray which initiates the changes leading to radium. It is probable that if the absorption is adequate to reduce the kinetic energy below a certain critical amount, there would be no propagation of disruption.

The remarkable fact observed in Mr. Strutt's experiments that radium is more abundant in the heavier silicates of plutonic rocks than in the lighter is not opposed to this view, but rather in keeping with it; and the absence of detectable radium in metallic meteorites need not be occasioned by the absence of uranium, but by the slower breakdown of the latter.

I cannot claim to speak authoritatively on the literature of this subject, but I can recall no other experiments bearing on this matter than those quoted by Prof. Rutherford in the last edition of his "Radio-activity." The case of uranium does not appear to have been investigated. Prof. Rutherford records an experiment in which he dissolved some pure radium bromide in 1000 times its bulk of a solution of barium chloride, and found no change in the γ radiation. I venture to suggest that this experiment is not conclusive. Increasing the volume 1000 times increases the average distance of the molecules but ten times, even were these fixed in the medium. This leaves the intervening distances still of the order of millionths of a centimetre. The heaviest metal brought to such tenuity would exert no appreciable screening influence, even from the α rays, to say nothing of more penetrating radiations. Mr. Eve's experiments, which are also quoted by Prof. Rutherford, are not, I think, to the point.

As cosmical effects of the greatest interest are involved, I think the question of how far radio-active effects are spontaneous deserves full investigation, and I think more especially with regard to the primary step, the generation of radium from uranium. If this is dependent on the matrix and on concentration, entirely new considerations arise.

It is not impossible, in the present meagre state of our knowledge, that the penetrating radiations observed at the surface of the earth have to do with the genesis of radium from uranium, the failure of such rays to penetrate deep into the crust limiting the production. The suggestion is continuous with that advanced above. J. Joly.

Geological Laboratory, Trinity College, Dublin.

In reply to Mr. O. Fisher's interesting letter of October 11 in this Journal under the above heading, it may be suggested that, though a state of stable thermal equilibrium exists now in the earth, it did not in the past, and that the earth has cooled down from a great initial temperature. We are, however, met with this difficulty, that the movements of the crust have been enormous in *late* geological times, as shown in the great mountain ranges of Tertiary date. This seems to be a fact entirely antagonistic to the suggested explanation.

No doubt some of the current geologico-dynamic theories will go to the wall should Mr. Strutt's interesting researches be confirmed, but I am of opinion that his work will ultimately prove helpful to sounder ideas of the origin of earth structure. T. Mellard Reade.

Park Corner, Blundellsands, October 13.

The age of the great mountain ranges mentioned above by Mr. Reade, though comparatively late, is much earlier than that of the changes of vertical level investigated by Prof. Hull and Dr. Spencer to which I referred. They are evidenced by the drowned plains bordering the Atlantic on both sides, and by the deep cañons in them which are the continuations of existing river channels. These changes of level are considered to be of Pliocene or early Pleistocene date, and, therefore, geologically very recent. Godwin Austen came to a similar conclusion about the English Channel.

I thank Mr. Strutt for noticing (p. 610) my letter in Nature of October 11. The fact of uranium not having been recorded in analyses of the rocks, as referred to by Mr. Strutt, has occurred to myself, but not being a chemist I have not alluded to it. But it seems to me that there ought to be an appreciable store of uranium present, large in proportion to the radium it is producing, if the latter is not permanent. That there is not appears to indicate that the disintegration of the radium, and therefore the escape of heat from it, is in some way checked in the earth's crust, as suggested by Mr. Rudge in his letter to the *Times* of August 18, and that consequently the temperature gradient is not due to radium in the crust, but to the cooling of the interior. I think it is in this direction that we must seek for a reconciliation between radium and geology.

Graveley, Huntingdon, October 19. O. Fisher.

Meteorological Data.

I shall be glad if you will enable me through your columns to make known to those interested in the collection of meteorological data the following information.

A number of copies of the Cape of Good Hope Magnetical and Meteorological Observations, vol. ii., "Meteorological Observations, 1841–6," have been placed at my disposal by the Controller of H.M. Stationery Office for distribution. The volume contains hourly observations, for each day, of pressure, temperature, and humidity, with a journal of other meteorological data.

I shall be glad if any scientific institution or library which desires a copy will be good enough to communicate with me upon the subject at the Meteorological Office, 63 Victoria Street.

I have also available for distribution in a similar manner a few copies of the following works:—

"Meteorological Observations taken during the Years 1829 to 1852, at the Ordnance Survey Office, Phœnix Park, Dublin, . . . and Other Places in Ireland."

"Abstracts from the Meteorological Observations taken at the Stations of the Royal Engineers (including 15 Colonial Stations) in the Year 1853–4, with Notes on Meteorological Subjects."

"Abstracts from the Meteorological Observations taken at the Stations of the Royal Engineers (comprising 13 British and 18 Colonial Stations) in the Years 1853–4, 1854–5, 1855–6, 1856–7, 1857–8, and 1858–9."

"Abstracts from the Meteorological Observations taken in the Years 1860–61, at the Royal Engineer Office, New Westminster, British Columbia."

These volumes will be issued without payment.

I may also mention at the same time that the Meteorological Committee, acting in accordance with the recommendation of the fourth International Conference on Scientific Aëronautics, has undertaken to subscribe for a number of copies of the international publication of the observations of the upper air on the "international days," which will be issued by Prof. Hergesell, the president of the commission. I shall be glad to know whether any scientific institution or library wishes to subscribe for a copy of this publication. The amount of the subscription is *1l.* per annum.

W. N. SHAW.

The Breeding Habits of the Tsetse-fly.

I SHOULD be greatly obliged if you could find space in your columns for the following extracts from a letter which I have received from my friend Dr. A. G. Bagshawe announcing the discovery, I believe for the first time, of the pupæ of the tsetse-fly (*Glossina palpalis*) in nature. As this species of fly is now known to be the agent which disseminates the infection of sleeping sickness, any discoveries relating to its breeding habits are of the utmost importance from the point of view of devising measures for extirpating the fly or checking its increase. Together with my colleagues Lieuts. Gray and Tulloch, I spent a great deal of time, when I was in Entebbe, in searching for the pupæ of the fly, and we offered the native boys a rupee each for them, but all our efforts to find them in nature were unsuccessful, although captive flies deposited great numbers of pupæ in our cages. I ought, perhaps, to explain at this point that the tsetse-fly is viviparous, and produces a full-grown larva, one at a time; the larva is of a light yellowish tint when born, and wriggles about actively for an hour or so, and then turns in a short time to a dark brown pupa, about the size of a grain of wheat.

Dr. Bagshawe, who is already well known for the botanical collections he has sent home, has succeeded where we failed, and as I do not know what steps he has taken to secure the priority for this most important discovery, I hasten to make it public on his behalf. It will be seen that the pupæ have been found in the banana plantations. Since bananas are the staple food of the Baganda, it would be impossible to destroy the plantations without creating a famine. I may mention, however, that we found the tsetse-fly swarming on the deserted island of Kimmi, on the Victoria Nyanza, where there were no plantations, so that this is perhaps not its only breeding place.

E. A. MINCHIN.

Lister Institute of Preventive Medicine, October 17.

(*Extract from Dr. Bagshawe's Letter.*)

"On August 29 I got them [the pupæ] at last. I had marked down a particular spot as likely, and had pitched my camp near by to search. Along the lake shore for about 100 yards was a belt of bananas 10–20 (40?) yards in width, and behind that undergrowth, going back 100 yards or more. Fly were thick and bothered one up to sunset.

"On the second day one of the porters I had coached brought me a pupa while I was searching a hole in a tree. He had found it among the banana rootlets. I searched there at once, and soon found some empty pupa cases. The next day I had a lot of my people at work and 53 pupæ were found, all in the loose crumbling soil round the bananas. In the scrub behind there are none to be got. . . .

"I made a series of experiments lately to find out how long a stretch of river the individual fly haunts. I started on the assumption that a fly with five legs is as good as one with six, and if one snipped off a piece of a known leg that fly could be identified when caught again. Six series of experiments could be made. It worked admirably. The experiments want repeating on a larger scale (I hope to do it on the Semliki), but I have shown clearly that the range is *at least* a mile. This is the reason why the breeding places have eluded search so long.

"(Signed) ARTHUR G. BAGSHAWE.

"Albert Edward Lake, September 1, 1906."

Suspended Germination of Seeds.

IN Mr. Claridge Druce's letter in NATURE of October 11 he rightly remarks that in order to prove the suspended germination of seeds over long periods, instances are required in which the factors of wind-carried seeds, &c., can be with some certainty eliminated. The following case, though not absolutely conclusive, may still be of interest.

Personally I am of opinion that the seed of Digitalis does preserve its germinating power for a considerable time. A few years ago I cleared a space, speaking from memory, of say forty yards by thirty yards, occupied by old Portugal laurels 25 feet to 30 feet high, planted fully sixty years ago, with *Rhod. ponticum* lining the path in front; the space, except on the path side, is surrounded by thick coverts. The nearest growing foxgloves were to the west along a 6-feet path running parallel with the long side of the cleared area, and distant, say, ten yards; both sides of this intervening space are lined by old rhododendrons; seed blown along would fall on the path or the edge of the clearing. The laurels were removed in January and February, when all, or nearly all, the seed would have been shed. Notwithstanding this, the next spring the whole of the cleared ground was covered with a uniform carpet of seedlings, practically hiding the bare ground. It seems to me that, even if some wind-blown seed penetrated the evergreen barrier, the seedlings would have appeared in patches.

I have known many other somewhat similar instances, but none quite so specialised as the above. I may add that the spot is exceptionally protected from wind, having tall forest trees on all sides.

ARCHIBALD BUCHAN-HEPBURN.

Smeaton-Hepburn, Prestonkirk.

Biometry and Biology.

OWING to the proof of my letter in last week's NATURE reaching me too late for careful revision, one or two slips escaped notice. Of these, I would wish to direct attention to the interchange of the words *intra-racial* and *inter-racial* in the second paragraph on p. 609 (column 1, line 14).

KARL PEARSON.

Biometric Laboratory, University College, London, October 19.

SPEED AND STABILITY IN RAILWAY TRAVELLING.

THE Salisbury railway accident, being followed after no very long period by the somewhat similar disaster at Grantham, undoubtedly raised a feeling of considerable uneasiness in the public mind. The recent publication by the Board of Trade of Major Pringle's report on the former calamity should do something to allay this apprehension, if only because it shows that the cause of the derailment of the train was not "mysterious," but is fully to be explained. That the evil we know is less alarming than one which vaguely threatens is a fact for which we have classic authority.

The accident occurred on July 1 at the Salisbury Station of the London and South-Western Railway, the train being the special boat express from Plymouth to London, carrying passengers who had arrived by the American liner *New York*. The train consisted of four eight-wheeled vehicles hauled by a four-coupled engine with a leading bogie, having an eight-wheeled bogie tender. The coaches were not of excessive length, the longest being 48 feet, and all were on bogies; the engine was one of the company's usual modern express type, and although the boiler is mounted higher than was formerly the practice, the train was well calculated to run safely round curves under usual conditions: yet it was a curve that caused the accident. In saying this we are not verbally in agreement with Major Pringle's report or with the verdict of the coroner's jury at the inquest on the unfortunate victims, both of which attribute the accident to excessive speed. No doubt the speed at which the curve was taken was too high, but if the curve had not been so sharp the speed would have been perfectly safe; in fact, it was the curve which was the abnormal feature, the speed being ordinary for ordinary conditions. It may seem like splitting hairs to cavil over terms in this manner, but the matter has greater significance than may appear. If we allow the accident to have been due simply to speed, then the railway authorities have done all that they can do when they order drivers as they always have done—to reduce speed to within safe limits; but if it is stated that the accident was due to excessive curvature of track, then the company will appear not to have done all that is possible until they flatten the curve. Whether the danger warrants the expenditure is another matter, but we may remember that so long as drivers are human and liable to err, the chance of disaster is always present whilst such an abnormal curve exists on a main line over which express trains run; in other words, if the Salisbury curve did not exist accident from the same cause would be impossible.

Speed is always a doubtful point in the elucidation of the cause of accident, but there is no doubt, from the evidence at the inquest and the Board of Trade inquiry, that the train was travelling very greatly in excess of the thirty miles an hour laid down by the regulations as safe for the curve immediately to the east of Salisbury station. One witness estimated the speed to have been as high as seventy miles an hour, and Major Pringle considers that possibly this may not have been an extravagant estimate. When the engine and tender left the line it came into violent contact with a milk train moving on the down line, and the wreckage also struck a light engine standing in a bay close by. Particulars of the loss of life have been fully published, and it will be sufficient to say that on the express twenty-four passengers were killed, seven were seriously injured, the engine-driver and fireman were killed, and a ticket collector and two waiters on the dining car were injured. The guard of the milk train and the fireman of the light engine were also killed, and the driver was badly scalded.

The chief interest of Major Pringle's report, as in all reports of this nature, centres in his conclusion as to the probable cause of the accident. Speaking at large, there is no doubt, as we have stated, but that the disaster was due to high speed on an awkward curve, and the evidence all points to the fact that the engine and tender turned over bodily; how the forces set up acted so as to bring about the result is the problem that remains to be solved.

According to the plan of this part of the line, given in the report, the up line is straight through the station, but at the eastern end of the platform a curve to the left of ten chains radius (compound) extends for a distance of about ninety-two yards. In the body of the report is a statement attributing a radius of eight chains to the curve, this representing the sharpest part of it. There is a rising gradient of 1 in 158, and the maximum superelevation on the curve is 3½ inches. It was on this part of the line that the accident occurred, the overturned engine being found at the termination of the curve, and just in front of facing points with reverse curves of 7½ chains radius; naturally there could be no superelevation at the points. The report states that the three leading vehicles of the express were overturned in various directions, the frames stripped of woodwork and completely destroyed. The fourth vehicle fared little better. Comparatively little damage was done to the last vehicle, which came to rest in an upright position, with the last pair of wheels on the proper rails. The engine and tender were both overturned on their right sides, but less damage was done than might have been expected, and the engine was shortly afterwards hauled to Nine Elms on its own wheels. Five vans of the milk train were completely destroyed, and five were damaged. This destruction of rolling-stock was accompanied by remarkably little damage to permanent way on the up line over which the express was running, but a length of about forty yards of the down line was torn out and destroyed.

The weight of the engine was nearly 54 tons (53 tons 19 cwt.), 16 tons 17 cwt. being on the leading bogie, 19 tons 2 cwt. on the leading driving axle, and 18 tons on the trailing axle. The tender weighed 44 tons 17 cwt., 23 tons 2 cwt. being on the leading bogie, and 21 tons 15 cwt. on the trailing bogie. The centre of gravity of the engine was calculated at about 5 feet above the rail-level, and that of the tender at about 4¾ feet.

So far we have most of the chief data generally at command for calculating what would be the limit of safe speed for travelling over the part of the line where the accident occurred. Calculations for the centre of gravity of an engine are somewhat tedious, even when all data are at command, and the figures given appear somewhat low for an engine of the type. In former days this would have been of less consequence, but the tendency to raise the boiler, so that the chimney becomes nothing more than a "frill round a hole"—as a railway engineer recently said—makes the centre of gravity a factor that needs more attention, although the effect in this respect of the modern high boiler is far more apparent than real.

It is unfortunate that our chief railways were designed for lower speeds than are now required, and altogether for more primitive conditions; thus it is possible that when Salisbury Station was built it was not anticipated that a train would ever run through, and the curve of 8 chains would be without danger for a stopping train.

Major Pringle says that the engine in question, with a centre of gravity 5 feet above the rails, when traversing a curve of 8 chains, would be in unstable equilibrium at a speed of about sixty-seven to sixty-eight miles per hour, even if full allowance were made for the beneficial effect of 3½ inches superelevation. Major Pringle does not give his calculations, but, as he says, the result may be taken as agreeing with modern formulæ. The rule $\frac{WV^2}{1{\cdot}25\,R}=E$, where W = width of gauge in feet, V = velocity in miles per hour, R = radius of curve in feet, and E = elevation of outer rail in inches; or if the speed V were expressed in feet per second the formula would become WV^2/gR, where g is 32·2. If the formula were used to calculate the superelevation for a speed of sixty miles per hour, it would give superelevation of 25·6 inches; on the other hand, at the speed of thirty miles an hour—that laid down as a maximum by the railway company's engineers—the rule would give superelevation of 6·4 inches. The maximum superelevation on the South-Western Railway is 6 inches, and it is, of course, altogether impossible to work with any such superelevation as more than 2 feet. It will be understood that the whole of the constraining force required to keep the engine moving in the curve is supplied by the resolved component of the weight of the engine acting parallel to the plane of the radius towards the centre of curvature.

It will be evident, therefore, that superelevation is a remedy of limited efficacy for a serious defect. The centrifugal force at sixty miles per hour (a speed that the evidence of figures shows to have been exceeded, but which we adopt as a convenient standard) would be $\frac{54 \times 88^2}{32 \cdot 2 \times 528}$, or, approximately, $24\frac{3}{5}$ tons (24·597).

The accompanying diagram (Fig. 1) illustrates the resultant of the two opposing forces acting on the engine.

M = centre of gravity of the engine 5 feet above rail-level. The line MQ = the weight of the engine, and MF = the centrifugal force at sixty miles an hour to the same scale. Completing the parallelogram MFRQ, then MR = the resultant of the two forces. Producing MR, it cuts the rail-level at the point H, which is 5·29 inches inside the outer rail; AE is the superelevation. There would only be, therefore,

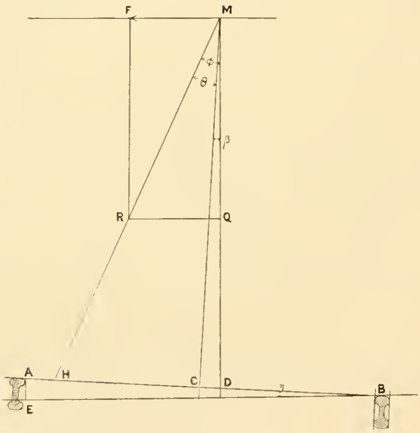


FIG. 1.

about 5 inches between the points A and H. The narrowness of the margin of safety with the data assumed is indicated very clearly in the diagram by the nearness of H to A; should H coincide with A, the engine is just on the point of turning over.

The working out of the problem is as follows:—

MQ = 54 tons.
MF = 24·596 tons.
MC = 60 inches.
AE = 3·5 inches.
AB = 56·5 inches.

$$\tan \phi = \frac{MF}{MQ} = \frac{24 \cdot 596}{54} = 0 \cdot 45548$$

$$\phi = 24^\circ\ 29'$$

$$\text{sine } \beta = \text{sine } \eta = \frac{AE}{AB} = \frac{3 \cdot 5}{56 \cdot 5} = 0 \cdot 0619$$

$$\beta = 3^\circ\ 33'$$

$$\theta = \phi - \beta = 24^\circ\ 29' - 3^\circ\ 33' = 20^\circ\ 56'$$

$$CH = MC \tan \phi = 60 \times 0 \cdot 383 = 23 \text{ (app.)}$$

$$AH = 28 \cdot 25 - 23 = 5\tfrac{1}{4} \text{ inches.}$$

Working backwards with the same data, and assuming the resultant to pass through A, it will be found that the critical speed would be practically sixty-six miles per hour.

In order to calculate CH quickly and with an approximation sufficient for practical purposes, the above working may be very much simplified by the following formula, which has been suggested by Prof. Dalby:—

$CH = h\left(\frac{V^2}{gR} - \frac{e}{G}\right)$. where e = superelevation in inches, G = the gauge in inches, V = the velocity in feet per second, $g = 32 \cdot 2$, R = radius of curve in feet, h = height of centre of gravity of engine above the rail level in feet.

The way in which the formula is obtained from Fig. 1 is as follows:—

$$\beta = \frac{AE}{AB} = \frac{e}{G} \text{ app.}$$

$$\phi = \frac{QR}{MQ} = \frac{WV^2}{gR} \div W = \frac{V^2}{gR} \text{ very approximately.}$$

$$\text{Therefore } \theta = \phi - \beta = \frac{V^2}{gR} - \frac{e}{G} \text{ approximately.}$$

$$\text{Therefore } CH = CM \times (\phi - \theta) = h\left(\frac{V^2}{gR} - \frac{e}{G}\right).$$

The above gives a very nearly correct result when the point H is in the neighbourhood of C, as it should be. The error increases as H approaches A.

We may compare the value of CH obtained by the two methods; we have already shown by the exact method that CH = 23 inches. Applying the approximate formula CH = 23·6 inches.

From the foregoing calculations it would appear that if the train were travelling at a speed of more than sixty-six miles an hour the engine would turn over sideways, but it will be understood that deductions drawn in this way are not proof, though they may be evidence, of what has occurred. The speed of the train is, of course, a very indeterminate quantity; the maximum superelevation was, as stated, $3\frac{1}{2}$ inches, but, to judge by the plan, this did not extend on the curve for a greater distance than about 50 feet, and it would appear that at the spot where the trouble commenced (to judge by the damage to the line) the superelevation was somewhat less. Again, in placing the position of the centre of gravity of the engine, there are various unknown factors which it would be necessary to take into consideration to enable a true result to be reached; for instance, there is the unequal compression of the springs causing lateral displacement of the centre of gravity, rush of water in the boiler, and the extent of wear of wheels and rails.

G. R. DUNELL.

ESTIMATION OF BLOOD-PRESSURE.

THE subject of blood-pressure is one of great interest both to the physiologist and the clinical physician. By blood-pressure is meant the pressure which the blood exerts on the interior of the heart and blood-vessels, but it is chiefly with the vascular blood-pressure—arterial, capillary, and venous—that the physician deals. Our conception of intravascular pressure is facilitated by considering what happens when an aperture is made in an artery, capillary, or vein of a living animal. In the case of the artery the blood squirts out with considerable force, the height of the jet measuring the pressure exerted on the interior of the vessel. Experiment shows that the pressure falls slowly from the heart to the region of the smallest arteries, or arterioles, where there is a considerable fall, the pressure in the capillaries and veins being comparatively low; in the large veins opening into the right heart it may, indeed, be minus, owing to the suction action of the thorax, and hence when these veins are cut air may actually be sucked into the blood-stream.

The vascular blood-pressure is subject to considerable variation both in health and disease, and it will readily be seen that its accurate estimation is of great clinical value. To take an illustrative case. In certain poisoned states of the blood the small arteries undergo considerable contraction; in consequence of this the blood cannot pass into the capillaries and veins with its wonted facility, and tends to be dammed back upon the large arteries and heart; in other words, the blood-pressure rises in the left ventricle and in the whole arterial tree proximal to the contracted area, and this heightened pressure is further augmented by an increase in the force of the heart-beat, called forth by the necessity to overcome the increased resistance. An increased strain is thus put upon the heart and arteries, and this, if long continued, may lead to disease in them; and in this way such serious affections as aneurism, heart-disease, and apoplexy may be brought about. The importance of early detecting such cases of augmented pressure is apparent, in that it enables steps to be taken to correct the underlying faulty condition of blood, and thus to ward off grave consequences.

Until recently the physician had to be content to rely upon his sense of touch in estimating blood-pressure, and thus it was that the older physicians spoke of a "hard" and a "soft" pulse, the former indicating a high and the latter a low blood-pressure. More modern physicians describe the pulse as "compressible" or "incompressible," or the vessel as being in a state of high or low "tension," according to the readiness with which it yields to the pressure of the finger. This tactile method is, however, far from trustworthy. Not only is long experience needed to acquire even moderate efficiency in it, but from a variety of causes the most skilful are liable to make false estimates by its means; nor do the findings admit of accurate record. In short, though useful as a rough-and-ready method, it lacks the precision needful for scientific observation.

The earliest method of estimating the arterial blood-pressure consisted in cutting the artery of an animal and observing the height to which the blood was forced out. Later the more delicate plan was adopted of connecting the interior of the vessel with a mercurial manometer, by means of an elastic tubing filled with saline solution. Clearly neither of these methods is available for clinical purposes. Recently, however, a method has been devised in which the employment of the knife can be dispensed with, and one, moreover, yielding results quite as accurate as those just referred to. It consists in enveloping some part of the upper extremity—arm, forearm, or finger—in a gutta-percha bag, and connecting the latter, by means of a tubing, with a manometer. The bag is blown up until the pulse on the distal side of it is obliterated, the pressure then registered by the manometer representing the "systolic," or "obliterative" pressure. The "diastolic" pressure, or that obtaining between the heart beats, is measured by noting the excursions of the manometric index produced by the pulsations of the artery; it is held that the maximum movements occur when the pressure on the artery is just sufficient to balance the diastolic pressure.

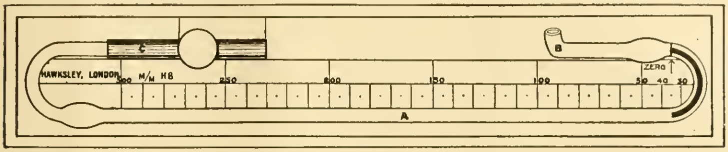


FIG. 1.—Dr. George Oliver's Hæmomanometer (reduced to half size). A is the graduated glass tube along which moves the coloured spirit-index, represented by the dark curved line at the right-hand bend; B is the open end on to which fits the rubber tube communicating with the enveloping bag, or armlet; C is kept closed by means of an air-block, while the blood-pressure is being taken.

Hitherto the manometer most frequently used in these observations has been the ordinary mercurial one; but Dr. George Oliver, of Harrogate, has recently devised an instrument which is not only more handy, but would appear to give more accurate readings than the mercurial manometer. It consists of a fine bored glass tube (Figs. 1 and 2) which during use is kept closed at one end, and connected at the other with the enveloping bag by means of elastic tubing. A minute drop of coloured spirit introduced into the glass tube serves as the index. At the commencement of an observation the index is at zero, which is situated at the open end of the tube. As the bag is blown up the index is driven onwards, compressing the air in front of it, and advancing with every increment of pressure. The instrument is readily graduated by means of a mercurial manometer. It will be seen from this description that the

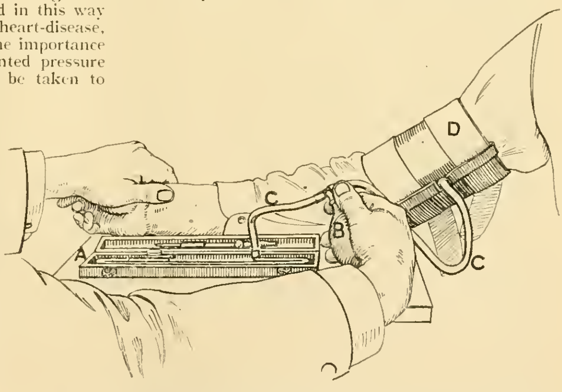


FIG. 2.—Method of employing Dr. Oliver's hæmomanometer. A is the hæmomanometer; D is the armlet; C is the rubber tubing connecting the armlet with the glass tube; B is the rubber ball for inflating the armlet; this is provided with a screw (covered by the thumb), by means of which the armlet and tubing may be gradually deflated.

pressure on either side of the index is equal, a circumstance which tends to reduce to a minimum the errors due to inertia of the index, and this is of great advantage in estimating the diastolic blood-pressure.

In a valuable booklet recently issued by Dr. Oliver [1] on blood-pressure gauging, he sets forth some of the more important results he has arrived at by means of this ingenious instrument. This physician attaches considerable importance to the study of the pressure in the smallest arteries and capillaries by means of a digital bag. He finds that while arteriolar dilatation lowers the pressure in the larger arteries by lessening peripheral resistance, it tends to augment that in the capillaries and pre-capillary vessels by increasing their supply of blood. During muscular exercise, on the other hand, the pressure throughout the entire length of the systemic arteries is increased, owing to the fact that the dilatation of the arterioles is accompanied by a considerable augmentation of cardiac action. The essential circulatory change attending upon digestion, so far as the systemic system is concerned, is, according to Dr. Oliver, an increment in the capillary and pre-capillary pressure, whereby an increase of lymph-exudation is effected, and the products of recently digested food thus speedily conveyed to the tissues. Such an augmentation in the exudation of lymph he claims to have demonstrated.

Of special interest are Dr. Oliver's observations on the blood-pressure of the aged and elderly. With advancing years the smaller vessels tend to become rigid and impervious, and thus to lose their power of dilating in response to physiological requirements, such as digestion and muscular exercise. When this happens the blood-pressure in them is found to be habitually low, and to fail to rise readily during digestion, or as the result of administering such a drug as nitroglycerine, which normally dilates the smaller arteries. In this way the physician is able to gauge the condition of the blood-vessels with a precision which was quite impossible with the older methods. In cases of premature degeneration of the blood-vessels, Dr. Oliver believes that much may be done to check the degenerative process. Among the methods he employs to this end is the administration of certain substances the deficiency of which in blood is thought by some to be largely responsible for the phenomena of senility.

These brief references suffice to show the practical value attaching to the clinical study of blood-pressure. The student in this important branch of investigation will find great help from Dr. Oliver's book, the more so that only salient and practical points are dealt with, and these in clear and simple language.

MENDEL'S CORRESPONDENCE WITH NÄGELI.[2]

THESE letters constitute a valuable addition to the pile of literature that has accumulated under the name of one of the most remarkable figures in the history of biology—Gregor Mendel; for we doubt if ever has so great a fame been built on the contents of a single short paper. The fact that this paper remained unknown from 1865, when it was published, until 1900, when it was rediscovered, is both the measure of how much Mendel was before his time and the reason for the uniqueness of the picture of him which presents itself to the eyes of most of us. We have, it is true, neat and compendious biographies of Mendel, but they reveal to us little of the man himself, and it is still a distant and mysterious monk that appears to us, with his classical peas in his cloister garden. The value of these letters is that they lift the veil for us here and there, and extend to us an invitation to a "private view" of his work, and offer us an opportunity of a nearer acquaintance with its author.

The correspondence was begun by Mendel, who wrote to Nägeli on New Year's Eve, 1866. In this letter he referred to Nägeli's great services to the study of hybrids occurring in nature, mentioned his own results with peas, gave an account of some new experiments he was starting with the hawksweed, and ended with what was probably the reason for his writing, an appeal for help and advice with these experiments.

Nägeli answered on February 24, 1867, addressing Mendel as Verehrtester Herr College. He recommended some hawksweed species for the proposed experiments, but the chief interest the letter has for us lies in the criticism which it contains of Mendel's well-known formulæ. Nägeli said: "Die Formeln dürften Sie wohl ebenfalls für empirische halten, da dieselben als rationellen nicht zu erweisen wären." Mendel's reply to this criticism is a little difficult to understand, and Prof. Correns remarks in a footnote, "Ich weiss nicht, ob Mendel hier das, was Nägeli unter empirischer und rationeller Formel meinte, ganz verstanden hat." But I suggest Mendel's reply becomes intelligible if we divide it into two sections (the first of which ends with the sentence to which Correns's note is appended), and regard each section as an answer to one of two interpretations, of the criticism, by Mendel, who I imagine was not quite sure what Nägeli meant. In the first part of his answer Mendel interprets the criticism as meaning that the simple formulæ, in which only one pair of characters is concerned, are "empirical," and that the complex ones, in which many are concerned, are "rational." I think we may be pretty sure that Nägeli did *not* mean this; however, I am not here concerned with what he did mean.

Nor do I stop to discuss what Nägeli may have meant when I come to consider the second section of Mendel's reply. The point is that it begins with the words "Was schliesslich die Angaben über die Verschiedenheit der von den Hybriden gebildeten Keimbläschen und Pollenzellen betrifft. . . ." Mendel is discussing an entirely different subject now, and he shows unconsciously by this fact that it never occurred to him that Nägeli might mean by his criticism that while of course it was impossible to deny the numerical proportion of the different categories (1D : 2DR : 1R), that was a very different thing from stating one's belief that the suggested interpretation of that proportion (the random union of

$$50\%\,D + 50\%\,R \text{ with } 50\%\,D + 50\%\,R)$$

was true, and that it was very desirable that these two entirely different things should not be confused. Nägeli may or may not have meant this, but the point of interest is that it did not occur to Mendel that he might have done, which shows that so far was he from confusing these two things that the possibility that he might have done never occurred to him as an interpretation of Nägeli's criticism.

I have discussed this at some length because such confusion is not rare among modern students of heredity.

This second letter of Mendel's was accompanied by several packets of peas, which were sent to set Nägeli's doubts at rest.

[1] "Studies in Blood-pressure: Physiological and Clinical." By Dr. George Oliver. (London: H. K. Lewis, 1906.) Price 2s. 6d. net.

[2] "Gregor Mendel's Briefe an Carl Nägeli, 1866–73. Ein Nachtrag zu den veröffentlichten Bastardierungsversucben Mendels." Edited by C. Correns. Abhandl. d. K. S. Gesellsch. d. Wissensch., math.-phys. Kl. xxix. iii. Pp. 189–264. (Leipzig: B. G. Teubner, 1905.) Price 3 marks.

The remaining letters, of which there are eight, consist of two things—on the one hand of discussion of the results of the hawksweed experiments and of appeals for rare or unobtainable species of that genus, and on the other of personal and friendly communications. The former are interesting only to the specialist, and to him even the interest is chiefly historical, since Mendel did his crossings without the knowledge which we now possess, that the hawksweed sometimes exhibits parthenogenetic reproduction.

At the beginning of the third letter we get a glimpse of Mendel. He is giving his reason for not having studied the hawksweeds in their natural habitat in the neighbourhood of Brünn, and proceeds: ". . . . auch tauge ich mich nicht mehr recht für botanische Excursionen, da mich der Himmel mit einem Uebergewichte gesegnet hat, welches sich bei weiteren Fusspartien, namentlich aber beim Bergsteigen, in Folge der allgemeinen Gravitation, sehr fühlbar macht."

Later, in the same letter, we read of him nearly ruining his eyesight by the extremely difficult operation of castrating Hieracium, and we can picture him, with bent head close to flower, absorbed in his beloved experiments. That Mendel did this work because he loved it, and not for the hope of any reputation he might gain by it, is abundantly evident. The impatience with which he waited for the blossoming of certain hybrids finds eloquent expression in the last words of the third letter. And Prof. Correns remarks in his introduction: "Die Briefe zeigen, dass das was Mendel *veröffentlicht* hat, in der Tat in gar keinem Verhältnis steht zu dem, was er *gearbeitet* hat." The reason that he published so little lies also in the fact that in '68 a great change took place in his circumstances, which robbed him of his time. ". . . . Meine Wenigkeit wurde nämlich am 30 März von dem Kapitel des Stiftes, dessen Mitglied ich bin, zum lebenslänglichen Vorstande gewählt."

That Nägeli entertained a high opinion of Mendel is shown by the trouble that he took to obtain the plants which Mendel wanted; and that, as a result of this correspondence, Nägeli grew not only to esteem him as a man of science, but to value him as a friend, is shown by the fact that in the first five letters he addresses Mendel as Verehrtester Herr College, but that in the last five he calls him Hochgeehrter Herr und Freund. And that, I think, sums up one's feelings when one reads these letters. At the beginning, we feel, Mendel stands to us in the relation of a *College* only; at the end we feel that he is both our *College und Freund*. Is there not something that attracts us in passages like the following, from the end of the seventh letter? "We have been rejoicing here for weeks past in the most glorious spring weather. Compared with the yearly average, the vegetation is thirteen days in advance, and everything is in leaf."

A. D. D.

NOTES.

The pupils of M. Moissan are taking the opportunity presented by the twentieth anniversary of the isolation of fluorine to offer their distinguished master a medal in commemoration of this important event in the history of chemistry. The execution of the medal has been entrusted to M. Chaplain. The promoters of this happily-conceived scheme have decided to extend to men of science generally an invitation to contribute to the expenses. Every subscriber of 25 francs will receive a replica in bronze of the medal. Donations may be sent, up to November 30, to the treasurer to the committee of management, M. P. Masson, 120 boulevard Saint-Germain, Paris. Fuller particulars may be obtained from the secretary of the committee, Dr. Guichard, 3 rue Michelet, Paris.

Prof. T. H. Middleton, professor of agriculture in the University of Cambridge, has been appointed assistant secretary to the Board of Agriculture and Fisheries, in succession to Dr. W. Somerville.

The death of Mr. William Sedgwick, a member of the medical profession who combined the active duties of his calling with the pursuit of scientific investigation, is announced in Wednesday's *Times*. Mr. Sedgwick was born in 1821, and during the 'sixties of last century he devoted much attention to the study of heredity, and published articles upon the subject which were referred to and quoted by Darwin. Soon after his establishment in Marylebone as a general practitioner, London was visited by the great cholera epidemic of 1854; and Mr. Sedgwick devoted much attention to the chemical changes incidental to the disease, and made them, in 1889, the subject of his presidential address to the Harveian Society.

The death is announced in St. Petersburg, on October 19, of Prof. T. T. Beilstein, the well-known Russian chemist. His numerous researches in organic and analytical chemistry, and especially his work on the aromatic series, enriched science with many new discoveries, and gave a new direction to chemical industry. He also made extensive researches on Caucasian naphtha and coal-tar. His works, written in German, were very numerous, the chief of them being his "Handbuch der organischen Chemie" and his text-book on analytical chemistry. Prof. Beilstein was born in St. Petersburg on February 5, 1838. He studied chemistry under Prof. Bunsen at Heidelberg, and also attended the lectures of Liebig at Munich. He studied physics under Prof. Jolly, and at the age of eighteen published his first work on the diffusion of liquids. At Göttingen he obtained the degree of Doctor of Philosophy. In 1859 he became assistant professor of chemistry at the Breslau University, and in 1866 was appointed professor of chemistry at the St. Petersburg Technological Institute, where he remained the rest of his life. He also lectured at the St. Petersburg Military Academy, and was made an academician of the St. Petersburg Academy of Sciences in 1886.

The proposed new scheme for the mathematical tripos will be voted upon at Cambridge this afternoon. In a letter to the *Times* of October 22, the professors of mathematics and of the cognate subjects of physics and engineering, and all the other official teachers of mathematics in the University, state the chief grounds upon which they are in favour of the proposed changes. The traditional system of placing the names in the mathematical tripos list in order of merit is shown to be unsatisfactory, and to involve the sacrifice of the educational interests of many students. The number of men who wish to devote their whole course at Cambridge to the study of mathematics is much smaller than twenty years ago. At the present time, however, there are a considerable and increasing number of students of engineering and of physics who require mathematics up to a fairly high level, but do not come into contact with the mathematical school proper. To provide for the needs of the important class of men who ought to spend part, but not the whole, of their time at Cambridge in studying mathematics is one of the chief objects aimed at in the proposed new scheme. It will be for the advantage of the special mathematical students, as well as of those who learn mathematics with a view to its application in physics or in applied science, that the teaching of the subject be unified. The two classes of students may thus avoid the opposite dangers of taking a too purely abstract view of the science on the one hand, and of regarding it as consisting of a set of empirical rules on the other. The letter is signed:—Robert S. Ball, Lowndean professor of astronomy and geometry; G. H. Darwin, Plumian professor of astronomy; A. R. Forsyth, Sadlerian professor of pure mathematics; B. Hopkinson, professor of mechanism and applied mechanics; J. Larmor, Lucasian professor of mathematics; J. J. Thomson, Cavendish professor of experimental physics; H. F. Baker, Cayley lecturer in mathematics; E. W. Hobson, Stokes lecturer in mathematics; and R. A. Herman, J. G. Leathem, H. W. Richmond, university lecturers in mathematics.

Dr. William Osler, regius professor of medicine at Oxford, delivered the Harveian oration at the Royal College of Physicians on October 18. He took as his subject "The Growth of Truth" as illustrated by the history of Harvey's discovery of the circulation of the blood. Truth, he said, grows like a living organism, and its gradual evolution may be traced from the germ to the mature product. All scientific truth is conditioned by the state of knowledge at the time of its announcement. Thus, at the beginning of the seventeenth century, the science of optics and its mechanical appliances had not made possible (so far as the human mind was concerned) the existence of blood capillaries and of blood corpuscles. Jenner could not have added to his inquiry a discourse on immunity. Sir William Perkin and the chemists made Koch possible, Pasteur gave the conditions which produced Lister, Davy and others furnished the preliminaries necessary for anæsthesia. To scientific truth alone may the *homo mensura* principle be applied, since of all the mental treasures of the race it alone compels general acquiescence. That such general acquiescence, such aspect of certainty, is not reached *per saltum*, but is of slow, often of difficult, growth, marked by failures and frailties, but crowned at last with an acceptance accorded to no other product of mental activity, is illustrated by every important discovery from Copernicus to Darwin. The growth of truth corresponds to the states of knowledge described by Plato in the "Theætetus"—acquisition, latent possession, conscious possession. Scarcely a discovery can be named which does not present these phases in its evolution. In a hundred important problems acquisition has by slow stages become latent possession; and then there needs but the final touch, the crystal in the saturated solution, to give us conscious possession of the truth. When those stages are ended, there remains the final struggle for general acceptance. But however eminent a man may become in science, he is very apt to carry with him errors which were in vogue when he was young, errors that darken his understanding, and make him incapable of accepting even the most obvious truths. It is a great consolation to know that even Harvey came within the range of this law; it was the most human touch in his career.

After an interval of only three weeks, another violent hurricane burst over the more western portions of the West Indies on October 17, apparently with little or no warning of its approach. As is usually the case with tropical storms, the area of the cyclonic whirl was small, for while the Cuban provinces of Havana and Pinar del Rio were devastated, Matanzas and Santiago were not affected. In the city of Havana the cyclone attained terrific violence on the morning of October 18, structures being rocked as if by an earthquake. Many buildings were demolished, there were numerous shipping casualties, and the loss of life was considerable. The storm was accompanied by deluging rain, which soon flooded the streets and rendered vehicular traffic of all sorts impossible. Enormous waves raised by the wind dashed thirty-five lighters in pieces against the wharves. The destruction in the city is estimated at a couple of million dollars. Passing on to Florida, the hurricane wrought great havoc on its way, wrecking ships and causing great loss of life. One captain reports that he took shelter under Elliott's Key on the morning of October 18, but shortly afterwards a huge wave swept the island, and its 250 inhabitants are believed to have perished. Owing to the interruption of telegraphic communication, the full extent of the damage in Florida is not known, but at alligator-breeding Miami various places of worship, the concrete-built prison, and a hundred houses were involved in the ruin. Mixed up with the information relating to the Cuba-Florida hurricane are messages reporting immense destruction by floods in the Central American Republics. So far as can be gathered from the brief cablegrams, rain-storms, and not wind-storms, have been the cause of the damage. In San Salvador the storms are said to have been incessant during ten days, the country being flooded, and the physical features completely altered in many places. Aqueducts and iron bridges have been carried away, the railway, electric lighting, and telegraph services disorganised, there has been great loss of life, a man-of-war lost, and the losses in cattle and crops have been very heavy. The casualties in Guatemala and Honduras are estimated at many millions of dollars.

The type of weather has been very unsettled during the past week, and exceptionally heavy rains have occurred in Scotland and in the north-east of England, while in most parts of the country rain has fallen each day. Snow has occurred at times in Scotland. In the south and south-east of England the weather has been unusually warm for the time of year; and with the single exception of October 19 the reading of the thermometer at Greenwich has exceeded 60° each day. On Monday, October 22, the Greenwich temperature was 69°, which is 3° higher than any previous record on the corresponding day since 1841, a period of sixty-five years, and on Sunday, October 21, the thermometer registered 67°·5, which is 1°·5 higher than any previous reading. The nights have also been exceptionally warm, the thermometer at times scarcely falling below 60°. Strong winds and gales have occurred over the northern and western portions of the kingdom.

According to a paper by Dr. W. E. Hinds, forming Bulletin No. 59 of the Entomological Bureau of the U.S. Department of Agriculture, the damage done to crops by the Mexican cotton-boll weevil is in a fair way of being to a considerable extent neutralised as the result of the presence of the insect itself. Cotton-bolls (or buds), it appears, when pierced by the beak of the weevil show a decided tendency—more strongly developed in some strains than in others—to proliferation, producing internally a number of large thin-walled cells placed so close together, and so loosely combined, that the whole structure presents a granular and gelatinous texture. Amid this abnormal tissue (which is in no wise poisonous to the insects) the grubs of the weevil are hatched, and proceed to develop. A considerable percentage is, however, found to perish, and it is inferred "that the great majority of the deaths due to proliferation may be caused by the mechanical effect of the formation in first enveloping the larva so closely as to prevent its movement, and then the continued formation producing sufficient internal pressure slowly but surely to crush to death the foe whose attack has called forth this as self-defence on the part of the plant." Proliferation may be stimulated by puncturing the cotton-buds, while strains should be selected for cultivation in which the proliferating tendency is most marked. Already the effects of proliferation in keeping the weevil in check appear to be of more importance than those due to parasites, and it is expected they will rapidly increase. Of course the weevil will endeavour to accommodate itself to the new conditions, but, since man is on its side, it is hoped that the plant will conquer.

In the latest issues of the fishery series of the publications of the Danish Commission for the Study of the Sea (Meddelelser fra Kommissionen for Havundersøgelser: Fiskeri, vol. ii., Nos. 1–3, Copenhagen, 1906), the larval and post-larval stages in the life-history of certain members of the flat-fish and cod families are described in great detail, with a wealth of illustration. The plaice, dab, and flounder form the subject of the first part, and while the features by means of which the young stages of each may be recognised are pointed out, the illustrations show the manner in which the symmetrical larva gradually changes into the unsymmetrical "flat-fish." The statement that young plaice have been found while in the early bottom-stage in deep water is shown to be due to confusion with the dab, and the special need of protection by the former on account of its shallow-water habitat is emphasised. Attention is directed to the curious circumstance that when leaving the pelagic for the bottom stage these fishes diminish in size. From the other species the dab, when it reaches the bottom-stage, is distinguished by its large eyes and narrow bodily form. In the second part the early stages of several of the more typical members (Gadus, &c.) of the cod-family are described and illustrated, while in the third part the species of ling (Molva) receive attention. All the lings are distinguished from cod by the great length of the pelvic fins in the early stages, and it is not a little remarkable that two such nearly-related species as the common and the blue ling should differ widely in regard to the development of pigment-bands on the hinder part of the body at this period of life. The blue ling in this respect occupies, indeed, a position intermediate between the common ling and the torsk (Brosmius).

In the fourth part of the "Plankton" series of the above-mentioned publication Mr. O. Paulsen discusses the distribution of the crustacean *Calanus finmarchicus* in Icelandic waters. This species, which forms the staple food of several kinds of fishes, breeds chiefly in the spring, when death follows propagation. There is, however, reason to believe that a certain percentage breeds at other seasons. Reproduction takes place only in the sea to the southward of Iceland, these crustaceans being carried to the west, north, and east coasts of that island by the Irminger current. As the species forms an essential element in the food of the herring, it is probable that the migrations of the shoals of the latter fish are largely influenced by the presence of swarms of the crustacean. Towards autumn the numbers of Calani at the surface decrease, and as the species has then reached its second developmental stage, it is probable that it descends into deep water to pass the winter, rising again to the surface with the return of spring to undergo the final transformation.

In the Calcutta *Medical Journal*, vol. i., No. 2, Mr. C. L. Bose is the author of an article on the toxic principles of the bitter variety of the fruit of *Luffa aegyptiaca*. The fruit is not infrequently compounded into a curry, and in consequence of a case where the effect was injurious an examination was made resulting in the extraction of two glucosides, the one resembling *colocynthin* in some of its reactions.

To accompany a collection of botanical books and portraits illustrating the history of plant classification, arranged in the botanical gallery of the Natural History Museum, South Kensington, the keeper of the department has drawn up a short guide explaining the chief features of the various exhibits. Among early works may be seen the "Materia Medica" of Dioscorides dated 1499, Brunfels's "Herbarium," Gerard's "Herbal," and Bauhin's "Prodromus." The collection also includes a copy of Linnæus's "Systema Naturæ," and volumes by de Jussieu, de Candolle, and more recent noted systematists.

The botanical series of Memoirs of the Department of Agriculture in India is inaugurated with a volume giving an account of the early stages in the development of the haustoria of *Santalum album*, by Mr. C. A. Barber. The haustoria arise on the root of the seedling as early as the lateral rootlets, and independently of any stimulus due to contact with foreign bodies; they continue to form on the young rootlets, providing the most important absorbing organs. The chief features are the central core or nucleus, and the external clasping folds; when the haustorium comes into contact with an inorganic body, a succession of nuclei and folds may be produced. Frequently a strand of glandular cells is developed that assists in penetration.

The number of Engler's *Botanisches Jahrbuch* issued in August, vol. xxxviii., part ii., contains a series of determinations of new African plants, forming the twenty-ninth fascicle of "Beiträge zur Flora von Afrika." The volume opens with a short list of Cyperaceæ, prepared by the late Mr. C. B. Clarke. Dr. R. Schlechter, who contributes a quota of Orchidaceæ and Burmanniaceæ, alludes to the rarity of species of the latter order; five species are now added, of which two, allied to Thismia, are placed under new genera, Afrothismia and Oxygyne. The Compositæ and Labiatæ are determined by Drs. M. Guerke and O. Hoffmann. The paper in the supplement on the Cornaceæ deserves attention, if only for the discussion of the aberrant genus Garrya. The writer, Mr. W. Wangerin, restores the order Garryaceæ, and places it near the Betulaceæ and Salicaceæ. Evidence is also adduced for separating the genera Alangium, Nyssa, and Davidia from the Cornaceæ.

The new series of archæological monographs to be issued by the Bureau of American Ethnology starts with a description of the antiquities of the Jumez Plateau, a mountainous region in New Mexico lying west of the Rio Grande del Norte. This country supported at one time a numerous population, but on account of climatic changes it was abandoned some six or eight centuries ago. It abounds in the ruins of ancient settlements, which fall into two classes—cliff-dwellings, some of which are artificial, some natural, and the pueblos or many-chambered houses inhabited by several families. One of the latter contains upwards of six hundred rooms, and they were usually erected in situations capable of defence. The popular theory that the cliff-dwellings were the work of the ancestors of the present Indian tribes must now be abandoned, partly because there is no resemblance between the art of the two races, and, secondly, the ancient people were dolichocephalic, while the existing inhabitants are brachycephalic. This older race, of whom little is as yet known, was skilled in various arts, particularly that of mortuary pottery, and the finds from their settlements include weapons and implements of stone, bone, and shell, with some rude stone images, fire and medicine stones, all of which are illustrated and described by Mr. E. L. Hewett.

THE reports of H.M. Inspectors of Mines show that the use of coal-cutting machinery in British collieries continues to increase. In 1903 there were in use 643 machines, 755 in 1904, and 946 in 1905. These 946 machines produced more than eight million tons of coal, and as the total output of Great Britain was 236 million, there is still a wide field open for the introduction of coal-cutting machines. Of the machines in use, 500 were driven by compressed air and 446 by electricity.

THE most striking paper in the *American Journal of Science* for October is that by Mr. A. L. Day and Mr. E. S. Shepherd on the lime-silica series of minerals, in which the authors give the results of a study of mineral and rock formation by direct measurement at the temperatures at which the minerals combine and separate, like the solutions of ordinary chemistry under ordinary conditions. The entire series of mixtures of lime and silica have been prepared and studied. The only serious attempt hitherto made to determine the constitution of this series of minerals is that of Boudouard (Journal of the Iron and Steel Institute, 1905, p. 339), but the method he used is shown to be a very inaccurate one.

THE summary report of the Geological Survey Department of Canada for 1905 (Sessional Paper, 1906, No. 26) gives a concise account of original investigations carried out in the field and at the Ottawa headquarters with the object of increasing the knowledge of the mineral wealth of Canada. The staff of the Survey numbers sixty-seven, and under the direction of Dr. Robert Bell a large number of important explorations and surveys were carried out during the year. Dr. Bell himself gives an account of the cobalt mining district on the Timiskaming and Northern Ontario Railway. Specimens of pure silver weighing from a few pounds up to twenty pounds or more have been obtained in a number of the mines. Nuggets of mixed silver and calcite, weighing upwards of 100 lb., are exhibited in some of the mining offices in the district.

THE seventy-third annual report (1905) of the Royal Cornwall Polytechnic Society contains, among other papers of scientific interest, a verbatim report of a lecture entitled "An Early Chapter in the History of Cornwall," which was delivered by Sir Norman Lockyer at Penzance in April last. Sir Norman explained that the work he has recently inaugurated, dealing with the *raison d'être* of the stone circles and other stone monuments of the county, has barely commenced; much more remains to be done, but the evidence so far obtained, that their erection depended upon the utilitarian necessity for regulating the calendar by observations of celestial timekeepers, is so remarkably conclusive that it is very desirable that many other workers should carry it on until the whole of these monuments have been considered in all their details. The results obtained in Cornwall amply confirm the similar conclusions obtained from the study of Egyptian temples, and are themselves confirmed by the latter. A number of slides showing Lady Lockyer's photographs of the principal circles, *e.g.* "The Hurlers" and "The Merry Maidens," were exhibited on the screen, accompanied by maps and tables showing the wonderful similarity of purpose of sight-lines which, owing to varying local conditions, are themselves dissimilar in their directions.

WE have been favoured by Mr. F. Berwerth with a reprint of an interesting paper he has contributed to *Tschermaks Mitteilungen* (vol. xxv., part iii.) on the meteorite of Kodaikanal, Palni Hills, Madura district, Madras. This meteoric iron is of special interest in that, on etching, it exhibits a crystalline mass of large octahedral iron grains between which globular masses of silicates of unusual character have separated out. The general structure of the iron is thus of a porphyritic type. The ratio between the iron mass and the silicates is approximately 10 to 1. Careful examination has shown that the silicate segregations are of two kinds, a spherolithic ground mass and glassy globules. The former consists of weinbergite, diopside, bronzite, apatite, and chromite, and the latter of a glassy magma containing suspended bronzite and chromite. The new silicate compound to which the author gives the name of weinbergite is found by analysis to have the composition represented by the formula $NaAlSiO_4+3FeSiO_3$. Mr. Berwerth also sends a reprint of his paper on artificial metabolites contributed to the Vienna Academy of Sciences (*Mathem. naturw. Klasse*, vol. cxiv., part i.), in which he gives the results of experiments made with a small plate of the Toluca iron to ascertain the accuracy of his view that the great group of crystalline-granular meteoric irons are octahedral irons re-crystallised in consequence of heating in a solid condition. The plate, 5 mm. in thickness, was embedded in powdered charcoal in a graphite crucible and heated for seven hours at a temperature of about 950° C. The results obtained induce the author to propose to term the re-crystallised meteoric irons "the group of the metabolites." With the increasing knowledge of the physical characters of the artificial iron-nickel alloys, fresh light will be thrown on the various forms of iron metabolites.

A CHEAP edition (price 7*s*. 6*d*. net) of M. Vallery-Radot's "Life of Pasteur," translated from the French by Mrs. R. L. Devonshire, has been published by Messrs. A. Constable and Co. The original English edition appeared in two volumes five years ago, and was reviewed at length in NATURE of December 5, 1901 (vol. lxv., p. 97). As Pasteur's son-in-law, M. Radot had exceptional opportunities for preparing this biography, and his work is a faithful and fascinating history of Pasteur's scientific life and aspirations.

OUR ASTRONOMICAL COLUMN.

A NEW FORM OF PHOTOMETER.—In the attempts which from time to time have been made to photograph the solar corona without waiting for a total eclipse of the sun, the intensity of the atmospheric halo about the sun's disc has played an important part. Obviously the most suitable locality for these attempts would be where the atmospheric glare is least intense. With this in view, MM. Deslandres and Bernard have designed a photometer having for its special aim the determination of the intensity of the circumsolar light.

The apparatus consists of an equatorially-mounted telescope tube having affixed to the narrower end, which is directed towards the sun, an opaque disc which just occults the actual solar disc. At the other end of the tube the light is received on the one half of a small piece of ground-glass, the other half of which may be evenly illuminated by the light from a standard osmium lamp. By varying the distance of the latter the illumination of both halves may be equalised, and the distance of the lamp read off on a suitably divided scale.

M. Deslandres suggests that this photometer will be found extremely useful in determining the most suitable localities for solar observations of all kinds. By the interposition of violet glass the relative intensity of the glare which would affect spectroheliograph observations might be determined, and, similarly, the substitution of red glass would show the suitability of the atmosphere for the experiments on the photography of the corona, in which it is proposed to utilise the red rays (*Comptes rendus*, No. 3, 1906).

A Novel Planisphere.—In collaboration with Mr. G. P. Serviss, of the Brooklyn Institute, Mr. L. Barritt, of 150 Nassau Street, New York, has recently published a planisphere which should prove very useful to amateur astronomers, teachers, and others who are interested in celestial phenomena.

As regards the constellations the apparatus is similar to other planispheres, but, in addition, it allows the user to determine the approximate positions of the planets, the sun, and the moon at any time and date. This is effected by having the ecliptic divided up into degrees, so that small discs representing the various bodies may be affixed at any indicated point in their respective paths. A set of tables accompanying the apparatus shows where each disc is to be affixed at different dates during the next twenty years, and thus by placing these discs as directed, and rotating the circular card for the current time and date in the usual way, the actual position of each celestial body may be seen at a glance. The observer may also, of course, determine approximately the times of rising and setting for each body on any date during the period 1906–1925. The price of the complete apparatus is five dollars.

The Oxford University Observatory.—Prof. Turner's report of the work done at the Oxford University Observatory during the period May 1, 1905, to April 30, 1906, directs attention to the fact that the observatory staff is almost entirely engaged upon the proof-reading of the Oxford section of the Astrographic Catalogue, and that, in consequence, it does not seem advisable to undertake any new piece of observational work. The first of the eight volumes of the catalogue is now practically ready, and the printing of it has been commenced. It contains the measures of 66,000 star-images on the 160 plates with centres of declination $+31°$.

The report also contains brief accounts of the eclipse expedition to Aswan, and of the meeting of the Solar Research Union at Oxford in September, 1905.

THE PONCA SUN DANCE.[1]

Few Amerindian ceremonies have attracted more attention than the Sun Dance. It is found among the Arapaho, the Cheyenne, the Dakota, and the Blackfeet; and now we have a record of the rite among the Ponca. Unfortunately this account of the dance is far from complete; Mr. Dorsey was able to witness it once only, in addition to which it had become a theatrical performance for the benefit of white visitors.

The ceremony is held in June or July, and the name means "Sun-seeing-Dance," *i.e.* a dance which the sun witnesses; the priests are medicine-men who have fasted four times during previous ceremonies; these "thunder-men" select the dancers, and it is a considerable honour to be thus chosen, for each dancer is held to bear a part of the sufferings of the tribe. Camp is moved on the day before the dance, the time of the ceremony having been previously proclaimed; continence must be observed by all who take part.

Five days in all were needed when Mr. Dorsey was present, of which the first was taken up with preparations. The forenoon of the second day was occupied with a mimic combat, after which the ceremonial huts were removed into position by female relatives of the priests. The supposed enemies in the fight were the men who left the camp to "spy the centre-pole" of the dance lodge; while the lodge was being erected, the centre-pole was felled and brought to the camp; at the same time four altars were prepared, one for each hut. The third day opened with a race to the centre-pole, which was still outside the camp, lying crosswise to the sun. It was then painted and raised into position; an altar was prepared, and before it was finished the dancers entered the lodge, bringing a painted buffalo skull. Prayers were offered by the dancers, and the dance began; it was continued at intervals during the whole of that day and night, and on both the fourth and fifth days the sunrise performance was specially important; on several occasions the priests made before the performers what seem to be hypnotic passes. Until the final dance all fasted; female relatives then brought food to the dancers, and the chief laved the mouth and sprinkled the head of each dancer with water. The last ceremony was the offering of a portion of skin, cut from the shoulder of each dancer, to the sun, by placing it at the foot of the centre-pole.

Raising the Centre Pole on the third day of the Ponca Sun Dance.

All the participants were painted more than once, and careful descriptions of them are given, together with coloured plates of the more important. The remainder of the thirty-five plates show the altars and various scenes of the rites.

Mr. Dorsey was struck by the comparative simplicity of the ceremony, but he suggests that it may possibly be a case of degeneration. The centre-pole represents an enemy, and in its fork is supposed to be the Thunder Bird's nest; the altar is the sun or fireplace, which existed in the beginning; the buffalo bull came from the interior of the earth. The altar consists of the sage plant, symbolical of the people, the sun, and the buffalo. No satisfactory account of the origin of the dance could be obtained, and Mr. Dorsey offers no suggestion as to its significance. It has, however, been dealt with in the annual reports of the Bureau of Ethnology (vol. xi.) as regards the Dakota, and vol. iv. of the Field Columbian series contains a long account of the Arapaho dance by Mr. Dorsey himself. The statement on p. 88 of the present report that torture is not found among the Arapaho appears to be directly contradicted by the latter report (pp. 179 *et seq*).

N. W. T.

[1] "The Ponca Sun Dance." By G. A. Dorsey. Field Columbian Museum, Anthropological Series, vii., ii. (Chicago, 1905.)

GEOLOGICAL STUDIES IN SOUTH AFRICA.

THE Report of the Geological Survey of the Transvaal Mines Department for 1904 (Pretoria, 1905, price 7s. 6d.) is a folio volume, issued at a very moderate price. It contains twenty-three plates, from which our figures are reductions, and two large coloured maps, the latter being conveniently placed in an envelope

FIG. 1.—Weathering of granite on characteristic kopje near Chuniespoort, N. Transvaal.

at the end. The cessation of topographical work in the country must in future hamper systematic geological mapping, and the Geological Society of South Africa has already approached the Colonial Secretary in Pretoria on the subject (Proc. Geol. Soc., S. Africa, 1906, p. liv). It might be thought that military considerations alone would be sufficient to place an accurate map among the first requirements of the colony.

The director of the Survey, Mr. Kynaston, describes a traverse of the country between Pretoria and Pietersburg, during which he visited the remarkable Salt Pan, some twenty-five miles N.N.W. of Pretoria. This lake, which is about as salt as the Dead Sea, lies in a circle of granite hills, 250 feet below their crest, and about 200 feet below the general level of the country on their outer side. Its salts include 72·70 per cent. of sodium chloride and 27·25 per cent. of sodium carbonate. Except that an explosive origin has been suggested by Cohen, no adequate explanation of the hollow is as yet forthcoming. Considering, moreover, the antiquity of the last volcanic eruptions in this area, a crater of explosion ought to have become long ago filled up by products of denudation. One feels tempted to ask if it is possible for the materials filling an igneous neck to sink back long after they have solidified. Could the fragmental materials so common in South African pipes behave in this way? Mr. A. W. Rogers has cited cases where the weathering of these necks has caused hollows at the surface; but the Salt Pan near Pretoria is 200 feet to 250 feet in depth.

FIG. 2.—Weathering of Permian glacial conglomerate, showing the original boulders, Toitskraal, Elands River.

On Mr. Kynaston's return journey from the mouth of the Elands River, the most northerly known outliers of the glacial Dwyka conglomerate were traversed (Fig. 2). The boulder-bed, as described in supplementary notes by Mr. Mellor, does not seem more than 50 feet thick, and is associated with sandstones. It was laid down, as in other cases, on a land-surface eroded by streams, and the original topography is now being revealed by the denuding action of the Elands River and other agents.

Mr. A. L. Hall (p. 37) describes the geology of the tin fields north-east of Pretoria, where the ore occurs promisingly in a rock of greisen type; and Mr. Mellor (p. 45) deals with the picturesque area of Rhenoster Kop. The Permian glacial striation in this district, seen on the uptilted Waterberg Sandstones, has an almost constant direction of S. 33° E. After other papers on special districts, Mr. S. M. Tweddill describes some of the rocks collected, and has been allowed a handsome series of photographic plates, showing his thin slices in ordinary light and with crossed nicols. The latter figures are produced by the three-colour process, but it is questionable if much is gained by them. Colour-photographs of the sections in ordinary light would probably be more effective, and would equally serve to confirm the author's determinations. The "acicular crystals of Clay-slate" in the description of Plate XV.*a* puzzle us not a little, especially as in the text on p. 76 the "stellate forms" are similarly said "to be clay-slate." In a country where everything depends on field-relations, where the scale of phenomena is large, where the mention of a new discovery suggests comparison with something else a thousand miles away, one probably expects too much from the petrographer. One can imagine the prospector, who has returned bronzed and muscular after his days upon the veld, reading the bare descriptions of rocks with a certain irritation. If they could be inserted in connection with the account of the masses in the field, their true interest would at once appear, for the South African of all men has a pleasurable keenness for geology.

This fact is well attested by the publication of the discussions that take place at the meetings of the Geological Society of South Africa (Proceedings of the Society for 1905), and by the considerable space given to written criticisms and replies. The Transactions would be very incomplete without these additions, which may be commended to the notice of many publishing societies in our islands. Dr. F. W. Voit, for instance, read a paper (Trans. Geol. Soc., S. Africa, vol. viii., p. 106) on September 4, 1905, entitled "Preliminary Notes on 'Fundamental Gneiss Formation' in South Africa," in which he claimed that the gneisses of the Limpopo Flats correspond to the fundamental formation of the continent of Europe. At the meeting three members contributed structural and mineralogical details from their own notebooks (Proc. for 1905, p. lvii), recorded with an altogether admirable clearness of expression. The full paper was read on October 30, 1905 (Trans., p. 141). Dr. Voit points out, in agreement with his predecessors, that the main granite is intrusive in the Swaziland beds, "long drawn out lenses of quartzite, chlorite, actinolite, and other schists, swimming, as it were, in a granite magma." But the Limpopo gneisses are, for him, still older, and he looks forward to finding the granite intrusive in them also. By the way, we must object to his using, on p. 145, the term "interbedded igneous sheets" for intrusive masses that have come up along planes of fracture in the granitoid mass. On November 20 (Proc. for 1905, p. lxv) the author sent in a letter in which he supported his views by quoting Mr. Anderson's observations in Natal, and on December 18 Messrs. Sandberg and Jorissen made a reply to Dr. Voit, in which Credner is cited as their authority, in a manner that almost recalls the Wernerian discussions of a hundred years ago. The bottom, if we may speak irreverently, is here knocked out of the "Urgneissformation" with considerable vigour, and the references to European literature, though disfigured by a few misprinted place-names, add zest to a spirited discussion.

Dr. Hatch, in his presidential address (Proc. for 1906, p. xxv), refers to Dr. Voit's suggestion, and remarks that the Limpopo gneiss may be only "a sheared or metamorphic portion of the granite." The address, on the geological history of the South African formations, covers ground on which much has been written, and on which silence might now conveniently be preserved, until some of the critical questions touched on can be decided by new and indubitable evidence.

Mr. J. P. Johnson (Trans. Geol. Soc., S. Africa, vol. viii., p. 135) describes and illustrates primitive stone implements from the plateau of the Victoria Falls. Mr. Lamplugh directed attention to these (Report of Brit. Association for 1905, p. 300) as being possibly older than the excavation of the Batoka Gorge, and Colonel Feilden has already urged their importance upon the readers of this Journal (Nature, vol. lxxiii., p. 77). We trust that we have said enough to show that geology in the best sense, as a critical and comparative science, flourishes in the dusty and inchoate city of Johannesburg. Probably there is no part of the world where geological phenomena play so large a part in the thoughts of cultivated men.

Grenville A. J. Cole.

AËRONAUTICS AND METEOROLOGY.

The fifth conference of the International Commission of Scientific Aëronautics was held at Milan, and commenced its sittings on October 1. The conference was formally opened by Prof. Celoria, representing the committee of the Milan Exhibition, M. Gavazzi, representing the municipality, Prof. Palazzo, and Prof. Hergesell, president of the commission.

A large number of representatives attended the conference; Mr. Dines represented the Meteorological Office, and the other English members were Major Baden-Powell, Mr. Patrick Alexander, and Mr. Charles Cave.

The first meeting for the discussion of scientific questions was held in the afternoon of October 1 under the presidency of General Rykatchew and Prof. Palazzo. Prof. Hergesell read his report, and various questions were discussed relating to the business of the conference. In the evening the committee of the exhibition entertained the members of the conference at dinner.

On October 2 the members went to Pavia, where M. Gamba showed them over the observatory, and liberated two *ballons-sondes*. After visiting the university the members were entertained at luncheon by the municipality of the town.

The second meeting was held on October 3 under the presidency of Prof. Assmann and M. Teisserenc de Bort. Dr. Erk urged the necessity of making ascents in the neighbourhood of the Alps for studying local phenomena, such as the Föhn. M. de Quervain explained a method of using small pilot balloons for determining the winds at different altitudes; small india-rubber balloons were liberated and watched with a theodolite; assuming that the balloon ascended with uniform velocity, it was possible to determine its course from one station. Prof. Hergesell spoke very highly of the method which he had used at Strasburg and elsewhere, and mentioned that in Spitsbergen he had watched the balloon to a distance of 80 kilometres. M. Ebert explained his method of determining the deformation of the electrical equipotential surfaces in the neighbourhood of a balloon, and exhibited a new apparatus for measuring the ionisation of the air.

The third meeting was held in the afternoon of October 3 under the presidency of Colonel Vives y Vich and Mr. Cave. General Rykatchew and M. Riabouschinsky read the reports of the work of their observatories. M. de Quervain read a paper on the thermal inertia of thermometers used in kite and balloon ascents. In connection with this an important discussion took place on the relative value of *ballons-sondes* and kites for the study of the air up to 5000 metres or so. Prof. Hergesell strongly advocated the use of balloons in preference to kites; General Rykatchew and M. Berson thought that kites were far more suitable.

Mr. Rotch read a paper on the ascents of *ballons-sondes* in America, and General Rykatchew read a paper on the temperature gradient as observed at Pavlovsk.

Prof. Hergesell explained a method of recording vertical movements in the atmosphere by attaching a "log" to balloons. M. de Quervain gave proofs of the reality of the isothermic zone.

In the morning of October 4 the members visited the aëronautical section of the exhibition, and *ballons-sondes* were liberated by M. Gamba, M. Teisserenc de Bort, and Prof. Hergesell. In the afternoon the fourth meeting was held under the presidency of Mr. Rotch and M. Scheimpflug. General Rykatchew described M. Kouznetzow's method of determining the height of clouds at night by means of a search-light, and gave some of the results obtained at Pavlovsk. M. Köppen, M. Teisserenc de Bort, and Mr. Rotch observed that the method had been used at Hamburg, in France, and in America. Mr. Alexander read a communication on the forms of propellers for flying machines.

M. Moedebeck urged the necessity of having descriptive charts for aëronautical purposes that would show, for example, dangerous places such as those where there were wires carrying currents at a high potential. M. Scheimpflug gave an account of his method of making maps from photographs taken from balloons. M. Teisserenc de Bort read a report on the necessity of extending the number of stations at which ascents are made, and Prof. Hergesell said he would make every effort to carry out this suggestion. Prof. Palazzo said he hoped that he would shortly be able to establish a kite station on Mount Etna. M. Hinterstoïsser then gave a lecture on aëronautics from the points of view of science and sport, and illustrated it with lantern-slides.

On Friday, October 5, M. Mangili, president of the committee of the exhibition, entertained the members in an excursion by steamboat on the Lago Maggiore. It had been proposed to make kite ascents, but this proved impossible owing to want of wind. Prof. Hergesell attempted to demonstrate his method of dropping *ballons-sondes* at sea. Unfortunately his apparatus had not arrived, and the *ballon-sonde* sent up did not come down as soon as was intended, and was last seen at a great height and still ascending.

The fifth meeting was held on October 6 under the presidency of M. Koppen and Mr. Dines. Prof. Hergesell explained his method of making balloon ascents at sea. Two balloons are used, one being held by a fastening that can be opened electrically; a small battery is sent up with the instruments, and the electromagnetic release can be worked by a contact actuated by the barometer, or by a contact on the recording drum of the instruments; the latter has been found the better method in practice. One balloon being released, the system slowly falls, until a float hanging below the instruments touches the water; the balloon is inflated so as to hold the instruments above the sea, the float alone touching the water. Both M. Teisserenc de Bort and Prof. Hergesell stated that they are designing a method by which instruments may be dropped from *ballons-sondes* by wireless telegraphy; the former also hopes to be able to detach kites by the same method. M. Teisserenc de Bort thought that for work on land, when for any reason the height of the ascent had to be limited, his method of using paper balloons was to be preferred.

Baron von Bassus exhibited an instrument for reading the records of kite and balloon ascents. He claimed that his instrument would give readings with great accuracy, and that simultaneous points on the different curves could be obtained easily. He thought that by its use small inversions of temperature could be detected that were often overlooked.

M. Teisserenc de Bort then gave an account of the expedition to the equatorial regions of the Atlantic organised by Mr. Rotch and himself. Extremely good results had been obtained, and, contrary to expectation, it was found that in the upper air far lower temperatures were recorded over the equator than at corresponding heights in temperate latitudes. Over the equator the isothermal zone did not seem to exist, but the temperature went on decreasing up to the highest points reached. At heights of 13 to 14 kilometres temperatures had been found as low as $-80°$ C.

At the concluding meeting, held on the afternoon of October 6, various resolutions were passed relating to future conferences. It was resolved that in future the meetings should be held every three years, and that, so far as possible, they should be restricted to three days. Papers relating to instruments and to methods of observation should have precedence over those dealing with the results of observations. It was also agreed that, instead of the present arrangement of having one international day each month, there should be three days together four times a year for the purpose of the international ascents. This arrangement should come into force in March, 1907.

The president then read telegrams that it was proposed to send to the King and Queen of Italy, to the Spanish Minister of War and others, who had taken an interest in the work of the commission. After several speeches the conference then closed.

On Sunday, October 7, an aëronautic *fête* was held in the grounds of the exhibition, and eight balloons made ascents, several members of the conference being passengers. The majority of the balloons descended in the neighbourhood of Pavia.

MODERN NEEDS IN UNIVERSITIES.[1]

UNIVERSITIES in America and Canada are paying more and more attention to our own language and classics, and less and less to Latin and Greek. Not that the latter are excluded, but they no longer outrank other branches of study. Their doors are open to the new forces of the day, and they have at their heads a body of remarkably able and zealous men who not only keep the universities foremost as progressive educative agencies, but whose potent voices are heard upon public questions, as leaders of the higher ideals in politics and national affairs. Much can also be said of those occupying similar positions in Scotland. St. Andrews has just erected a new chemical laboratory for research, Dundee is about to erect such schools as we are to-day to open for Edinburgh. We all know where Glasgow stands in modern branches of education. Aberdeen has just been supplied with new buildings efficiently equipped for the study of science and medicine. No less than eleven new chambers have been assigned to modern studies, to meet pressing demands. The University of London recently separated economics and engineering from arts, and established separate faculties. It is also announced that owing to the unrivalled facilities found in the metropolis, it has to be prepared for the advent of new schools of practical study or research. In the new Universities of Liverpool, Manchester, Birmingham, Leeds, and Sheffield, modern studies are to be paramount. They are to resemble the American type. Harvard University has just been left 800,000*l.* sterling for an institute of technology, but as one of the foremost of such schools is in Boston, she has proposed union with that, and offered if needed new buildings, as part of the University. McGill University, Montreal, has just had handed over to her the agricultural college built by Sir Wm. Macdonald at a cost of 600,000*l.* Thus the millions are now being devoted to science and practical studies, theology and classics being in the opinion of donors already amply provided for. This betokens a steady march forward from the policy of the past, not that it is desirable to exclude any of the former university courses, but there should be added others needed to guide and advance the new knowledge which is creating new conditions.

I judge Scotland to be as far and as happily advanced beyond England in university as she is in elementary public-school education. Her universities are not for a class, but for the people, stirring hives of Democracy. But Scotland may expect the new universities of the five principal English cities to approach nearer to American institutions in character, for their educational atmosphere and aims are very different indeed from those of Oxford and Cambridge, and similar to those of the great American cities. They will be modern universities, fully equipped for the work of to-day. Scotland has to keep marching on. The progress of scientific departments in British universities, considerable as it has recently been, of which the schools we are about to open here to-day are gratifying evidence, yet has not kept pace with the startling progress of science itself and the wonderful discoveries which threaten to revolutionise human conceptions. The discovery of argon by Rayleigh, Becquerel's rays, Röntgen rays, uranium, and, finally, the Curies' radium, threatens to relegate the old atomic theory itself to the list of discarded "creeds outworn," except that science has no creeds. She has only theories and opinions based upon phenomena, all held lightly because subject to progressive discoveries that may be revealed through her unceasing search for knowledge. Science has no preconceived dogmas; she has but one end, the pursuit of truth. It was long claimed for the classics that they alone appealed to the imagination, while dry, prosaic science was incapable of doing so. This is a grievous mistake. The recent discoveries that have startled the world are sublime, and appeal with intense force to the imaginative faculties of man. The scientific man of to-day lives in an atmosphere of wonder, arousing all his higher powers and compelling reverence. At each startling revelation he feels "as some watcher of the skies when a new comet swims into his ken."

The older branches of learning in our universities may well welcome the newer branch, cap in hand, not only as the foundation of material progress, but also as one of the very highest agencies in the imaginative domain. It is the man of science in our day

> "Who can extract each particular virtue from the sun,
> And teach dull nature what her forces are."

This mighty force of our day—science—has hitherto been the Cinderella of the sisterhood of knowledge, but the Prince has appeared at last and taken her by the hand. It is now the turn of the elder sisters to greet the once neglected princess. She will more than justify the millions which are now being showered upon her in the most progressive lands. Thus has the university developed to the present all-embracing type through the successive reigns of scholasticism, theology and ancient classics, always

[1] From an address delivered by Dr. Andrew Carnegie at the opening of new buildings for the natural philosophy and engineering departments of the University of Edinburgh on October 16.

behind the age, conservative in the highest degree. Science has arisen and established her claim to equality. We have long had the Republic of Letters; we now hail the Republic of Knowledge. The ceremony of to-day bears testimony to the growing power of Edinburgh University; her prominence as a teacher of one of the noblest of all professions, perhaps the one in which those who practise it devote gratuitously a greater part of their time and attention than the members of any other profession, is not likely to be lost. On the contrary, all evidence to-day leads to the opposite conclusion. She is to remain famous for her medical school, and is now also destined to increase her reputation as a scientific instructor through the possession of the increased facilities now provided. The physical laboratory and engineering school, which, with the cordial cooperation of the municipal authorities, have been so ably secured by the principal and the University Court, are the necessary tools which will enable her to extend her work in these important branches of knowledge. They mark an epoch in her long career, and are to testify to future generations that the officials in charge of her work in the beginning of the twentieth century were alive to the duty of keeping her abreast of the new knowledge, of enlarging the field of her activities, and of welcoming the development of the scientific and so-called practical courses, thus keeping her, true to her high mission, in the front rank in all branches. I heartily congratulate the University of Edinburgh upon to-day's acquisitions, from which I hope are to come worthy successors of Faraday, Lockyer, Becquerel, Curie, Rutherford, Rayleigh, Ramsay, Mendeléeff, Kelvin, Tait, and others, to give her such fame in science as the names of Hume, Carlyle, Dugald Stewart, Hamilton, Chalmers, Simpson, and others have already conferred upon her in other fields of knowledge.

AGRICULTURAL NOTES.

Condensed Vegetable Milk.—Mr. T. Katayama, a writer in a recent issue of the Bulletin of the Agricultural College, Tokyo (Bulletin, College of Agriculture, Tokyo Imperial University, vol. vii., 1, April, 1906), describes the preparation of condensed vegetable milk, a product which, though not yet in commerce, would appear to have possibilities for tropical countries. The Japanese prepare vegetable milk from soy beans by soaking, crushing, and boiling in water. The liquid obtained is said to be very similar in appearance to cows' milk, but it differs widely in composition. The average composition of soy milk is given as:—water, 92·5 per cent.; protein, 3·02 per cent.; fat, 2·13 per cent.; fibre, 0·03 per cent.; nitrogen-free extract, 1·88 per cent.; ash, 0·41 per cent. To this material Mr. Katayama added sugar and a little dipotassium phosphate, the latter to prevent protein separating out; he then evaporated the mixture, and obtained a condensed milk. This product is described as having a yellowish colour, an agreeable taste like cows' milk, but a slight odour of beans. It is recommended for culinary purposes as a cheap substitute for ordinary condensed milk.

Cherry Leaf Scorch.—Mr. E. S. Salmon, mycologist at the South-Eastern Agricultural College, Wye, directs attention (Journal, South-Eastern Agricultural College, Wye, No. 15, July) to a danger which threatens the cherry growers of Kent. For the past few years the cherry leaf scorch (*Gnomonia erythrostoma*) has been gradually obtaining a footing in the county. In 1901 Dr. Carruthers pointed out the dangerous character of this disease, but his warning, we are informed, was "wholly disregarded." During the past spring Mr. Salmon visited all the districts in which diseased trees were reported, and he publishes a map showing that leaf scorch now occurs in many orchards from Sevenoaks on the west to Selling on the east, and from Tunstall on the north to Pluckley on the south. It has thus already reached the borders of the Sittingbourne and Faversham districts, and with the next favourable season it will probably invade the valuable orchards in these important cherry-growing centres. The disease is easily detected. The young leaves are infected in spring, and in summer the leaves shrivel up and look as if they had been scorched. They do not fall off in winter, but persist until the following season, forming plague centres from which the young leaves are infected as the buds open. The only thoroughly effective remedy is the collection and burning of dead leaves; it is a costly process, but by this means the disease was banished by Prussian fruit growers after it had devastated some of their best orchards. Mr. Salmon also recommends the use of Bordeaux mixture in spring to render the young leaves proof against infection, and he is experimenting with this mixture in orchards near Pluckley; but he remarks that unless growers cooperate in fighting the disease there is little chance of getting rid of it.

Prussic Acid in Fodder Plants.—In vol. i., part iii., of the *Agricultural Journal of India*, Dr. J. W. Leather gives some particulars about the occurrence of prussic acid in fodder plants. It is well known to the Indian ryot that a feed of green *jowari* (*Andropogon Sorghum*) occasionally proves fatal to cattle, while in recent years stock-owners in this country have now and again been startled by cases of poisoning arising from the use of imported beans. It is only within the past year or two that the cause of such mysterious cases of poisoning has been explained. Certain plants contain glucosides which, when acted upon by a particular enzyme, produce prussic acid. Of such plants Dr. Leather mentions, in addition to Andropogon, flax, the two common beans *Dolichos lablab* or *val* and *Phaseolus lunatus*, the Rangoon bean, and the tapioca plant. The ferment is present in the plant, but, except conditions favourable to its activity occur, no prussic acid is formed. Hence it happens that a food, which is usually quite wholesome, may suddenly develop poisonous qualities. Dr. Leather analysed some green *jowari*, which had been fed to cattle with fatal results, and found in it 1·25 grains of prussic acid per lb. of green fodder. Analysing the same crop a month later, he found that the poison had diminished to 0·75 grain. This is in accordance with the ryot's experience; he is most afraid of young *jowari*. The leaves were found to contain much more prussic acid than the stalks, and ten times as much as the inflorescence.

Artificial Manures for India.—In connection with the possible introduction of a sulphuric acid industry into India, Mr. F. G. Sly, I.C.S., contributes a note on mineral fertilisers to the *Agricultural Journal of India*. He quotes experiments which show that soluble phosphatic manures would be of great value in Bengal, and he indicates that a demand for such manures may arise in India before very long. The native sources of mineral phosphates are not particularly promising, but it is suggested that Christmas Island phosphate, which can be landed in Calcutta for about 50*s.* per ton, would supply suitable raw material for the Indian manufacturer of superphosphate of lime.

Agriculture in Egypt.—The bi-monthly Journal of the Khedivial Agricultural Society of Egypt has given place to a year-book, and if subsequent issues maintain the promise of the first number former readers of the journal will appreciate the change. The first (1905) volume of the new year-book, which has recently reached us, is a well-printed, well-illustrated royal octavo book of 277 pages. It comprises two sections, the first contributed by officers of the society, the second by members of the staff of the Khedivial School of Agriculture. The greater part of the volume is devoted to the cotton crop. The first paper, by Mr. F. C. Willcocks, deals in detail with the cotton-worm, the larva of the moth *Prodenia littoralis*, which appeared in Egypt about forty years ago, and for thirty years has done serious damage. The Government has now adopted stringent measures in the hope of ridding Egypt of this plague. All cultivators are required to notify its appearance, and to collect and destroy the eggs at once. The larva damages the plant chiefly by feeding on the under-surfaces of the leaves, but it also attacks the buds and young bolls. This insect is very prolific, and there may be seven generations in a season. In a second paper Mr. Willcocks gives a very complete account of the cotton boll-worm *Earias insulana*, which is the destructive boll-worm of Egypt as well as of India. For this pest no effective remedy has yet been found. The cotton cut-worm *Agrotis ypsilon* is also described and figured. The secretary of the society, Mr. G. P. Foaden, writes a general article on the selection of cotton seed, and directs attention to the methods in use in the United States of America. Of the other contributions, the most important are those contributed by the society's botanist, Mr. W. L. Balls, on the physiology of a simple parasite, and the sexuality of cotton. The first paper gives an account of a damping-off fungus which produces a disease among seedlings known to the American cotton grower as "sore-shin." Mr. Balls attributes the failure of seedling cottons in Egypt chiefly to the attacks of this fungus. The actual damage done varies greatly in different seasons. Weather which is too cold for the young cotton plant is favourable to the parasite, and "sore-shin" is largely a question of temperature. Remedies are now being sought for, and it is suggested that careful attention to the seed-bed might prevent, or at least mitigate, the disease. Mr. Balls's second paper describes some cytological work undertaken as a preliminary to investigations on questions of heredity. The descriptions and drawings of the sex cells, of fertilisation, and of the seed should prove of interest and value to economic botanists engaged upon the improvement of the cotton plant.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—Combined examinations for sixty-six entrance scholarships and various exhibitions at Pembroke, Gonville and Caius, King's, Jesus, Christ's, St. John's, and Emmanuel Colleges will be held on Tuesday, December 4, and following days. Mathematics, classics, and natural sciences will be the subjects of examination at all these colleges. Forms of application for admission to the examination at the respective colleges may be obtained as follows:—Pembroke College, W. S. Hadley; Gonville and Caius College, the Master; King's College, W. H. Macaulay; Jesus College, A. Gray; Christ's College, Rev. J. W. Cartmell; St. John's College, Dr. J. R. Tanner; Emmanuel College, the Master, from any of whom further information respecting the scholarships and other matters connected with the several colleges may be obtained.

At a meeting of the master and fellows of Pembroke College, held on October 10, Mr. C. F. Russell, formerly scholar of the college, was elected to a fellowship. Mr. Russell was Bell scholar in 1902, and was bracketed fourteenth wrangler in the mathematical tripos, part i., 1904; he was placed in the second division of the first class in the mathematical tripos, part ii., 1905, and was Smith's prizeman in 1906.

The Gedge prize has been awarded to P. P. Laidlaw, of St. John's College, for his essay entitled "Some Observations on Blood Pigments."

Dr. Hobson, Prof. Larmor, Prof. H. Lamb, Trinity College, professor of mathematics at Victoria University, Manchester, and E. W. Barnes, Trinity College, have been nominated examiners for part ii. of the mathematical tripos in 1907, and Prof. Hopkinson and W. H. Macaulay, of King's College, examiners for the qualifying examination for the mechanical sciences tripos in the current academical year.

W. E. Dixon, of Downing College, and R. Stockman (Edinburgh), professor of materia medica and therapeutics in the University of Glasgow, have been nominated examiners in pharmacology, and T. S. P. Strangeways, St. John's College, and T. Ritchie (Edinburgh), examiners in general pathology for the first part of the third examination for the degree of M.B. in the current academical year.

Prof. J. A. Ewing, King's College, has been nominated an elector to the John Winbolt prize in civil engineering to be awarded in the year 1907; and Dr. Marr and Dr. J. W. Judd examiners for the Sedgwick prize.

Mr. J. J. Lister, fellow of St. John's College, has been nominated a member of the board of electors to the professorship of zoology and comparative anatomy until February 20, 1913, in succession to the late Prof. W. F. R. Weldon.

Mr. J. F. M. Drummond, Caius College, Cambridge, formerly Frank Smart student in botany, has been appointed lecturer in botany at Armstrong College, Newcastle-upon-Tyne.

The annual general meeting of the Association of Teachers in Technical Institutes will be held at the Birkbeck College, London, on Saturday, October 27, commencing at 3 p.m. The chair will be taken by Mr. W. J. Lineham, president of the association.

The Peking correspondent of the *Times*, in a telegram of October 21, announces the abolition of the old system of examinations in China. In partial substitution there will be held an annual examination in Peking of Chinese graduates educated abroad. This year all Chinese holding foreign diplomas were invited by the Board of Education to submit themselves for examination in the subjects they studied abroad. About fifty responded, of whom forty-two were admitted, twenty-three with Japanese degrees, seventeen with American, and one each with German and English. At the examinations nine were granted the Chinese doctorate, twenty-three the degree of Master of Arts, and ten were rejected.

The Bristol Education Committee has placed the Castle Council Schools, embracing large buildings which accommodated more than a thousand children, at the disposal of the governors and principal of the Merchant Venturers' Technical College, Bristol, which was recently damaged seriously by fire. These schools are being fitted with the necessary lecture theatres, laboratories, and workshops with all possible speed, and, meanwhile, other institutions in Bristol are lending their lecture theatres and laboratories. Fortunately a large part of the newest machinery of the engineering department of the college, especially the experimental engines and dynamos, which cost more than 2500*l.*, have been saved, as they were placed in a separate building containing many of the college workshops, and situated at some distance from the one injured by the fire; moreover, the basement of the main building has suffered comparatively little, and in this are the mechanical and electrical engineering laboratories and the engineering workshop.

The new agricultural college and research institute for Madras is now in course of erection. In 1905 a grant to the Presidency by the Government of India of 10,000*l.* per annum, which was subsequently increased to 20,000*l.*, added to the allotments made by the Government of Madras, removed all financial difficulty experienced by the Madras Agricultural Department, and will in time provide the necessary staff. The result of this improved financial position was the decision of Government to close the agricultural college at Saidapet, and establish a new college and research institute adequately equipped with laboratories and class-rooms with a suitable farm near Coimbatore. The staff will consist of an expert agriculturist as the principal of the college, a superintendent of the central farm, a Government botanist, and an agricultural chemist. Ultimately an entomologist and mycologist may be added to the staff, which will combine teaching with research work. The institution is to fulfil a two-fold purpose. Problems connected with the agriculture of the presidency will be studied in the laboratory and the field, while students will be given a general education in all branches of agricultural science. The farm will afford a field for experience and for a test of laboratory research, as well as a training ground for students, in the practical application of science to agriculture.

An addition to the University of Edinburgh Union was opened on October 19 by Mr. Haldane, the Lord Rector. Mr. Balfour, the Chancellor of the University, presided at the ceremony, and in the course of a speech delivered in calling upon the Lord Rector, directed attention to the true functions of a university. No university, he said, can be described as properly equipped which merely consists of an adequate professoriate, adequate lecture-rooms, adequate scientific apparatus, which only satisfies the needs, exacting though they are, of modern science and modern education. Something more than that is required if a university is to do all that it is capable of doing for the education of the young men of this country. A university life which consists only of the relation between the teachers and the taught, between the professor and the student, is but half a university life. The other half consists of the intercourse between the students themselves in the day to day common life, the day to day interchange of ideas and friendships, of commentary on men and things, and on all the great problems which an opening world naturally suggests to the young. A university which is deficient in that is but half a university, and no mere scholastic equipment can satisfy the void which is thus left. Mr. Haldane delivered an address before opening the new Union buildings, and spoke of the value of the corporate life at the University. No university, he remarked, does its work adequately if it does it only by training in the paths of learning. What is wanted is the moulding influence of the spirit of the place—a *universitas* which is a *universitas*, not of the arts, not of the sciences merely, but one which, like the State, moulds the individualities of those who belong to it. It is the spirit of the university as much as the abstract theories that are discoursed of there that tell in the composition of character; and what a significance the university has for the moulding of character. Leaders, he continued, are wanted in the great struggle of the nations to-day, and there is no school for training in leadership so fruitful, so complete, as that training of the university which bases science and art alike on the foundation of the widest culture. It is science and learning that form the true function of the professor; and it is the spirit of the men who are penetrated with the desire to absorb science and learning as things in themselves that communicates itself to those who come in contact and who live with them. That is why it always will be that the spirit of a university, the contact of its fellow-students, the influences which the corporate whole of university life exercises, will be the dominating influence in moulding the character and the quality of the students.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, October 8.—M. H. Poincaré in the chair.—The synthesis of amethyst quartz: researches on the natural or artificial colouring of some precious stones under radio-active influences: M. **Berthelot.** Natural amethyst was decolorised by heating to a temperature of 300° C., and then exposed to the action of radium chloride, the experiment being arranged so that the specimen was not in actual contact with the radium salt, and was not exposed to its emanations. The violet colour slowly returned. Similar results were obtained with violet fluor-spar, and the effects produced are attributed by the author to the reduction and oxidation of manganese compounds. Ordinary fused quartz tubes are also slowly coloured violet by the radium radiations. The bearing of these experiments on the coloration of minerals in nature is discussed.—The work done at the observatory at the summit of Mt. Blanc: M. **Janssen.** The season of 1906 was an exceptionally favourable one, and the work done included biological researches on rabbits and guinea-pigs by MM. Moog and Guillemard, heliometric researches by MM. Millochau and Féry, magnetic studies at different altitudes by M. Senonque, and studies of the surfaces of Venus and Jupiter by MM. Hansky and Stefanik. The results of these various researches will be communicated later to the academy.—The red colour of certain leaves and the colour of autumn leaves: Armand **Gautier.** The red colour developed in leaves which have been wounded, or in the autumn foliage, is not one and the same in all plants, as has been too hastily assumed. Anthocyanine has been regarded by botanists as the cause of the autumnal red in foliage, and as a uniform product derived from chlorophyll; in the case of the vine this is certainly not the case, since the colouring matter contains neither nitrogen nor phosphorus, two essential constituents of chlorophyll.—The principle of correspondence for an algebraic surface: H. G. **Zeuthen.**—Succinic pinacone: Louis **Henry.** This bi-tertiary alcohol is obtained in good yield by the action of methylbromide of magnesium on ethyl levulate. Both hydrochloric acid and acetyl chloride give the dichlorhydrin $(CH_3)_2C.Cl-(CH_2)_2.CCl(CH_3)_2$, and dilute sulphuric acid, even in the cold, gives the internal anhydride tetramethyl-tetramethylene oxide, the physical and chemical properties of which are given. Dry distillation gives an unsaturated tertiary alcohol.—The nature of the virtual sugar of the blood: R. **Lépine** and M. **Boulud.** The perpetual secretary announced the death of M. Etienne Georges Sire, correspondant of the academy for the section of mechanics.—Contribution to the study of the calorific emission of the sun: Ch. **Féry** and G. **Millochau.** A thermocouple of the same type as those used in the commercial Féry pyrometers is placed at the focus of a silvered mirror, a total reflection prism and eye-piece being added so that readings can be made as in a Newtonian reflecting telescope. Observations were carried out in two ways: placing the centre of the sun in coincidence with the cross wires of the telescope at different hours of the day, and observations of the effects produced at different points of the solar disc. Measurements were carried out at four stations at different altitudes, Meudon (150 metres), Chamonix (1030 metres), Grands-Mulets (3050 metres), and the Janssen Observatory at the summit of Mt. Blanc (4810 metres). Details regarding the standardisation of the apparatus and discussion of the results will be given in a later communication.—Observations of the sun made at the Lyons Observatory during the first quarter of 1906: J. **Guillaume.** Observations were possible during forty-three days in this quarter, the results of which are summed up in three tables showing the number of sun-spots, their distribution in latitude, and the distribution of the faculæ in latitude.—Observation of the total eclipse of the moon on August 4, 1906, and remarks on the subject of a squall at Phu-Lien, Indo-China: G. **Le Cadet.**—The liquefaction of wheat starch and seeds: A. **Boidin.**—The detection of adulteration of butter with cocoa-butter and oleo-margarine: Lucien **Robin.** Details of a method of analysis based on the difference in the solubilities of the fatty acids of butter and cocoa-fat in dilute alcohol.—The complexes of pure albumen: André **Mayer.**—The direct action of light on the transformation of the sugars absorbed by the young plants of *Pinus pinea*: W. **Lubimenko.**—Some new views, morphological and biological, on the stinging Diptera: E. **Roubaud.**—A hitherto undescribed organ in the thorax of flying ants: Charles **Janet.** An account, with a diagram, of a mesonotal diaphragm and metanotal diaphragm in ants after the nuptial flight.—The distribution of the Trias in Greece: Fritz **Frech** and Carl **Renz.**—The earthquake in Chili of August 16, 1906: A. **Obrecht.**—The amount of carbonic acid in sea air: R. **Legendre.** The average result from thirteen localities was 3·35 parts of carbonic acid per 10,000 of air.

October 15.—M. H. Poincaré in the chair.—A new and rapid method for the determination of the errors of division of a meridian circle: M. **Lœwy.** The author gives an outline of a method, fuller details of which will be communicated later, for increasing the accuracy of calibration of a meridian circle. The method has the great additional advantage of much reducing the time necessary for the work. Fixing a probable error for the position of each graduation at $\pm 0''{\cdot}02$, the time required to fix the position of each degree is about 100 hours, for half degrees 170 hours, and for quarter degrees 330 hours.—The principle of correspondence for an algebraic surface: H. G. **Zeuthen.**—The dialysis of the sugar of the blood: R. **Lepine** and M. **Boulud.** Under the conditions of the experiments described, the sugar in normal blood serum is not dialysable, but in abnormal cases dialysis takes place, notably when the serum contains newly-formed sugar. These facts are in favour of the idea that in the normal state the sugar is not free in the blood.—The transformation of M. Darboux and the fundamental equation of isothermal surfaces: Rudolf **Rothe.**—The uniform solutions of certain functional equations: M. **Fatou.**—The mechanism of ionisation by solution: Gustave D. **Hinrichs.**—The chemical functions of textiles: Léo **Vignon.** Quite apart from their fibrous structure and resulting development of surface, textiles behave as specifically active chemical molecules. The animal textiles (silk, wool) possess both basic and acid functions; the vegetable textiles are deprived of basic functions, and possess feebly acid functions comparable to those of the alcohols. Porous substances, such as animal charcoal, are inert from the chemical point of view.—The condensation of acetylenic nitriles with the amines. A general method of synthesis of β-substituted β-amino-acrylic nitriles: Ch. **Moureu** and I. **Lazennec.** Acetylenic nitriles of the type $R—C \equiv C—CN$ unite directly with primary and secondary amines, giving substituted acrylic nitriles of the type

$$R—C(NX_1X_2)=CH—CN.$$

These are neutral bodies, easily hydrolysable by acids, regenerating the amines, and forming ketones of the general formula $R—CO—CH_2—CN$. Examples are given showing the generality of the reaction.—Helicoidal arrangement in crystallised bodies: Fred. **Wallerant.**—A third mandibular canal in the infant: R. **Robinson.** This third dental duct, which has not hitherto been noted, is always found in young children. From about eight years of age it appears to atrophy, and leaves as the only trace of its existence a more or less marked depression, corresponding to its outlet. This depression has been noted by other anatomists, and has been regarded as a rudimentary alveole.—The penetration of *Treponema pallidum* in the ovule: MM. **Levaditi** and **Sauvage.** A contribution to the study of the hereditary transmission of syphilis.

NEW SOUTH WALES.

Linnean Society, August 29.—Mr. Thos. Steel, president, in the chair.—Notes on the native flora of New South Wales, part v., Bowral to the Wombeyan Caves: R. H. **Cambage.** This paper deals with the vegetation over a distance of about fifty miles westerly from Bowral, special reference being made to the changes which take place on the different geological formations. The flora of the basaltic area is shown to differ from that of the sandstone, while that of the syenite hill known as The Gib comprises species common to both.—The Mollusca of Masthead Reef, Capricorn Group, Queensland, part i.: C. **Hedley.** On the east coast of Australia the best-known points, from the view of a marine zoologist, are Torres Strait and the neighbourhood of Sydney. To investigate an intermediate station, the author organised an expedition to the south end of the Barrier Reef. Masthead Island, just outside the tropic of Capricorn, was selected for examination. The island and surrounding reef are described and compared with the coral islands of the Central Pacific. The zonal distribution of coral-haunting mollusca is reviewed.—New Australian species of the family Libellulidæ (Neuroptera: Odonata): R. J. **Tillyard.** In this paper eleven new species are added to the list of Australian Libellulidæ, bringing the total up from fifty to sixty-one. All the new species were taken in the Cairns district of North Queensland during the summer of 1904–5. Of these, three only are new to science. The remainder are species already known in other parts of the world, but so far unobserved in Australia.—Note on the cerebral localisation in the bandicoot (Perameles): H. G. **Chapman.** The positions of the cortical motor centres in the brains of marsupials have been described in the opossum (*Didelphys virginiana*) by Ziehen, and by R. Cunningham, and in the native cat (*Dasyurus viverrinus*) by Flashman. The results of an investigation of the motor areas observed in *Perameles nasuta* and *P. obesula* are communicated in the present paper. The centres described have been found regularly in each animal and on both sides of the brain.

DIARY OF SOCIETIES.

FRIDAY, OCTOBER 26.

PHYSICAL SOCIETY, at 5.—The Strength and Behaviour of Ductile Materials under Combined Stress: W. A. Scoble.—The Behaviour of Iron under Small Periodic Magnetising Forces: J. M. Baldwin.—Fluorescence and Magnetic Rotation Spectra of Sodium Vapour, and their Analysis: Prof. R. W. Wood.

SATURDAY, OCTOBER 27.

ESSEX FIELD CLUB (at the Essex Museum of Natural History, Stratford), at 6.30.—On the Salinity of the Sea-water along the Coast of Essex: Dr. H. C. Sorby, F.R.S.—Sponges: their Life-history and Development: M. Y. Wolfe.

THURSDAY, NOVEMBER 1.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Nitrification of Sewage: Dr. G. Reid.—A General Consideration of the Subaërial and Freshwater Algal Flora of Ceylon: Dr. F. E. Fritsch.—The Anæsthetic and Lethal Quantity of Chloroform in the Blood of Animals: Dr. G. A. Buckmaster and Dr. J. A. Gardner.

CHEMICAL SOCIETY, at 8.30.—A Development of the Atomic Theory which correlates Chemical and Crystalline Structure and leads to a Demonstration of the Nature of Valency: W. Barlow and W. J. Pope.—The Explosive Combustion of Hydrocarbons, ii.: W. A. Bone, J. Drugman and G. W. Andrew.—Contributions to the Theory of Solutions: (1) The Nature of the Molecular Arrangement in Aqueous Mixtures of the Lower Alcohols and Acids of the Paraffin Series; (2) Molecular Complexity in the Liquid State; (3) Theory of the Intermiscibility of Liquids: J. Holmes.—The Hydrolysis of Nitro-cellulose and Nitro-glycerol: O. Silberrad and R. C. Farmer.—The Determination of the Rate of Chemical Change by Measurement of Gases Evolved: F. E. E. Lamplough.—Experiments on the Synthesis of the Terpenes Part IX., The Preparation of δ-Ketohexahydrobenzoic Acid (δ-Keto*cyclo*hexanecarboxylic Acid) and of γ-Keto*cyclo*pentanecarboxylic Acid: F. W. Kay and W. H. Perkin, jun.—Experiments on the Synthesis of the Terpenes, Part X., Synthesis of Δ^1-*m*-Menthenol (8) and of Carvestrene: W. H. Perkin, jun., and G. Tattersall.—Some Derivatives of Catechol, Pyrogallol, Benzophenone and of Other Substances allied to the Natural Colouring Matters: W. H. Perkin, jun., and C. Weizmann.

LINNEAN SOCIETY, at 8.—The Structure of Bamboo Leaves: Sir Dietrich Brandis, K.C.I.E., F.R.S.—On a Collection of Crustacea Decapoda and Stomatopoda, chiefly from the Inland Sea of Japan, with Descriptions of New Species: Dr. J. G. de Man.—On *Hectorella caespitosa*, Hook. f., with Remarks on its Systematic Position: Prof. A. J. Ewart.—*Exhibitions:* Young Plaice Hatched and Reared in Captivity: the President.—Abnormal Specimens of *Equisetum Telmateia*, Ehrh.: George Talbot.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY, at 8.—Bridge Work Design: P. J. Waldram.

CONTENTS.

SUPPLEMENT TO "NATURE."

LOCALISATION OF CEREBRAL FUNCTIONS.

Histological Studies on the Localisation of Cerebral Function. By Dr. A. W. Campbell. Pp. xx + 360. Published by aid of a subsidy from the Royal Society. (Cambridge: University Press, 1905.) Price 18s. net.

THIS important monograph is a very valuable contribution to neurological science, for the following reasons: (1) It further establishes a correlation between histological structure and physiological function in the brain. (2) It furnishes a complete descriptive atlas of admirable illustrations of the cell and fibre structure of the human cerebral cortex, whereby neurologists will be enabled, by adopting Dr. Campbell's methods, to examine pathological states of the cerebral cortex and compare the same with the normal. (3) It deals with certain important pathological conditions of the cerebral cortex bearing upon the subject of correlation of function and structure in a fuller, more precise and detailed manner than has hitherto been attempted, viz. amyotrophic lateral sclerosis, tabes dorsalis, amputation of limbs, and deaf-mutism. (4) It adds to our knowledge, by a complete comparative survey of the cell and fibre structure, of the cerebral cortex in the following mammals:—cat, dog, pig, anthropoid apes, and man.

The author in a short introduction refers to the work of some previous observers, and claims that he has pieced together the disjointed knowledge of the histology of the cerebral cortex by a complete survey of its cell and fibre architecture. It is excusable for one who has devoted a number of years to its study to make the following statement:—"the microscopist will probably succeed in defining and rubbing the corners off the boundaries of the productive field" which experimental and clinico-anatomical observations have shown to be correlated with precise functions, which, however, have not, as the author says, come from the "pens" of the physiologists or from "an honoured *coterie* of observers following in the footsteps of Broca," but from an army, of whom, in England, Hughlings Jackson was the leader.

We doubt very much whether present methods of histology will throw any new light, beyond that which has been already shed by Flechsig, on the higher functions of the cerebral cortex; in fact, that Dr. Campbell should have used six out of eight brains from persons of unsound mind dying in Rainhill Asylum, with the assurance that they in no way differed from the normal, is not very hopeful in this respect.

Chapter i. deals with material and methods. The essential feature was the systematic examination of every part of the cortex according to a definite plan of dividing the hemisphere into fifty or sixty blocks; these were numbered, and sections from each block of the uniform thickness of 25 μ were taken at intervals of 1 mm. and subsequently stained for cells and fibres by two well known methods, then mounted. Microscopic drawings were then made to scale, the low power at a magnitude of 80/1 and the high power at 480/1.

Dr. Campbell, having thus acquired a topographical knowledge of the cell and fibre structure of the human cortex, has applied that knowledge to a comparative histological survey of the brain of the anthropoid apes, and of certain pathological conditions of the cerebral cortex.

Chapter ii. consists of general histological considerations on medullated fibre arrangement and cell lamination. It may be noted that the author has made seven layers of cells; it would probably have been better had he restricted the term layers to those which are laid down in the developing embryo.

Chapter iii. deals with the pre-central or motor area. Bevan Lewis and Clarke, in a valuable communication to the Proceedings of the Royal Society, 1878, mapped out the motor area by the presence of the large Betz cells, which they showed were found only in the ascending frontal convolution and a small co-terminous portion of the para-central lobule. Dr. Campbell confirms these observations, and shows that the same distribution of the large cells occurs in the anthropoid apes. Moreover, the distribution of these cells coincides absolutely with the field which Sherrington and Grünbaum have found respond to unipolar faradisation, thus affording the connecting link necessary to apply the stimulation experiments on the anthropoid apes' brains to the localisation of the motor area in man. Strong confirmatory evidence of the localisation of volitional muscular movements residing in the pre-central area is afforded by the examination of the brain in two cases of amyotrophic lateral sclerosis, a disease limited to the motor system of neurons. The author describes a wholesale disappearance of giant cells of Betz in this region. He asserts that in the same brain the post-central gyrus entirely escaped affection.

In three cases of amputation of the leg and a like number of cases of amputation of the arm, in which the central convolutions were examined in a series of sections, alterations were discovered limited in distribution to fields agreeing closely with the leg and arm areas delimited by experimental observation. At the level of the superior genu the annectant gyrus or buttress, which is relatively devoid of "giant cells," seems to be an important guide to the point where the trunk area intervenes between those of the arm and leg.

Chapter iv. is on post-central and intermediate post-central areas. This area is readily defined in the anthropoid ape and man, and is limited in its distribution to the post-central or ascending parietal gyrus and its para-central annexe; the floor of the fissure of Rolando is the anterior boundary. Its cortical structure is different from that of the pre-central area; it exhibits structural features similar to that of known sensory areas (the visual and auditory). Dr. Campbell therefore denies its motor function. But, it may be asked, would histological studies have been listened to any more now than when Bevan Lewis described the distribution of the motor cells had it not been that experimental observations on anthropoid apes showed that it did not respond to unipolar excitation, and that partial ablation gave rise to no interference with movement? The author makes a good deal of the fact that he has examined three cases of tabes dorsalis, and observed profound cortical alterations concentrated in this area. He would argue, therefore, that correlated systems of sensory neurons were alone affected. Without denying the probability of this fact, which has been put forward by previous authorities, it may be doubted whether the evidence is altogether satisfactory, for two of the cases were admitted tabo-paralysis, and the other was not free from suspicion.

Chapter v. deals with the visual area. There are two definite and distinct areas, named by Bolton visuo-sensory and visuo-psychic. The distribution of the first corresponds to the line of Gennari, and occupies especially the region of the calcarine fissure; it is therefore often spoken of as the calcarine, or more properly the striate area. Campbell confirms Bolton's work on the visuo-sensory area, and delimits the second definable visuo-psychic area, which forms a skirt to the first, and practically covers the remainder of the occipital lobe. It is characterised by a remarkable wealth of nerve fibres and curious large pyramidal cells. In the chimpanzee and orang analogous areas were demonstrated, but it was found that they extended much more widely on the lateral surface of the hemispheres. It is curious that Dr. Campbell has not observed that in a very considerable percentage of lunatics' brains the visuo-sensory (striate) area extends from 10 mm. to 30 mm. on to the external surface. Moreover, Eliot Smith has shown that this condition exists in a very considerable percentage of the brains of Egyptians.

Connected within the sylvian fissure, and occupying the transverse temporal gyri, is a small but important field characterised by coarse fibres and large pyramidal cells. This the author calls *audito-sensory*; the skirt of cortex circumjacent he terms audito-psychic. These two areas correspond with the primordial and intermediary myelogenic areas mapped out by Flechsig. The author remarks that the remainder of the temporal lobe is characterised by a poverty in cells and fibres of large size.

The angular gyrus is not endowed with any specialised architecture, although clinico-anatomical evidence shows that it has a special function connected with word vision. Dr. Campbell does not even consider the cortical localisation of impressions coming from the semi-circular canals by the external auditory nerves, although he describes cortical changes in a case of deaf-mutism.

The author admits that although histological researches of previous observers leave hardly anything further to be learnt concerning the morphology of the cell and fibre elements resident in the cortex of the limbic lobe, "yet the exact cortical localisation of the olfactory and gustatory centres is sadly wanting." The lobus pyriformis is probably the principal cortical centre, although not the sole one, governing the olfactory sense. Its structure is characterised by superficially placed clusters of stellate cells, and a tendency on the part of projection fibres to reach the surface.

The cell and fibre architecture of the hippocampal area and cornu ammonis show characteristic features, and yet the functions of these parts are obscure. Neither do we know the function of the gyrus fornicatus; but the author decides against its being concerned with common sensation by the fact that there is a total absence of large fibres and large cells found in other sensory regions.

Histological observations show that the cortex of the parietal lobe possesses all the cell laminæ of, and a similar arrangement of nerve fibres to, the intermediate post-central area, but it differs in containing a smaller number of special large pyramidal cells and of large medullated fibres. The boundaries of this region, however, are not very definite or its characteristics very clear. Is it a fact that "a homologous area can be traced phylogenetically throughout the *vertebrate* series," or does the author really mean mammals?

The intermediate pre-central area is characterised by a similarity of structure to the pre-central area in the fact that there are large cells and coarse, medullated fibres, but they are greatly reduced in numbers. He also points out that the stellate cells are much less abundant than behind the Rolandic fissure. He regards this area as being a cortical region presiding over complex later developed skilled movements, which clinico-anatomical observations had previously proved. Moreover, the area agrees closely with the intermediate area of Flechsig mapped out by developmental methods. He finds that the whole inferior frontal convolution is similar in structure, and he assumes, therefore, that it is similar in function, and therefore governs the motor element in speech. This argument is, however, not very convincing.

Chapter x. deals with the remainder of the frontal lobe, which he divides into frontal and pre-frontal. The results of this chapter are disappointing, for it might be expected that histological studies would have thrown more light on the possible functions of this lobe; for the author states on p. 248:—

"Without adding materially to our knowledge of the functions of the frontal lobes, histology throws light on some of the observations of previous observers." "No explanation can be given of the truth that stimulation of the frontal lobe produces eye movements."

He rather exaggerates the poverty of fibres in this region according to some authorities.

Chapter xi. is concerned with the island of Riel, which consists of two types of cortex, the anterior similar to the lobus pyriformis, the posterior to the adjacent first temporal convolution. The insula is old, and it plays a more important part in primitive mammals than in man.

At the end of each chapter is a summary and an index of references to the work of other observers on the subject. The book concludes with a valuable addendum, part i. containing a comprehensive survey of the cell and fibre architecture of the cortex of three types of mammals, the cat, dog, and pig.

Part ii. takes into consideration the function and homologues of the areas which can be defined by the difference in cell and fibre characters. There is a vast amount of information and patient, careful work in this book, and it is impossible in a review to do more than indicate some of the principal points; but all men of science who are interested in the subject of brain structure in man and animals will be well repaid by a careful study of the work, aided by the admirably executed twenty-nine plates illustrating the cell and fibre structure of the brain and the topography of the histologically defined areas. F. W. M.

PIONEERS OF GEOLOGY.

The Founders of Geology. Second edition. By Sir Archibald Geikie, F.R.S. Pp. xi+486. (London: Macmillan and Co., Ltd., 1905.) Price 10s. net.

A FOUNDATION should be laid on a sound bottom, and should be itself constructed so as to hold together in one solid mass. For this, each man engaged upon it must carry out thoroughly the work entrusted to him, one in an obscure corner mixing the mortar, another, more in evidence, laying the bricks.

So in the building up of systems of knowledge we must take care that our theories are based upon those ascertained facts which we call the laws of nature, and, further, that each stage in the superstructure is consistent It is difficult to appraise exactly the value of the work of each. Many a modest and retiring worker has suggested good things which have afterwards been followed up by others; many a thoughtful student has pointed out faulty reasoning upon which vast theories were being erected.

Sir Archibald Geikie, on a former occasion, came round and selected for commendation or for criticism some of those who have been most prominent in building up the science of geology, and pointed out what was good and what might have been better done. He now inspects more in detail the work of those who laid the very foundations or prepared the ground for their reception, and gives us, first of all, a sketch of what, as we gather from very scattered notices, were the views held by the Greeks and Romans on geological questions. Then he carries us through the dark ages, in which only a small spark of intelligent observation gleamed here and there.

In order to present the speculations of the earliest writers who have referred to the subject in some definite order, our author considers them under three heads. In the Mediterranean area underground processes forced themselves upon the attention of all thoughtful and observant men, and, when we remember the story of Graham Island, which was rapidly thrown up, had the British flag hoisted upon it by Admiral Smythe, and then disappeared, it is interesting to note that Strabo and Pliny confirm the sudden appearance of islands due to ejected material. These and other ancient writers, however, could not get very far in the exploration of earthquakes and volcanoes, but referred them to wind pent up in vast cavities in the bowels of the earth.

With regard to the processes at work upon the surface of the earth, we learn that the ancient philosophers inferred that the sea now covers areas that were once dry land, and that land will appear where we now find sea, but that these phenomena escape our notice because they take place successively during periods of time, which, in comparison with our brief existence, are immensely protracted.

Herodotus calls Egypt "the gift of the Nile," while Strabo points out that deltas are prevented from advancing seawards indefinitely by the wash of the waves.

Then followed the dark ages, so far as concerned investigations into the operations of nature, until the Arabs took up the work and the learned Avicenna translated Aristotle, and expressed, even more clearly than did his Greek master, opinions regarding the origin of mountains and valleys, which show a singular forecast of modern geology.

Sir Archibald Geikie leads us on in his happy style through the later middle ages, pointing out the prejudices that hindered free inquiry, and bringing in great names, like that of Leonardo da Vinci, which we would hardly expect to find among the pioneers of geology.

Many were the shifts to which men were driven in those days in order to avoid collision with ecclesiastical authority. Some said that what looked like bones, shells, and plants in the rocks were introduced during Noah's flood; some refused to admit that they were anything but earthy concretions; and one writer went so far as to suggest that even the potsherds of Monte Testaccio at Rome were only natural productions of the earth. Some clear-headed writers tried from time to time to place scientific inquiry upon a better and more independent footing. Steno, for instance, in the seventeenth century, broke away from all preconceived ideas and prejudices, and his treatise "De Solido intra solidum naturaliter contento" marks an epoch in the history of geological investigation.

The next phase was characterised by the appearance of a number of cosmogonies, or historical sketches of the manner in which it was supposed that the cru.t of the earth had been built up and reached its pr..ent condition. Men's judgment was often wrested, and facts and logic strained, in the attempt to make these "theories of the earth," as they were called, consistent with orthodox ideas and with themselves, but, though they did little to advance scientific truth, they at any rate forced people to think about such things.

Buffon recognised that the earth was only part of a great planetary system, and suggested that many of the changes produced upon its surface were such as would be evolved in a mass gradually cooling down. He worked long and carefully, appealing to observation and experiment, and often getting very near a good theory, but never quite achieving it.

Sir Archibald Geikie could not, of course, in the case of the ancient writers, tell us much of their personality, their bringing up, and early associations. The description of these gives a human interest to his account of the later writers, and enables us to realise many circumstances which coloured their scientific work.

It is interesting to learn that the majority of the more notable of those who have created the science of geology have been men engaged in other pursuits who have devoted their leisure to scientific research. Until lately there was no training in natural science such as can now be obtained at our universities and elsewhere. The nearest approach to it was the instruction given in the medical schools, and many of the best geologists have been medical men. None could, then, have been called professional geologists in the sense of having been trained specially for geological study, and but few in the sense of having made it their life's work and received pay for it, such as Sedgwick, who, having been a resident fellow of great distinction in both classics and mathematics, was appointed professor of geology, or Murchison, who, having been a soldier, was made director of the Geological Survey.

The author has recast and added to the biographical sketches of the great leaders of geology as drawn in his first edition, and has made a good book yet better. It is a work which should be in the hands of all students of geology, while the general reader cannot fail to be interested in this chapter in the history of discovery told in such charming, simple language.

ELECTROCHEMISTRY.

Experimental Electrochemistry. By N. Munroe Hopkins, Ph.D. Pp. xiv+284. (London: Archibald Constable and Co., Ltd., 1905.) Price 12s. net.

THE author's desire is, as he states in the preface, to produce a book which will prove useful both in the laboratory and in the lecture theatre, or, as he probably means, for home study. The book commences with a brief historical review of the subject, and the student is intended to carry out some of the classical experiments upon which the foundations of this essentially experimental branch of chemistry and physics have been built up. For example, he is instructed how to repeat Sir Humphry Davy's work on the isolation of the alkali metals. A portion of this chapter is also devoted to instructions how to manipulate the electrical supply by cutting down the current from the lighting mains with a lamp resistance, or to alter the voltage by means of a small motor generator. The author then comes to the subject of electrolytic dissociation. Dr. Hopkins is no half-hearted supporter of the ionic theory; it is evidently his sheet anchor, by which all other theories must be tested, and if they do not conform then there is evidently something lacking in these theories. It must be admitted that the author makes out a very strong case for the theory of electrolytic dissociation, and he gives experiment after experiment to prove his case. Chapter ii. deals with osmotic pressure and how to carry out the determinations; a complicated apparatus is described for experimentally proving the principle of Soret. In chapter iii. boiling- and freezing-point methods are dealt with, and experiments are described to show that chemical action will not take place except in the presence of moisture.

The next chapter treats of experiments in electrolytic induction. Some of these experiments are of an extremely interesting character, although whether opponents of the ionic theory would be prepared to admit that they are valid proofs of the theory is open to doubt. Starting with the well known fact that a negatively charged conductor will induce an opposite charge in the end of a rod brought into its neighbourhood, he describes experiments to show that the same holds good in the case of an electrolyte, and then argues that, as electricity can only pass through a liquid by means of ions, therefore the induced charge is caused by ionic movement. In the experiment of Ostwald and Nernst, where the actual liberation of hydrogen by an induced charge is made visible to the naked eye, the proof seems complete. The author, however, gives other very interesting cases where the induced charge is shown by means of a delicate mirror galvanometer, and in which no chemical change is obvious, any more than it is obvious in the case of a solid conductor. Some of the most novel experiments in this direction described by the author are those in which he shows that a magnet induces a current of electricity in an electrolyte, the magnet being placed in the centre of a glass coil containing the electrolyte.

The chapter on the velocity of electrolytic conduction is interesting, and the question of the absolute velocity of the ions is very fully dealt with. Here again the author shows his ingenuity by the number of novel experiments which he describes, and by his modification of the experiments of other workers. A large number of experiments are described to illustrate Faraday's laws, both in connection with dissolved and fused electrolytes. Dr. Hopkins also describes an experiment to illustrate the mechanical transfer of matter through solid glass. A piece of glass rod is taken with platinum wires fused into either end, the wires being about 1 cm. apart in the centre. The two wires are connected in series with a milliammeter and with the electric lighting circuit. No current, of course, passes, but on heating with a Bunsen burner until the glass commences to soften a deflection is noticed on the ammeter. With the softening of the glass, therefore, the ions are free to travel, at any rate; the glass is no longer an insulator.

The portion of the book dealing with electrolytic analysis is very short, and will be useful more as a suggestion as to what can be done than as a guide for analytical purposes. To a certain extent the same remarks apply to the electrolytic preparations which are given. The part devoted to furnace work, that is, laboratory furnace work, is pretty full. A good deal of space is given to the isolation of aluminium and also of sodium. The section devoted to calcium should be brought up to date.

An interesting account is given of the production of nitric acid from the atmosphere, with historical notes, and this chapter fails in one thing only—no mention is made of the Birkeland successful manufacturing process. This is hardly the author's fault, because it is so recent that the author could only have added it to the book as a supplement, bearing in mind the time a book takes to pass through the press. A few organic preparations are given, such, for example, as the preparation of chloroform; not having tried it as illustrated by the author we wonder whether it is a success. It looks very similar to the description of processes which we know are not successful.

The last portion of the book is devoted to primary and secondary cells, and to the generation of electricity from carbon. Nothing is impossible in science, and perhaps some day the glowing hope of many young and some old investigators may be realised, and the carbon cell become our source of electrical energy.

The book is well printed and splendidly illustrated. The author is an American, and it makes our mouths water to think of the magnificent equipment which his laboratory must possess. It is not difficult to understand why electrochemistry flourishes abroad; the foundations were laid here, part of the superstructure was raised, but where is the finished building? We advise those interested in electrochemistry, and also those who do not believe in it—and there are a goodly few—to read this book.

F. M. P.

THE VANISHING EAST.

A People at School. By H. Fielding Hall. Pp. viii + 286. (London: Macmillan and Co., Ltd., 1906.) Price 10*s*. net.

THERE are several different ways in which to write of foreign countries, and Mr. Fielding Hall, who knows his Burma as thoroughly as it can be known by a European, has chosen the psychological point of view and the philosophical method. He had already broken ground in this direction in his "Soul of a Nation," and one hoped that the fascinating study afforded by that book was to be continued in the present one, which deals with the Burmese in their transition stage. The hope is not altogether fulfilled. An author must not complain if his work is always measured by his own highest achievement, and, although "People at School" is an interesting and suggestive book, it is disappointing after the "Soul of a Nation." It is, as the author confesses, made up of chapters written at odd times, and the result of this method is a certain amount of repetition and some contradiction, while the style is so jerky and broken as to become fatiguing; but, when these criticisms as to manner have been made, one is still aware that the matter of the book is unusually good and interesting. So much has been written of eastern countries that it is no small achievement to give an unhackneyed rendering of so familiar a theme—and Mr. Hall is never conventional and at the same time is always faithful to life.

The first half of the book gives a picture of Burma before and at the time of the British "occupation" of Upper Burma. In writing of times that are past and gone, while still within our recollection, we have all to be on our guard against a popular illusion as to the "good old days." My sympathies are naturally with Mr. Hall in his half-stifled regrets for the picturesque period of Burmese history. I too knew old Burma; I too sat under a banyan tree and represented the majesty of England to a district, dispensing paternal justice with the sureness (and successfulness) of youth and profound faith in the mission of the Anglo-Saxon. I shared the dacoit hunts the wearisome monotony of which, varied by the writing of picturesque reports, Mr. Hall describes with such humour and veracity. Moreover, I assisted (as he was not able to do) in the settling-down period, and am able to endorse his remarks as to the only policy possible towards a conquered people and the folly of burning villages as reprisals; and we were both younger in those days than we are now and life was much more of a vast adventure. We must not cast too much personal glamour over the good old times when we comment on the dull sobriety of Burma to-day—the well administered Indian province.

Nevertheless, a feeling of depression creeps over me as I read of the Burman of to-day. He is prosperous, says Mr. Hall, but is losing his sense of the joyousness of life. One's memories of Burma are inextricably interwoven with the picture of a childishly happy people—the most attractively merry, gentle, light-hearted people of the East. Have we put them into a dull, conventional mill? Are we crushing them with the weight of our materialistic civilisation? Despite his half-hearted disclaimers Mr. Hall is evidently afraid that this is so, and, although he stoutly hopes that this is only a transition period—a people at school—and that manhood will bring the Burman a newer and brighter horizon, yet one cannot but regret that political destiny made it necessary for us to destroy the Burmese ideals when we could give them nothing better. Our system of government, as Mr. Hall shows clearly, while respecting native laws and custom, is inevitably a superstructure, unlike the system which grows up from the soil. Even our method of employing the headmen of villages as Government officials has its weak side, and it is interesting to note that a similar system regarding the chiefs of tribes is having the same effect in South Africa. Both headman and chief are no longer regarded by villagers or tribe as representatives of the people, but as those of the Government. It is a strong distinction.

There are several points on which I must join issue with Mr. Hall. He would have us believe that the Indian money-lender and coolie and the Chinese trader are really helpful to the Burmese and advance their progress. So long as the Burman is able to retain his hold of the soil that may be, but how long can he do this in the teeth of foreign invasion? Mr. Hall also rests too much of his psychology on the presumed "youth" of the Burmans as a race, disregarding their many points of resemblance with other Indo-Chinese peoples. One would have liked a comparison also with the Japanese, who have many of the "youthful" characteristics of the Burmese. While the former "adapt" Occidental civilisation, however, the Burmese can only "adopt" it, with the result that it seems to denationalise them.

The interesting chapter on women, who play so large a part in Burma, being the equals of men legally and socially, suggests another interesting comparison (which Mr. Hall seems to miss) with the French nation. The Burmese law of inheritance (that is the Buddhist law that a man may make no disposal of his goods after death) resembles the French system of dividing the property between the children. The result in both countries is to limit individual ambitions and to raise the legal status of women, who become co-partners with their husbands in all business affairs and are often much the better horse.

That this book is rather suggestive than conclusive is one of its charms, and no one who cares for the mysterious and vanishing East should fail to read this study of a people at school.

ARCHIBALD R. COLQUHOUN.

ELEMENTARY MATHEMATICS.

(1) *Easy Mathematics of All Kinds.* Vol. i. *Chiefly Arithmetic.* By Sir Oliver Lodge, F.R.S. Pp. xv+436. (London: Macmillan and Co., Ltd., 1905.) Price 4*s.* 6*d.*

(2) *Arithmetic for Schools and Colleges.* By John Alison and John B. Clark. Pp. viii+471+xlvii. (Edinburgh and London: Oliver and Boyd, 1905.) Price 4*s.*

(3) *Elementary Trigonometry.* By H. S. Hall and S. R. Knight. Fourth edition, revised and enlarged. Pp. xv+415. (London: Macmillan and Co., Ltd., 1905.) Price 4*s.* 6*d.*

(4) *Engineering Mathematics, Simply Explained.* By H. H. Harrison. Pp. 165. (London: Percival Marshall and Co.) Price 1*s.* 6*d.* net.

(1) ONE of the reasons which induced a busy scientific man like Sir Oliver Lodge to write a book on easy mathematics is thus given by the author in the preface:—

"The mathematical ignorance of the average educated person has always been complete and shameless, and recently I have become so impressed with the unedifying character of much of the arithmetical teaching to which ordinary children are liable to be exposed that I have ceased to wonder at the widespread ignorance, and have felt compelled to try and take some step towards supplying a remedy."

No teacher of arithmetic or elementary mathematics can afford to be without this most suggestive book, in which the results of much thought and a wide experience are presented in a deeply fascinating style, and untrammelled by conventional or artificial restrictions. The first four chapters give suggestions for teaching very young children the operations of counting and the simple rules of arithmetic. The appeal is made through their games and any concrete things in which they are likely to have an interest, and vulgar and decimal fractions and negative quantities seem to present no difficulties. The writer is emphatic in his declaration that the whole subject of mathematics is essentially experimental and should be developed on an experimental basis. Concrete quantities are quite early dealt with like abstract numbers, and multiplied and divided freely, *e.g.* 60 miles/1 hour is the *speed* of an express train. The author advises that units should, where suitable, be inserted in the numerator and denominator of a fraction, and cancelled like ordinary numbers, in order to emphasise the *dimensions* of the quantities under consideration.

But it is impossible in a short article to give any adequate account of the book, treating as it does, to mention only a few things, of the decimalisation of money, indices, logarithms, incommensurables and discontinuity, approximations, progressions, means and averages, differentiation, &c., with interesting historical references and digressions, the whole being continuously illustrated and illuminated by applications drawn from the wide domain of natural science, of which the author has so extensive a knowledge.

(2) The arithmetic by Messrs. Alison and Clark is a very complete treatise, written mainly on conventional lines, and devoting a large portion of its space to commercial aspects of the subject. But the authors do not forget that the physical laboratory has also claims on their attention, and they give many good exercises in physics and mechanics, using four-figure tables of logarithms, and approximate methods of computation in appropriate cases. The authors are very partial to abstract reasoning, and general propositions seem to us to be introduced and deductions established somewhat prematurely, before the boy can have the concrete and experimental knowledge requisite to understand the matter. Thus in chapter vi., immediately after the completion of the four simple rules, the laws of the operations for the symbols are fully discussed; but it is wisely hinted that this chapter may be skipped on a first reading.

The text-book is intended for use in both schools and colleges. It is profusely supplied with examples of varying grades of difficulty. The answers collected at the end of the volume themselves occupy forty-seven pages of closely printed matter. The book is very suitable for advanced pupils and for prospective teachers, but beginners would require guidance as to what parts to omit.

(3) The new edition of Messrs. Hall and Knight's "Elementary Trigonometry" has been revised and enlarged by the introduction and use of four-figure tables of logarithms and antilogarithms of numbers, and of natural and logarithmic functions of angles, also by examples of the graphing of trigonometrical functions, and the insertion of additional examples of a practical nature. A first course is specially outlined which, by omitting some of the more advanced formulæ, allows numerical computations by four-figure tables to be reached at a comparatively early stage, and most teachers will no doubt follow this plan.

The revision has brought the fourth edition up to modern requirements, and little more need be said about a book the great merits of which are so generally recognised. In defining the ratios and establishing the fundamental formulæ for angles of any magnitude, we should like to have seen the essentially vector nature of the subject made more manifest, and at intervals enforced by examples drawn from physics and mechanics. There seems no good reason why in elementary text-books of trigonometry practical applications should in the main be confined to the ship-tower-flagstaff type of examples.

(4) The text-book on engineering mathematics by Mr. H. H. Harrison comprises chapters on arithmetic, algebra, trigonometry, mensuration, logarithms, squared paper, and the calculus. The presentation of the subject by the author is crude and uninteresting, no examples are provided for practice, and the book cannot be recommended for any class of student.

TROPICAL MEDICINE.

Lectures on Tropical Diseases, being the Lane Lectures for 1905 *delivered at the Cooper Medical College, San Francisco.* By Sir Patrick Manson. Pp. viii+230. (London: Constable and Co., Ltd., 1905.) Price 7*s.* 6*d.* net.

TROPICAL pathology no doubt owes much of its fascination to the fact that new diseases, or the causes of old diseases, have only within the last decade been completely elucidated, and that every year, if not every month, fresh facts appear and fresh subjects of inquiry suggest themselves. Thus almost before the ætiology of sleeping sickness was fully elucidated, students of tropical pathology were given a fresh subject of inquiry from the discovery of the cause of the dreaded "tick fever" of Tete on the Zambesi, and of other parts of tropical Africa. When the interest in the Anophelinæ and *Stegomyia fasciata* had somewhat waned, the tropical pathologist had his attention diverted to tsetse-flies, and then again the hue and cry was in the direction of ticks, especially in Africa towards *Ornithodorus moubata,* the transmitter of the spirochæte of "tick fever."

In India the malariologist must have recently received a severe shock to find that many of his most familiar cases, which he designated "malaria cachexia with enlarged spleen," are in all probability due to an entirely new parasite, or at least the parasite can be found in the organs of such cases. In tropical pathology Africa has provided many of these novelties, but, in the opinion of medical men who have travelled widely in tropical Africa, there is not now much probability left of the production of a completely "new" disease. We do not, of course, imply that many minor discoveries do not remain to be made, and, indeed, even great ones, such as the causes of yellow fever and beri-beri; and to the investigator who is content with elucidating minor problems these fascinating lectures will afford numerous examples of the kind of work that still remains to be done.

But a word of caution is perhaps necessary; for the reader is presented with a host of interesting suggestions and speculations, and unless he advances cautiously and weighs these carefully in the light of experience, he may well take the phantom hypothesis for fact, for it would be possible in this particular branch of pathology to adduce examples where hypothesis simply has actually retarded the acquisition of knowledge. We would prefer rather to see the investigator laboriously accumulate facts and to base on these his own hypothesis rather than, starting with a ready-made hypothesis, to try and adapt his facts to it. With this caution we think these lectures should serve as a stimulant to the jaded investigator depressed by the slowness of his own advance, as he perhaps remembers that it took Ross some two years or so to work out the mosquito cycle of the malaria parasite, and that the first hypothesis as to the path followed by the parasite in the mosquito was a wrong one.

While, then, a perusal of these lectures has raised some doubts in our minds as to the general validity of presenting those, presumably novices, with a number of interesting suggestions, yet for even the veteran there is abundance of sound common sense to be found here which he will do well to treasure up. If, further, we venture to criticise various statements in detail, we do not do so in a spirit of opposition, but simply as an expression of a difference of opinion. The author (p. 2) refers to helminthology as "until recently an insignificant if not a despised branch of pathology"; but surely this is somewhat forgetful of the claims on our gratitude and respect of such helminthologists as Leukart, Dujardin, Rudolphi, Cobbold, Küchenmeister, &c. We can only in part agree with the opinion that, regarded "as a cultivating medium, there is no difference between the juices and tissues of an Esquimaux and those of a Caucasian or those of a negro." For what else but a difference of medium is the explanation of the fact that the healthy countryman will survive wounds and infections that prove fatal to the less resistant townsman? It is partly a difference of medium in the host, we believe, that causes malaria to be a mild disease in temperate regions, and a deadly one in tropical climates, where in both cases we may be dealing with a single infection of a particular person. In what else does the good of change of air, a sea voyage, &c., consist, but in producing a change of medium in the host in which, *e.g.*, the dysentery amœba is living?

In treating of filariasis (p. 80) we do not think the author sufficiently emphasises the fact that the final link in the chain of evidence connecting the mosquito with the transmission of filaria is wanting. Grassi and Noe's experiments on the transmission of filariæ to dogs by means of mosquitoes are by no means convincing, and to experiment on man is hardly possible. In the case of the malaria parasite the experiment has been done several times, but it was Schaudinn who actually first saw the malarial sporozoit penetrate the red cell. We had made the same experiment as Schaudinn on many occasions without success, except that we saw the sporozoit transformed into a body indistinguishable from a so-called "ring form," and if the investigator follows out the method given on p. 98 he will not see what Schaudinn describes. For Schaudinn expressly says that on using sporozoits taken from the salivary gland he got no results; it was only on using sporozoits taken from large oocysts in the stomach that he got (two) successful results.

In discussing the ætiology of sleeping sickness we think the author scarcely puts Colonel Bruce's discovery in its proper light. We would say that without Castellani's observation possibly Bruce would not have thought of or discovered the trypanosome, just as Dutton might never have discovered the *Trypanosoma gambiense* had it not been for Forde. But to claim Castellani as the discoverer of the ætiology of sleeping sickness is, we consider, hardly right. Further, the author appears to have some doubts as to whether this trypanosome is really the cause of the disease, and cites, by way of caution, the fact that similar evidence could have been adduced in favour of the embryo *F. perstans.* But to us it seems that the "evidence" in favour of *F. perstans* was never at any time on the same footing as that of *Trypanosoma gambiense*, and, as a matter of fact, collapsed immediately the hypothesis was tested by facts.

We cannot here discuss the evidence in favour of regarding *T. gambiense* as the cause of sleeping sickness, but it is supplied by a body of epidemiological, pathological, and experimental evidence surely conclusive.

Finally, the author suggests (p. 124) that, in the case of *T. gambiense*, the negro of the endemic areas of this parasite has acquired an immunity similar to that of antelopes in regard to *T. brucei*. But, so far as we are aware, there is not the slightest evidence of this, and, in fact, the evidence is to the contrary, viz. that where a negro has *T. gambiense* in his blood he will surely die sooner or later (of sleeping sickness).

We consider that for the medical man the most valuable portions of the book are those dealing with the diagnosis and treatment of tropical fevers, and these should be taken to heart, for it is not uncommon, for example, for a patient to die of liver abscess who has been treated throughout for "fever"; but fever is not always malarial, as is too often supposed.

The book has numerous illustrations in the text, but, with some exceptions, these are not entirely successful. We would heartily recommend those who wish for a series of stimulating, unconventional lectures to peruse this book. J. W. W. STEPHENS.

PROGRESSIVE TEACHING IN PHYSIOLOGY.

Recent Advances in Physiology and Biochemistry. Edited by Leonard Hill, M.B., F.R.S. Pp. xix + 740. (London: E. Arnold, 1906.) Price 18s. net.

THE rapid advances that physiology is making are reflected not only in the journals that deal with research, but also in the vigour with which the teachers of the subject are applying themselves to their duties in relation to their students. At several centres in London there are every year now given courses of advanced lectures, open free to all the students of the London medical schools, in which they may hear from the lips of the investigators themselves the result of their research, and witness the most important of their experiments.

The book now before us is a corresponding expression of this teaching energy, and one can only hope that authors and publishers alike may find their venture a success. Students have not the time for hunting up original papers, but they ought readily to imbibe a summary of recent research when it is presented to them in an attractive way.

The collaborators deal with subjects on which each is competent to speak, because they have themselves worked at those they write about. Thus the editor, Mr. Leonard Hill, treats of the subjects of respiration and fat-metabolism. Dr. J. J. R. Macleod gives a summary of recent work in connection with carbohydrate metabolism, uric acid formation, and the immunity question. Another aspect of the respiratory process is dealt with by Dr. Pembrey, who also writes on internal secretions; and some interesting chapters on lymph production, absorption, and excretion by Dr. Beddard follow next.

All the subjects are treated in a lucid manner, and will give to advanced students a clear idea of the present position reached by physiologists on many of the thorny problems that beset the path of the original worker.

The opening articles of the volume, which are from the pen of Prof. B. Moore, come into a somewhat different category. He deals with the applications of physical chemistry to physiological phenomena, especially in connection with secretion, and the action of enzymes. He gives the latest views and results on this most important subject, and teachers and students alike owe him a debt of gratitude for his able treatment of these somewhat obscure questions. Those parts which relate to the rules and formulæ which regulate the processes of reaction-velocity and the like will be found rather difficult to many, for physiologists and medical students are, as a rule, rather rusty in their mathematics. But Prof. Moore's articles are not mere abstracts of the work of himself and others, for he has chosen them as the vehicle for the promulgation of a new doctrine, of which the keynote is struck in the opening chapter. The main object of his succeeding chapters is to convince the reader that this new conception is right, and will explain much that has hitherto been puzzling. The cell is treated as a transformer of energy, but the new energy produced, which is characteristic of living structures, cannot be brought into line with the known forms of energy in the inorganic world. It differs from heat and electricity, for instance, as much as, or more than, heat and electricity differ from each other, and he dubs it "biotic energy." Biotic energy is not, however, the old vitalistic principle revived under a new name, for it obeys the law of conservation of energy, and its investigation is capable of numerical and exact treatment just as that of heat and electricity is. A review is not the place to enter into any detailed criticism of such a view. The idea will serve to stimulate others to renewed research, and one foresees it will meet with considerable opposition in the future. Any doctrine which involves controversy is to be welcomed, and finality in the discovery of truth is brought nearer as the workers are provided with new theories as a basis of work. W. D. H.

SUPPLEMENT TO "NATURE."

THE ENTROPY OF RADIATION.

Vorlesungen uber die Theorie der Wärmestrahlung. By Dr. Max Planck. Pp. viii+222. (Leipzig: Johann Ambrosius Barth, 1906.) Price 7 marks.

A QUANTITY of heat Q is transferred by radiation from a body the surface of which is at temperature T_1 to a body the surface of which is at a lower temperature T_2. From this cause alone the former body loses a quantity of entropy Q/T_1, while the latter gains a quantity of entropy Q/T_2. The net gain of entropy of the bodies arising from the transaction is $Q(1/T_2-1/T_1)$. Where and how does this gain take place?

Some people have expressed the view that the notion of entropy has no place in radiation phenomena, and that it is only a convenient symbol introduced for the purpose of representing a certain class of heat phenomena occurring in material bodies. But the entropy gained or lost by a body measures the gain or loss of unavailable energy on the supposition that energy can be converted into work by means of ideal reversible engines working between the body and an indefinite medium at unit absolute temperature. It will thus be seen that the change of entropy above considered represents a definite amount of what Mr. Swinburne calls "incurred waste," a change which cannot be undone, which leaves an indelible imprint on the state of the universe, which represents a loss of availability, or, from an engineering point of view, a loss of value. We might say that, though the energy Q has not been altered in amount, it has become a less marketable commodity by the change. It thus becomes important to examine exactly where and how the change of entropy has taken place, that is, to extend the notion of entropy to the ether.

If we begin by attempting to apply reversible thermodynamics to the ether, we arrive at a single result only, namely, Boltzmann's differential equation connecting Maxwell's formula for the radiation pressure with Stefan's law for the intensity of radiation inside a black cavity. For this particular kind of radiation entropy is fully defined, and the energy per unit volume being proportional to the fourth power of the absolute temperature, the entropy is proportional to the cube, being 4/3 of the energy divided by the temperature.

In this case there is no violation of the relation between unavailable energy and entropy which forms the basis of the thermodynamics of a material body. At the temperature of the cavity the unavailable energy represented by the entropy is 4/3 of the total energy, but the discrepancy is accounted for by the work of expansion against the radiation pressure. Further, as the author shows, the gain of entropy when communication is established between two black cavities at unequal temperatures is calculable by ordinary thermodynamic methods, just as is the gain of entropy produced by diffusion of two portions of gas at unequal pressure or temperature or both.

Irreversible changes will necessarily occur at the surface of a body unless either the surface is perfectly reflecting or the incident radiation in the ether is of the character of black-cavity radiation; for the radiation emitted by a body is necessarily distributed in all directions, while it can absorb radiation falling on it in particular directions.

If, on the other hand, a uniformly heated black body is radiating heat into space, the radiation received at an external point will be limited in direction by the solid angle which the body subtends at that point, and this will decrease as the distance from the body increases, but no passage of heat from a hotter to a colder body is necessarily associated with the outward propagation of the radiation. We may imagine an ideal perfectly reversible burning glass capable of concentrating the radiation on a receiving body in such a way that it converges from all directions on the body, the solid angle formed by the directions being thus increased to 2π. If the radiating and receiving bodies are perfectly black, the latter will be in a state of thermal equilibrium with the ether if its temperature is equal to that of the radiating body, and the radiation may thus be absorbed at the temperature of emission by perfectly reversible methods.

This does not mean that the outward propagation of radiation from a finite body is reversible, for if a body, say a sphere, commences to radiate into infinite space previously devoid of radiation, available energy is lost in consequence of the radiation pressure set up. If, now, we imagine the sphere surrounded by a concentric perfectly reflecting sphere, and suppose that at the surface of this latter the energy of radiation per unit volume is ψ and radiation pressure f, then, if the volume of the sphere is decreased by dV, the sphere will have to absorb heat-energy ψdV which is unavailable at the temperature T of the sphere, and, moreover, available energy $f dV$ will have to be supplied in order to overcome the radiation pressure. Hence it appears that even in this case the entropy per unit volume at any point of the ether assumes the form $(\psi+f)/T$, where T is the black-body temperature corresponding to the same intensity of radiation per unit solid angle. And as the radiation proceeds outwards the quantity $f dV/T$ represents the gain of entropy over and above the quantity of entropy taken from the radiating sphere which is given by the dQ/T formula.

These introductory statements will give some idea of the difficult task which Dr. Planck has undertaken in his endeavour to trace the connection between radiation phenomena and the assumed principles of irreversible thermodynamics. So many physicists have given up this task as hopeless that Dr. Planck has had to rely, to a large extent, on his own investigations; and the list of original papers, published between 1896 and 1902, affords an insight into the amount of time and thought the author has given to the subject in its many and varied aspects. The present book, based as it is on the courses of lectures delivered by Dr. Planck at Berlin during the session 1905/6, is intended to place the whole subject before the reader in a connected form. Briefly stated, the following is the order of treatment:—

The book opens with an introductory sketch of definitions and first principles, the proof of Kirchhoff's law, and the definition of a black body. In the second section we have an investigation of Maxwell's formula for the radiation-pressure, Boltzmann's proof of Stefan's law, and Wien's law of distribution of the energy over the different parts of the spectrum, based on the well-known application of a modified form of Doppler's principle. In the last chapter of this section Dr. Planck gives a general discussion of the entropy and temperature of monochromatic radiation. Although the method of treatment is different from that adopted in the introductory part of this review, the conclusions appear to be identical. In particular, it is pointed out that emission without absorption is irreversible, absorption without emission impossible.

In the third part emission and absorption are considered from the point of view of the electromagnetic theory. A resonator is under the influence of periodical or stationary waves. In these circumstances Dr. Planck investigates the oscillations induced in the resonator, and assigns meanings to the entropy and temperature of the resonator which account satisfactorily for reversible phenomena; but the equations of the electromagnetic field being deducible from those of rational dynamics cannot of themselves account for irreversibility, for, corresponding to the solution representing any given process, another solution representing the reverse process can be obtained by changing the sign of the time-differential dt. Whether the case is stated in this or in some other form, there is no *a priori* reason for asserting that waves cannot converge to a point as readily as they diverge from it. The convergent wave motion simply represents a second solution of the differential equation of propagation, which is commonly omitted merely on the grounds that the corresponding phenomenon does not exist.

The subsequent sections represent an exposition of the valuable work done by Dr. Planck in applying to radiation phenomena the same probability considerations which have led to such fruitful results at the hands of Boltzmann in connection with the kinetic theory of gases. Dr. Planck starts with the assumption that the entropy of a system in a given state depends in some way on the probability of that state, whence it follows that if the system consists of two parts which are independent of each other, and we assume that the entropy of the whole is the sum of the entropies of the parts, the entropy must be a logarithmic function of the probability. A short account of Boltzmann's work for the case of monatomic gases follows, and Dr. Planck then shows how to determine expressions for the entropy of radiation from analogous considerations.

Now Boltzmann's work was not independent of an assumed *a priori* law of probability. He first supposed that for an individual molecule all values of the energy were *a priori* equally probable, and, considering the case of a large assemblage of molecules the total energy of which was constant, he found that the most probable distribution only agreed with the Boltzmann-Maxwell law in the case in which the molecules were moving *in two-dimensional space*. To obtain the Boltzmann-Maxwell law in other cases it was necessary to start with the assumption that for an individual molecule all values of the *coordinates and momenta* were *a priori* equally probable. If we mistake not, Dr. Planck in § 148 starts with Boltzmann's first assumption. He supposes he has to deal with a large number N of resonators, that the total energy is divided into a large number P of equal elements, and that these elements are distributed at random among the resonators perfectly independently of each other. This is, of course, an assumption, but it is shown in § 150 to be equivalent to assuming that all values of the electric and magnetic coordinates of the resonator (f and df/dt) are equally probable. There appears, however, to be an alternative assumption in the case of oscillators distributed in space, namely, that all values of the rectangular components of f and df/dt are equally probable, and this might lead to a different result. Would it? and if so, which is right?

In any case, the important fact remains that Dr. Planck obtains results consistent with Stefan's law, notwithstanding that this law cannot possibly represent equipartition of energy at all temperatures between ether and matter. Perhaps the other assumption here suggested would result in equipartition, or the writer of this review has omitted to take account of something in the book. The fifth section is mainly taken up with applications to irreversible processes. In it the consequences of imagining a direct reversal of radiation processes are carefully discussed; the behaviour of an oscillator in a field of radiation is then investigated; the next chapter deals with the conservation of energy and increase of entropy, and, finally, we have a detailed discussion of the particular case of an oscillator exposed to black-body radiation.

It will be thus seen that Dr. Planck's work belongs to a class of investigation which has played an all-important part in building up our knowledge of physical phenomena. It deals with the logical consequences of certain well-defined hypotheses, and as such brings us measurably nearer obtaining a clear and definite idea regarding the irreversible processes associated with radiation. Moreover, the author is careful to define the limitations of his method. As he points out, an unfilled gap still exists in the theory, as he does not fully discuss the tendency to an equilibrium state between oscillations of different periods. The fact that the oscillators are really in motion shows, in connection with Wien's method, that there is a tendency to an equilibrium distribution, and this process may be capable of association with increase of entropy. All readers must express the hope that Dr. Planck may have an opportunity of pursuing this investigation further.

Dr. Planck's book has the great merit of being very readable and intelligible. It is quite easy to see everywhere what the author is driving at; many points of discussion that a reader would naturally suggest are considered by him exactly where the discussion is wanted, and it will be very easy to criticise the work in the light of any further developments which may arise at the hands of future investigators.

In extending the notion of entropy to radiation, he is working on the lines best calculated to advance our knowledge of thermodynamic phenomena. When a system is in the course of undergoing an irreversible transformation, the entropy at any instant is a definite quantity, provided that at that instant it is possible to conceive a reversible compensating transformation which would bring the system back to its initial state, and also that a definite line can be drawn between the forms of energy that are to be regarded as available and unavailable. In the case of radiation, it is important to push the notion of entropy as far as it will go. Only when this has been done, and the results compared with those of experiment, will it be possible to say whether any limitations exist in the statement that perpetual motion of the second kind is impossible; but the vague and indefinite statements that have hitherto been made regarding the possibility of such motion have mostly been based on the consideration of processes which, when performed cyclically, involve considerable absorption of available energy, and the prospects of obtaining perpetual availability from the ether in *ordinary* cases of radiation are anything but hopeful. G. H. Bryan.

ELEMENTARY BOTANY.

(1) *A Text-book of Botany.* By John M. Coulter. Pp. vii+365. (London: S. Appleton, 1906.) Price 5*s.* net.

(2) *A First Course in Practical Botany.* By G. F. Scott Elliot. Pp. viii+344. (London: Blackie and Son, 1906.) Price 3*s.* 6*d.*

(3) *First Studies of Plant Life.* By G. F. Atkinson. Edited for use in English Schools by Miss E. M. Wood. Pp. xiv+266. (Boston and London: Ginn and Co., 1905.) Price 2*s.* 6*d.*

(4) *A Text-book of Botany.* Part i. The Anatomy of Flowering Plants. By M. Yates. Pp. v+147. (London: Whittaker and Co., 1906.) Price 2*s.* 6*d.* net.

(1) INFLUENCED, it may be, by one's early training, it has always seemed most reasonable to begin an elementary course of botany with morphology, working in so soon as convenient the explanation of form and structure in the light of purpose served, an arrangement that is adopted by Prof. Coulter in his text-book.

The nature and modifications of leaf, stem, and root are first considered, after which the student is directed to the study of unicellular organisms, then to the examination of types of increasing complexity selected from the main taxonomic groups. The summaries of these groups have been carefully prepared, the account of the fungi being specially comprehensive yet brief. Following on the Bryophyta and ferns, a brief sketch of the two generations of the horsetails and lycopods leads up to the phanerogams. The lessons on flowers and fruits are introduced with the angiosperms, and ecology receives due recognition in the last few chapters.

As the book is liberally supplied with illustrations, chosen with much forethought, it is observable that Prof. Coulter has brought his extensive survey within a remarkably small compass. The merit of the book lies in the judicious selection of essential facts and principles. The numerous references to economic plants constitute a novel feature that is most noticeable in the chapters on the classification of phanerogams. There would be little or no objection to offer if the author made the most of their botanical characters, but these are omitted, and only commercial facts are given, occupying space that would be better filled with botanical information.

Apart from this adverse criticism the book deserves high commendation, and is admirably suited to its purpose for use in secondary schools.

(2) The practical course drawn up by Mr. Scott Elliot presents a somewhat unusual arrangement, inasmuch as the experiments are grouped on a morphological basis; this has, it is true, some advantages, but not sufficient to prefer it to the more usual physiological disposition.

A considerable amount of space is devoted to the flower, as, in addition to one or two chapters, full descriptions of two or more flowers are appended to each day's work. The practice of giving students, when time is available, a few flowers each day is excellent, but it seems unnecessary to provide detailed descriptions of all of them; further, the sequence—if there is a sequence—is not suitable to beginners. The theoretical discussions preceding, but not always relevant to, the practical work are also long, and curtail the space that is allotted to the actual experiments. The experiments, numbering nearly a hundred, are fairly representative, although the fundamental experiments of transpiration, respiration, and osmosis are not so satisfactory or complete as one could have wished. A sufficient amount of anatomical work is included, and a useful bibliography is appended referring the student to accounts of original investigations.

(3) Among the many elementary books dealing with plant life, the studies by Prof. G. F. Atkinson, published about four years ago, have a freshness and vitality of their own. The numerous references to American plants that are not known in this country robbed the book of much of its value for use in schools in the United Kingdom. This defect has been remedied by the introduction of British types, also, we note, of British expressions. Excellent as were the original drawings and photographs, the substitutes prepared by Miss Wood and Dr. J. W. Ellis are quite up to the same standard.

(4) The small volume prepared by Miss Yates is on the lines of the German "Repetitorium," and presents a collection of morphological definitions and terms with illustrations. In the course of thirteen chapters the author collates the different organs of flowering plants, their modifications, and the scientific terms

used to denote special features. The list of terms is very complete, and includes a few, *e.g.* "marcescent," "fovilla," and "sobole," that would not have been missed. A few of the definitions, notably those of the seed and leaf, might be more accurately expressed, and among misprints one of the most noticeable is "aetoeris" for "etaerio"; but on the whole the author has done her work well, and the book should prove useful.

THE PHOTOGRAPHY OF COLOUR.

Natural-colour Photography. By Dr. E. König. Translated from the German, with additions, by E. J. Wall. Pp. 94. (London: Dawbarn and Ward, Ltd., n.d.)

Colour-correct Photography. By T. Thorne Baker. Pp. 95. (London: Dawbarn and Ward, Ltd., 1906.) Price 1*s.* net.

THE first of these volumes deals with the reproduction of colour and the second with the representation of coloured objects in black and white or monochrome.

Towards the end of the first volume we read that "colour photography is not a purely mechanical copying of nature, carried out with mathematical precision, and that, indeed, it will never be. He who works quite automatically will never advance." The statement as to the present is certainly true, and the prophecy, though bold, is, literally, justifiable so far as experience goes. The reproduction of colour is thus essentially different from the representation of form, for this latter depends only on the perfection of one's instruments and a commonly intelligent use of them. Colour photography, as at present practicable, may be described as a kind of simplified chromolithography, inasmuch as the choice of colours rests with the worker or those who provide him with materials, and the depth of tint depends on the worker's judgment. Its distribution is mechanical, but, again, this depends on the colour-screens or filters used in the photography, which are never more than approximately what they are desired to be. And when it is remarked that the colours used are none of them permanent in the sense in which carbon or platinum is permanent, it is obvious that, so far as the colour goes, colour photography does not furnish more trustworthy records than painting or any other colour-production method, except, perhaps, that the possible errors of the unskilful may be a little more limited.

At the same time, there are certain principles which, if they could be perfectly applied, would give perfect colour reproduction. Remarkably fine work has been done by those who have adhered as closely as possible to these principles, as well as by those who have trusted chiefly to empirical methods. The volume before us is a small one; it merely mentions the underlying principles, being devoted almost entirely to the practical details of the "subtractive method" of three-colour photography, that is, where the three coloured prints are superposed so that their absorptions are added, and to the "additive method," in which the three colours themselves are added to each other, as when they are separately projected by optical means on to the same screen, or united in the eye itself by means of mirrors. That the two methods are not so radically different as they might at first appear to be is obvious from the fact that, to a certain extent, the colour-screens used are interchangeable. We think that a little more of the theoretical basis would have made the practical details more understandable. Spectrum diagrams of the effects of the various colour-filters might have been given, and, in dealing with three-colour work, some confusion might have been avoided by omitting the reference to yellow as a fundamental colour, thus giving four colours instead of three to deal with. We are astonished to read at p. 47 that "it is a recognised fact that photography always reproduces shadows much too dark." It would have been better to blame the photographer for this rather common error than apparently to justify him by suggesting that he is helpless.

As to the scope of the volume, photo-mechanical methods are altogether and designedly excluded, as the book professes to appeal to amateurs and others who are photographers, but not to commercial printers. The direct processes such as Lippmann's, and those in which the colour work is practically done by the maker of the materials, are only shortly referred to in the introduction. As a practical guide to the working of those methods that are now generally available for amateurs the volume will be found very useful, as it gives formulæ for the various colour-filters and dyes for staining, quite practical instructions for making the filters and other apparatus, and deals systematically with the subject.

Mr. Thorne Baker's volume is more than the title indicates, for he gives a chapter on the representation of colours incorrectly, as may be sometimes desirable for distinguishing emphatically between two or more colours. To get a coloured flashlight that will shorten the exposure by increasing the brilliancy of the colours to which the plate is less sensitive, he recommends to mix magnesium powder with a twentieth to a fortieth part of a mixture of equal weights of calcium and lithium carbonates. The author gives much other useful information in the ten chapters that deal with the various branches of the subject. We do not see, however, why the exposure should be shortened when the studio blinds are coloured instead of using a coloured screen as usual, nor why metol should be "*not* recommended" as a developer. Such advice would be more acceptable if the reasons for it were given. The explanation given at p. 85 of the fact that "the exposure required with cells of different thickness does not vary directly as their width" is incorrect; it is not a matter of absorption by the glass sides of the cell, but of the selective absorption by the coloured liquid. But the book as a whole forms a useful introduction to the subject, and contains some formulæ and suggestions rarely met with.

C. J.

ESSAYS AND ADDRESSES ON CHEMISTRY AND PHYSICS.

Abhandlungen und Vorträge zur Geschichte der Naturwissenschaften. By Prof. E. O. von Lippmann. Pp. xii+590. (Leipzig: Veit and Co., 1906.) Price 9 marks.

THE author of these collected essays and addresses, the director of the sugar refinery at Halle, is perhaps best known to English chemists by his contributions to the chemistry of the sugars and his comprehensive treatise on the same subject. Dr. Lippmann is clearly, not only a sugar technologist and chemist, but a classical scholar and litterateur.

The essays before us deal mainly with the history of various branches of physical and chemical science, and have been written, as a rule, to commemorate some special occasion. From the chemistry of Pliny and Dioscorides we pass to the history of freezing mixtures, of gunpowder, of the thermometer, and of bismuth. The history of sugar and the discoveries connected with its development have naturally claimed a share of the author's attention.

In the final section are included such divers subjects as the scientific work of Lionardo da Vinci, the philosophy of Francis Bacon, the natural science of Shakespeare, a tercentenary address on Descartes, and the law of the conservation of energy of Robert Mayer. The essays are short, the style simple and easy, and the matter excellent.

The ordinary chemist with little leisure for historical research and unequipped with the requisite classical erudition will find these pages full of things which he is glad to know. He discovers, for example, that Geber, whom he has probably been taught to venerate as the greatest of the Arabian alchemists, must take his place beside Basil Valentine as a mythical creation. In the abstract from Pliny's "Natural History" he will find that purified wool-fat (our modern lanoline) was a valued cosmetic among the Romans, and that they were familiar with both a hard and a soft soap. Whether these corresponded to their modern equivalents we are not informed, nor is it anywhere stated that the caustic alkalis were known, yet the saponification of tallow would doubtless necessitate the use of these substances.

One of the most interesting essays is that on the history of gunpowder. The author takes some pains to establish the fact that saltpetre, and consequently gunpowder, were unknown to the Greeks and Romans, and that the so-called Greek fire was a mixture of which the principal ingredients were mineral oil and quicklime. In contact with water, the heat generated by the hydration of the lime would ignite the mineral oil. The author brings evidence to prove that the Chinese were not the discoverers of gunpowder, and consequently that the Arabians did not introduce it into Europe from China during the eighth and ninth centuries as commonly supposed. The first Arabian writer to mention saltpetre lived apparently early in the thirteenth century, and the author considers that the knowledge of the manufacture of fireworks and gunpowder is derived from the "Firebook" of Marcus Græcus, which appeared about the middle of the thirteenth century in Constantinople, and was the source from which Roger Bacon, Albertus Magnus, and Thomas Aquinas drew their information. Finally, the use of gunpowder for discharging projectiles is ascribed to the monk Berthold Schwarz, or Bertholdus of the Black Art, who accidentally discovered its power when preparing the mixture for medicinal purposes. The last statement agrees substantially with Boerhaave's account, who says that Berthold made his secret known to the Venetians. "The effect is," says Boerhaave, "that the art of war has since that time turned entirely on this one chemical invention; so that the feeblest boy may now kill the stoutest hero," and he concludes with the pious wish, "God grant that mortal men may not be so ingenious at their own cost as to pervert a profitable science any longer to such horrible uses."

There is one curious point in this interesting story which seems to require explanation. Whilst the author considers that the *nitrum* mentioned by Pliny represents native soda, it seems unlikely that the efflorescence which Pliny also mentioned under nitrum as being collected from walls and used as a manure should in all cases have been this substance. The white efflorescence in cattle stalls and places where animal matter was undergoing putrefaction must have been a common observation, and must date back to a very early time. It is therefore difficult to believe that nitre was unknown until the thirteenth century, as the author states.

Further on in the volume we come across an interesting little contribution to the history of the thermometer in the form of a poem of the early part of the seventeenth century. The name of the first inventor of the thermometer seems to be wrapped in some obscurity. Although Boerhaave in his treatise ascribes the invention to Cornelius Drebbel, of Alcmaer, in W. Friesland, who lived in the sixteenth century, yet in the appendix to his "Elements of Chemistry," published in 1753, of which the writer possesses a copy, he states that Robert Fludd, an Oxford physician who lived at the beginning of the seventeenth century, found in an ancient manuscript a statement to the effect that it was an old invention which had been revived and improved.

One of the essays which is sure to attract the reader is the history of the sugar industry. The various steps are described by which the sugar-cane was transplanted from India to Persia in 500 A.D., introduced by the Arabs into Egypt about 640 A.D., thence along the shores of the Mediterranean to the Canaries, Madeira, and St. Thomas by the Portuguese in 1420, and so to the West Indies, where it flourished so luxuriantly that it killed the European industry. An interesting table of prices, which range from about 40*l.* the cwt. in 1260 to 7*l.* 13*s.* in 1800, is included at the end of the essay.

The two following essays are devoted to the rise and development of the beet-sugar industry, which, like that of the coal-tar dyes, is a history of successful scientific effort. It has taken less than a century for half the sugar of the world to be supplied from the beet.

Space will not permit a more extended review of this interesting volume, but enough has perhaps been said to indicate its character and scope.

J. B. C.

SCIENCE AND ART OF MEDICINE.

A System of Medicine. By many Writers. Edited by Prof. T. Clifford Allbutt, F.R.S., and Dr. H. D. Rolleston. Vol. i. Pp. xvi + 1209. (London: Macmillan and Co., Ltd., 1905.) Price 25*s.* net.

A PARAGRAPH in the preface to this new edition of Prof. Clifford Allbutt's great "System of Medicine" sufficiently explains the necessity for a revision. The editors (for Dr. H. D. Rolleston is now associated with Prof. Allbutt in this capacity) point out that "the life of a text-book of medicine is comparatively short, and that it is desirable that a new edition should appear before the first has ceased to represent accurately the present positions of medical knowledge." With this object it is intended to revise and bring out every year a new volume corresponding to one of the first edition.

The volume under review is the first to be issued under this scheme, and interesting and instructive articles by Prof. Allbutt and Dr. Payne on the history of medicine serve as a fitting introduction to the more technical portion. The first half of the latter comprises a number of articles, which are really concise monographs, on subjects ancillary to the practice of medicine, the names of the contributing authors being a sufficient guarantee of their general excellence. In this way the practitioner is furnished with brief but sufficient guides to such subjects as nursing (Miss Amy Hughes), dietetics (Sir Dyce Duckworth and Dr. Hutchison), climatic treatment of disease (Sir Hermann Weber and Dr. Foster), hydrotherapy (Sir Hermann Weber and Dr. Parkes Weber), physical exercises (Mr. Corner), massage (Dr. Mitchell), electrical treatment (Dr. Lewis Jones), X-rays (Dr. Williams), &c. The important subject of the hygiene of youth is dealt with by Dr. Clement Dukes, and a natural complement to this, old age, is discussed by Sir Hermann Weber and Dr. Parkes Weber. Medical statistics are in the able hands of Dr. Tatham, and a readable account of the national records of mortality is thus presented. It is a question whether some details of statistical methods and of the mathematical pitfalls of statistic making might not with advantage have been included.

Five articles have been devoted to the science of medicine; these comprise the general pathology of nutrition, by Dr. Mott; the general pathology of new growths, by Dr. Andrews, which includes all the recent work on cancer genesis; the clinical examination of the blood, by Dr. Drysdale, giving a good account of this important subject; inflammation, by Prof. Adami, probably the best account of this subject in the English language; and fever, by the late Sir J. Burdon-Sanderson, with additional chapters by Dr. Hale White and Dr. Pembrey.

The last 300 pages include some of the acute infections. Septicæmia, pyæmia, and erysipelas are dealt with by Mr. Watson Cheyne; infective endocarditis, by Prof. Dreschfeld; cerebro-spinal fever, by Dr. Ormerod (in which, by the way, no mention is made of the small outbreaks of this disease which have occurred in the British Isles since 1900); influenza, by Dr. Goodhart; and relapsing fever, by Dr. Rabagliati and Dr. Bulloch, the latter giving a very complete and up-to-date account of the bacteriology of the disease and of spirochætes in general.

Enteric fever and the so-called paratyphoid infections are treated in a very complete manner, Prof. Lorrain Smith dealing with the bacteriology and Prof. Dreschfeld with the clinical subjects; no point seems to have been overlooked.

Diphtheria is similarly dealt with in a very complete fashion; epidemiology, by the late Sir R. Thorne, revised by Dr. Hamer; bacteriology, by the late Prof. Kanthack, and revised by Dr. Andrewes; clinical features, by Dr. Gee; and serum treatment, by Dr. Herringham; in the latter section, while eight pages are devoted to statistics showing the efficacy of the treatment, a mere paragraph describes the dosage, &c., and no reference is made to the use of an anti-microbic serum in cases in which the bacilli persist during convalescence.

Tetanus is described by the late Sir George Humphry, the article being revised by Prof. Woodhead. An excellent account of the pathology of the disease is here presented, but the passage of the toxin along the nerve trunks is not emphasised so much as it might be, and no reference is made to the injection of anti-toxin into the course of the great nerves in cases of traumatic tetanus.

Altogether this volume commands admiration, and if its high standard be maintained, as it doubtless will be, in the succeeding volumes, this "System of Medicine" will form a lasting monument of the high place which British medicine holds at the present time.

PRACTICAL ZOOLOGY.

A Course in Vertebrate Zoology. By Dr. H. S. Pratt. Pp. x + 299. (London and Boston: Ginn and Co., n.d.) Price 7*s.*

THIS work, a companion volume to one on invertebrates published four years ago, is a laboratory manual, and gives directions for the dissection of the dog-fish, the perch, Necturus, the frog, a turtle, a pigeon, and a cat. It is on the whole a trustworthy guide, and may usefully serve as a handbook for a short course on vertebrate anatomy. The animals chosen are, with two exceptions, already described in text-books available in every laboratory, and we are at a loss to discover what particular office the present volume serves to fill, as in fulness, accuracy, or mode of treatment it does not surpass its predecessors. We presume that it represents the author's course of teaching, and owes its existence rather to the desire to emphasise that experience than to the supposed existence of a gap in anatomical literature which it may be held to fill.

As the writer desires attention to be directed to misstatements or improvements, we may limit our remarks to matters of detail, since of such accurately known types as those he has chosen the bulk of the descriptions can hardly be other than correct. In serial order, then, we note the following points on which revision is required.

The mucous canals of the dog-fish are termed sense-organs (p. 2), instead of the tubes containing the sense-organs; water is said to enter the spiracle as well as the mouth; the anus is described as the outlet of the cloaca (p. 3); and an ear-opening is affirmed and denied in the same paragraph (p. 15). But it is in connection with the nervous system that we encounter the least satisfactory description. No mention is made of the pre-olfactory nerve which has been demonstrated in elasmobranchs, nor of the buccalis branch of the lateral line system; whilst the old and incorrect statement that the lateralis nerve is a branch of the vagus is again repeated. The spinal nerves and limb-plexuses, to which so much attention has lately been directed, are omitted.

In the description of the perch the account of the nervous system is equally unsatisfactory, and there is the same absence of any attempt to delimit the nerves of the lateralis group or to point out their function and distribution. In this respect the work is very much behind the times. A serious slip occurs on p. 45, where, in connection with the ear of the perch, it is stated:—

"At the anterior end of the sacculus is a small pocket containing a minute otolith called the lagena; this is the structure which in mammals becomes the cochlea."

As it stands the sentence is nonsense, since, of course, the pocket, and not the otolith, is the lagena. A similar slovenliness of composition is responsible for such sentences as (p. 67) "Note the position of the limbs in reference to the trunk, which in Necturus is of a primitive character," in which it is hard to say whether the position or the trunk is referred to; or this, "If the human arm be extended straight out from the body with the thumb up . . . the back of the hand will be dorsal . . . ." We should have thought in the position referred to the hand would be vertical.

The description of the frog and of the turtle call for no special remark, but in his prefatory account of the pigeon the author states:—

"Another effect which has been correlated with the loss of teeth in the bird is the development of a greater intelligence. Inasmuch as the weight of the head is strictly limited by the conditions of the animal's existence, a larger brain could develop than would have been possible if the teeth which characterised primitive birds had not disappeared."

A larger brain and greater intelligence are certainly not convertible terms, and it is as misleading to speak of "primitive" birds in this connection as it is to assume that birds' brains have enlarged since Cretaceous times. Such a statement, however, is pardonable in comparison with the explanation of the air sacs on p. 169: "Their function is somewhat obscure but they probably help supply (*sic*) the lungs during rapid flight." The need for revising the physiological statements made in this book may be shown by this further quotation: "it is largely because of the development of feathers that birds have become warm blooded"! (p. 166).

The use of the book would have been aided by putting practical directions into special type, and by giving fuller instructions for the injection of blood-vessels. But, notwithstanding these drawbacks, the work remains as a useful guide to those teachers who wish to arrange a course in comparative anatomy.

F. W. G.

TARIFF REFORM AND THE EMPIRE.

Compatriots' Club Lectures. First Series. Edited by the Committee of the Compatriots' Club. Pp. vi+327. (London: Macmillan and Co., Ltd., 1905.) Price 8*s.* 6*d.* net.

THIS volume consists of a series of papers and lectures given at meetings of the Compatriots' Club, a non-partisan body, "constituted" (as the prefatory note states) "in March, 1904, with the object of advancing the ideal of a united British Empire, and of advocating these principles of constructive policy on all constitutional, economic, defensive, and educational questions which help towards the fulfilment of that ideal."

Although the club is non-partisan, the same cannot be said of the papers in this volume. They are mostly controversial in tone, and too frequently adopt the vocabulary of the political platform. The object throughout is to advocate Mr. Chamberlain's Tariff Reform proposals. The two most prominent writers on economic subjects among the contributors are engaged in almost purely personal conflicts with their opponents on the fiscal question. Prof. Ashley, in "Political Economy and the Tariff Problem," gives an interesting, and indeed masterly, sketch of the progress of economic science from Adam Smith and Friedrich List to the present time, with the main object, however, of providing a counterblast to the manifesto on the fiscal question by fourteen English economic experts, which appeared some two years ago. Dr. Cunningham, in "Tariff Reform and Political Morality," attacks the same manifesto on the curious ground that it was an attempt to "provide the public with excuses for apathy"—"to undertake to do their thinking for them." He makes a similar complaint, with perhaps more point, about another manifesto, signed by some eminent ecclesiastics, which appeared in the *Guardian*, and, incidentally, comes into conflict with Mr. Harold Cox and the editor of the *Echo*.

Mr. J. L. Garvin's paper, read at the inaugural meeting of the club, and since published as a supplement in the *National Review*, on "The Principles of Constructive Economics as Applied to the Maintenance of Empire," which appears first in the volume, describes the club's *raison d'être*. Conscious purpose and effective action of the State itself are to take the place of *laisser faire*. What follows is a re-statement of Mr. Chamberlain's proposals and an estimate of their effects upon national development and Imperial unity. So far he is clear enough, but his argumentative methods are not convincing. He discards the use of statistics, since they do not rouse enthusiasm, and since "no cause was ever carried by figures." Enthusiasm without knowledge is dangerous, and the cause which Mr. Garvin advocates can hardly be carried without figures. Consequently, his recapitulation of the familiar assertions concerning the decline of British industries carry little weight. Mr. Garvin, indeed, admits the general prosperity of this country, but considers it the result of our exceptional natural resources. Elsewhere he attributes the prosperity of Germany and America to their tariffs, not (so far as can be gathered from this paper) to their natural resources. He also makes a bold attack upon the "fallacy" that exports balance imports, but argues from the point of view of *supply*, leaving *demand* out of consideration.

Mr. H. W. Wilson, in "Tariff Reform and National Defence," makes a strong plea for efficiency in the services, and especially for the increased superiority of our naval power. He regards Tariff Reform as the only possible means of raising the required revenue. He adds two valuable tables illustrating the naval expenditure and strength of the chief Powers.

In "Imperial Preference and the Cost of Food," Sir Vincent Caillard maintains that preference will not raise prices, apparently because the foreign producer can defeat the preference given. Sir John A. Cockburn deals with "The Evolution of Empire"; Mr. H. A. Gwynne with "The Proper Distribution of the Population of the Empire," in the course of which he makes some startling suggestions for encouraging emigration to the colonies by State action; and Mr. John W. Hills, in "Colonial Preference in the Past," summarises the history of the "old colonial system," without, however, noticing its effect upon the loss of the American colonies.

J. H. S.

IMPERIAL FOREST POLICY.

Manual of Forestry. Vol. i. Forest Policy in the British Empire. By Dr. W. Schlich, F.R.S. Third edition, revised and enlarged. Pp. ix+246. (London: Bradbury, Agnew and Co., Ltd.) Price 6s. net.

IN the present edition Prof. Schlich has made some important additions which add considerably to the value of the volume. The volume is divided into three parts, viz. part i., the utility of forests; part ii., the State in relation to forestry; and part iii., forestry in the British Empire.

In part i. the direct and indirect utility of forests are considered, and the author has stated in a very clear and concise manner the great importance of forests to man. Sometimes people are too apt to estimate the utility of forests according to the money value of the timber grown, and to forget the important and beneficial influence which proper afforestation confers on the soil, the climate, and the whole sister industry of agriculture. The indirect utility of forests is of importance, not only to the proprietor and agriculturist, but to the entire State, and is one of those questions of general interest which has been almost wholly neglected in the past. The author deserves great credit for bringing this matter so prominently into notice.

The duty of the State in relation to forestry forms the subject-matter of part ii., and here the author is entirely at home with a subject to which he has given much time and thought, and on which he is a recognised authority. The extent to which the State should go in maintaining, or assisting in the maintenance of, forests is carefully considered from a thoroughly practical point of view.

In part iii. the wider question of forestry in the British Empire is dealt with in a very masterly fashion. As a result of his long experience and wide knowledge, the author is well able to deal with this subject. Space forbids our entering into details, but we are quite certain that but few people realise the enormous amount of revenue which is at present lying dormant or actually lost to the Empire through the deplorable inattention that is given to many of our colonial forests. India is, of course, a notable exception, and the success which has attended proper forest policy in that part of the Empire should stimulate other colonies to follow the good example. This, however, they seem slow to do. Nevertheless, there are signs of awakening interest, for example, in Canada. Many of our colonial forests have suffered severely at the hands of settlers through pure lack of knowledge. It is quite possible to use the forest without abusing it, and to cut timber in such a way that the forest will continue to give a sustained, if not increasing, yield; but this implies a proper knowledge of forestry, and here the author makes out a strong case for improved educational facilities, the end results of which would be increased revenue and benefits from our forests at home and in all parts of the British Empire.

As an example of what may be done in this direction, Prof. Schlich shows (p. 106) how, principally through the exertions of one man, namely, Dr. Brandis, "the greater portion of the Lower Burmah teak forests was saved, forests which now yield an average annual net revenue of $2\frac{1}{2}$ million rupees."

The volume contains many well-chosen photographs to illustrate the different points mentioned in the text, as well as a rainfall map of India. A useful appendix dealing with forestry in the United States is also included in the book. The author is to be congratulated on the production of a work which is of true importance from a national point of view.