THURSDAY, JUNE 22, 1893.

THE THEORY OF FUNCTIONS.

Theory of Functions of a Complex Variable. By Dr. A. R. Forsyth. (Cambridge University Press, 1893.)

WHAT is the theory of functions about? This question may be heard now and again from a mathematical student; and if, by way of a partial reply, it be said that the elements of the theory of functions forms the basis on which the whole of that part of pure mathematics which deals with continuously varying quantity rests, the answer would not be too wide nor would it always imply too much.

It cannot be denied that the teaching of pure mathematics in this country has followed curiously restricted lines. While in geometry and the theory of forms the student has for many years past had the advantage of excellent English text-books, the general theory of functions has been entirely unrepresented till the appearance of the treatise whose title stands at the head of this notice. Of treatises on special classes of functions, if we omit those written purely with a view to applications, Cayley's "Elliptic Functions," published in 1876, is the sole representative; while till last year there was no work on the theory of numbers. The theory of groups, and its applications to the theory of equations, is still unrepresented in native English mathematical literature, though here we have the translations of Prof. Klein's "Vorlesungen über das Icosaeder," and Herr Netto's "Substitutionentheorie," published, the one in 1888, and the other last year. At Cambridge, and probably to a great extent in other centres, the teaching and the course of study of individual students have tended on the whole to follow the lines of the available English text-books, and where these have been incomplete or entirely wanting there has, till very recent years, been no sufficient introduction to the corresponding subjects.

Why a subject of such fundamental importance for the advancement of pure mathematics as the theory of functions should have happened to fall into this latter class, it is not easy to tell. It may be said to have been first put on a secure footing by Cauchy's great memoir on integrals taken between imaginary limits, which was published in 1825. Many advances were made by a number of eminent mathematicians in the following years, and the study of the subject received a great impetus from the new and very fascinating method of presenting it which Riemann gave in his famous memoirs on the theory of functions of a complex variable (1851), and on the theory of the Abelian functions (1857).

Weierstrass and his pupils, again, developed their theory from a standpoint which is essentially distinct from that of either Cauchy or Riemann. The growth of the subject during the last thirty years has been remarkable, and it is probably safe to say that the foreign literature of the subject is now more extensive than that of any other branch of pure mathematics. The number of text-books that have been published directly on the subject is wonderful in itself, and more so when it is remembered that almost every foreign treatise on the Differential and Integral Calculus contains some introduction to the theory of functions.

If there is any justice in the preceding remarks, the want of a treatise on this subject has too long caused a serious gap in our mathematical literature; and it may be at once said that Dr. Forsyth's book supplies that want so completely that it is not likely to be felt again for a long time to come.

Among the large number of foreign treatises above referred to are several which, in their own line, it would be difficult to improve upon; but they all, or nearly all, deal with the subject from a single point of view, being indeed written with that intention. Dr. Forsyth, on the other hand, has aimed at giving a complete introduction to the theory; and it may safely be said that, with his book as a guide, the task of the student who wishes to enable himself to follow its various recent developments will have lost half its difficulty.

The bringing of the various parts of the subject, and the different points of view from which they may be approached, into their proper connection with each other has here been done in the most masterly way; while though Dr. Forsyth expressly disclaims in the preface to have dealt at length with anything but the general theory, he has carried the developments of the subject in the direction of doubly-periodic and allied functions, Abelian integrals, and automorphic functions to a point from which the student can have no difficulty in passing on to the study of any recent work done in these branches.

It is impossible in the limits of a short article to give any complete account of a book extending to over 700 pages, but some attempt may be made to describe the order of treatment. The first four chapters are devoted to the simpler properties of uniform functions, their expansion in power-series and their integration. Chapters v., vi. and vii. deal with uniform transcendal functions, giving the principal results of the investigations of Weierstrass and Mittag-Leffler. In this connection the very remarkable result due to Weierstrass is given, which is expressed by him in the following words:—"Dass der Begriff einer monogenen Function einer complexen Veränderlichen mit dem Begriff einer durch arithmetische Grössenoperationen ausdrückbaren Abhängigkeit sich nicht vollständig deckt." The writer of a recent criticism in this journal would probably say that this statement deals only with the morbid pathology of mathematics; but the pure mathematician at all events should surely know, as far as possible, what is implied in the word function.

Non-uniform functions are introduced in chapter viii. They are regarded, to begin with, as arising from the various continuations of a power-series, the most general point of view that can be taken; Riemann's method of dealing with algebraic functions and their integrals not being introduced till considerably later. The following chapter deals with the integrals of non-uniform functions; and from the particular examples given arise some of the simplest singly- and doubly-periodic functions, whose properties, when uniform, are discussed in Chaps. x., xi., and xii. This part of the subject aptly ends with a demonstration, due to the author, of the theorem that if $f(u)$, $f(v)$, and $f(u+v)$ are connected by an algebraical equation with constant coefficients, $f(u)$ must be either an algebraic, a simply-periodic, or a doubly-periodic function of u. The proof of this important theorem by

Weierstrass, to whom it is due, has never been printed; and the only published proof, besides the one which Dr. Forsyth gives, appears in a paper by M. Phragmen in vol. vii. of the "Acta Mathematica," and is on entirely different lines. Whether either proof is entirely satisfactory is a point on which differences of opinion may conceivably occur, though of course there is no doubt as to the truth of the theorem itself.

Chap. xiv., which is headed "Connectivity of Surfaces," is purely geometrical, and strictly has nothing to do with the theory of functions. It was however necessary for the author to introduce such a digression if the following chapters dealing with Riemann's theory were to be understood, since there is no treatise to which reference could be made for the various theorems and results that have to be used. The chief properties of a Riemann's surface, regarded as arising from an algebraical equation between the variables, are discussed in Chap. xv. Though there is no difficulty in conceiving the geometrical nature of a Riemann's surface from a description, the relation between the surface and the set of functions (algebraische Gebilde) whose study it is intended to simplify is not so readily grasped at first by the student; and it would not perhaps have been amiss to have dealt with this relation in one or two simple cases, at some length, as an introduction to this part of the subject. In Chap. xvi., the surface still being regarded as defined by a given equation, the properties of uniform functions on the surface, and of their integrals, is investigated.

From this point to the end of the book we have to do, more or less directly, with the fundamentally new conception of Riemann which has been so wonderfully developed during the last ten or fifteen years. The Riemann's surface, as defined by a given equation, affords a most convenient means of study of a system of connected functions. Suppose, however, the surface to be given quite independently of any equation. The possibility at once suggests itself that the surface may serve as the definition of a set of connected functions. Riemann's own demonstration that this is the case has since been shown to be faulty, but the conception is an invaluable one, and it has been placed on a secure foundation by Schwartz (and others), by means of the so-called existence theorem. Chap. xvii. is entirely occupied with the proof of this theorem, and in Chap. xviii. follow the investigations with respect to the form and nature of the integrals and uniform functions, so shown to exist, on a Riemann's surface given arbitrarily.

Chaps. xix. and xx. deal at length with the theory of conformal representation. This forms one of the most obviously interesting parts of the subject, and is also one of those which lend themselves most readily to the purposes of application; and it is to be noted that, although owing to necessities of arrangement these chapters occur near the end of the book, the author suggests that, on a first reading, Chap. xix. should be taken at an early stage.

The last chapter in the book gives an introduction to the theory of automorphic functions, the previous one being taken up by a necessary digression on groups of linear substitutions. Dr. Forsyth follows M. Poincaré in actually obtaining analytical expressions for the functions in the form of the ratio of infinite series, analogous to the expressions for elliptic functions as ratios of the theta-functions. These analytical expressions, though of great interest, are too complicated in form to be readily used for deducing the properties of the functions they represent, so that their properties must be inferred from their quasi-geometrical definition by means of a "fundamental region"; and this is essentially the method of dealing with them used by Prof. Klein.

In thus shortly stating the contents, or rather the headings, of the successive chapters some risk is run of representing the book as a mere compilation. Nothing could possibly be further from the truth. From the nature of the case it is inevitable that the greater portion of the book should be taken up with detailing the results of other writers, but Dr. Forsyth has done this in a most independent way. The book is instinct all through with an original spirit; in numerous instances, where clearness or conciseness were to be gained, the author has modified or completely altered the usually-given proofs, while, as has been already stated, the various parts of the subject have been brought together, and the many different ways of dealing with them have been used, in such a way that the theory is presented to the reader as a connected and harmonious whole. Dr. Forsyth is to be warmly congratulated on having brought to so successful a conclusion what must have been an extremely arduous task. If it is not ungracious to "ask for more" so soon, we may express the hope that he will now go on to deal, as completely and successfully, with functions defined by differential equations.

The book itself is beautifully printed and the figures, many of which must have required careful drawing, are well reproduced. The table of contents is sufficiently complete to form a sort of *précis* of the whole; and lastly, we have to be grateful for three separate indices. The first of these, an index to all the technical terms used in the book, whether English or foreign, is a most useful addition; especially for those who wish to use the book without reading right through it. W. BURNSIDE.

TINCTORIAL ART AND SCIENCE.

A Manual of Dyeing: for the use of Practical Dyers, Manufacturers, Students, and all interested in the Art of Dyeing. By Edmund Knecht, Ph.D., Christopher Rawson, F.I.C., and Richard Loewenthal, Ph.D. (London: Charles Griffin and Co., 1893.)

THE present work consists of three volumes, two of letterpress, interspersed with illustrations of plant, which run to over 900 pages, and a third volume containing specimens of dyed fabrics. It is a substantial contribution to an important branch of technology, and the authors have succeeded fairly well in meeting the requirements of the various classes of readers for whose use the work has been written. The first general impression produced on looking through the volumes is one of satisfaction that the subject is handled in a more scientific way than has hitherto been the case in such works. The only feeling of disappointment to which the consideration of the book gives rise is in no way attributable to the authors, but is due to the circumstance that so little is known about the scientific relationship between a colouring-matter and the fabric which is dyed thereby. All that is known about the theory of dyeing is ably stated in the introductory chapter, and one of the

authors (Dr. Knecht) has himself made some very interesting investigations in this field. But, in spite of all that has been written, the subject of dyeing has still to be taught as an art rather than as a science. The centres of the tinctorial industry in this country, such as Leeds, Manchester, Bradford, and Huddersfield, are now provided with Technical Schools, in which the dyeing department is made a special feature. If we might venture to offer a word of advice to those who are providing for this industry, it is that adequate provision should be made for the scientific side of the subject by the equipment of laboratories and the appointment of competent specialists for carrying on original investigation in connection with dyeing. The dyeing departments in those schools which we have had the opportunity of visiting are admirably equipped for instruction in the principles of the art, but the instructor has to devote so much time to this part of the work, and the students who attend are, as a rule, so ill-prepared in general scientific training that the instruction given cannot rise much above that handicraft level against which the writer has had so frequently to protest in connection with other branches of technology. Till this defect is remedied, the results achieved by our technical schools will not be commensurate with the endowment bestowed upon their equipment.

The work which has given rise to these reflections will go far towards placing the tinctorial art on a higher scientific level. It is not, as the authors state in the preface, "a mere 'cookery-book,' containing 'rule of thumb' recipes." A detailed analysis of its contents would be out of place in these columns, but a general idea of its scope may be given. The introductory chapter, as already stated, deals with the theory of dyeing. So far as wool and silk fibres are concerned, the authors consider that the evidence is in favour of a chemical as opposed to a purely mechanical explanation :—

"According to the mechanical theory, wool dyed with magenta, for instance, would simply absorb the unchanged hydrochloride of the dyestuff, and thus assume the same colour in the solution of the dyestuff. But experiment has shown that this is not the case. It absorbs the colour base, which is, however, in itself colourless. Where then does the colour come from? We can come to no other logical conclusion than that the colour base has combined chemically with some constituent of the fibre to form a coloured salt."

But this explanation does not enable us to see how the dyed "constituent" is combined with the other constituents of the fibre :—

"This objection is easily met by assuming that what is taken up *is* in chemical combination with some insoluble constituent of the fibre and is held by the rest of the transparent or translucent substance of the fibre in a state of *solid solution*."

Thus the theory advocated is partly chemical and partly in that debateable region where chemistry and physics have recently come into apparent collision. Researches in connection with the theory of dyeing have more than a purely technical value, and we hope that Dr. Knecht will continue the good work which he has commenced. With respect to cotton the authors state :—

"With the large numbers of direct cotton colours which are placed at our disposal, and which are continually increasing in number, the question becomes more and more important from a theoretical point of view. It is not probable that it will ever be solved by vague theoretical speculations based on one or two known facts. In all probability the solution of the question will require much laborious work, including many quantitative determinations."

The technical part of the work begins with Part II., dealing with the textile fibres of vegetable and animal origin, such as cotton, flax, hemp, jute, China grass, wool, silk, &c., not omitting Chardonnet's artificial "silk" prepared from nitrated cellulose. The third part is devoted to water from the dyer's point of view, and the fourth part to washing and bleaching. Parts V. to VIII. deal with the materials used in dyeing. All these materials are classified into the three groups, Chemicals, Mordants, and Dyestuffs, and are described under the collective (and most objectionable) name of "drugs." The acids and alkalies employed by the dyer are first treated of, then the mordants, which are discussed in a very thorough manner, no less than 150 pages being devoted to them. Three parts (VI., VII., and VIII.) are devoted to the natural, artificial organic, and mineral colours respectively.

The machinery used in dyeing forms the subject of Part IX., the investigation into the tinctorial properties of colouring matters that of Part X., and the concluding part treats of the analysis and valuation of the materials used by the dyer. There is an appendix of miscellaneous subjects such as weights and measures, thermometer scales, specific gravities, light and colour, &c.

The foregoing synopsis of its contents shows that the work is well calculated to fulfil the object which the authors had in view, viz. to serve "as a book of reference or *vade mecum* to the educated dyer." But it is not really for an individual class that this book is written; it appeals to several distinct kinds of readers. It may safely be asserted that there are few, if any dyers, in this country, however "educated," who could with equal intelligence follow every section of the work under consideration. The practical dyer who is most skilful in applying colouring matters to fabrics is generally hazy in his notions of chemistry, and absolutely ignorant so far as concerns the finer questions of the "constitution" of the complex products which chemistry has placed at his disposal. In order to understand properly the chemical portions of this manual a very sound foundation of chemical science must have been previously laid. On the other hand, a person who is thoroughly acquainted with the chemistry of dyestuffs would be worse than useless—he might be actually destructive—in the dye-house unless he had been trained in the application of colouring matters on a large scale. We are sometimes told that the practical dyer need know nothing of chemistry; that he would not do his work any better when possessed of such knowledge. There are still to be met with here and there so-called "practical" men who go further and assert that the possession of too much chemical knowledge would unfit the dyer for his work. But public opinion appears to be undergoing a healthy change in this as in other departments of technology. It may be long before we produce the ideal technologist who is equally acquainted with the chemical nature of his materials and the mechanical methods of applying them. It appears, however, that this combination of knowledge is just what is wanted in the industry. The joint authorship of the present manual perhaps

supplies the best illustration of this principle that could be furnished.

A word or two as to the illustrations, of which there are no less than 116 incorporated with the text. We notice with some regret the prevailing fault so common in technical manuals: no scale of size is in any case given. This perhaps is of no consequence to the practical dyer who is already acquainted with the "plant," but as the work is also intended for students the omission is serious. Much of the machinery also is of foreign make; it is to be hoped that this has not the same significance as the fact that by far the greater number of artificial colouring matters described in the seventh part are of foreign manufacture. In the art of dyeing this country still holds a very good position, and it is satisfactory to find that the authors have not had to go outside Yorkshire for the dyed patterns forming the third volume of their work.

Perhaps the best recommendation that we can offer in favour of the present manual is that there is nothing which in our opinion calls for very serious criticism. The chemical formulæ might, in many cases, have been more economically packed; in some instances "bonds" have apparently dropped out (benzoflavine, p. 469; nile-blue, p. 486, and the oxazines generally; anthracene, p. 577, &c.). The authors formulate the so-called "bicarbonates" on p. 68 on the type $M''O(CO_2)_2$. The utility of the third volume would have been much enhanced if the pattern sheets had been paged and indexed separately, so as to have facilitated reference to any particular pattern. The appendix on light and colour (p. 881) wants amplifying in view of the importance of this subject to the tinctorial industry, and some account of Abney's researches on colour should have been given. This section would also have been made more intelligible by the introduction of a few illustrations of absorption spectra and the practical method of mapping them.

About seventeen years ago we had occasion to notice a work of a somewhat similar nature in these columns (vol. xiii. p. 283). No more striking illustration of the advancement in the art of the dyer could be furnished than by comparing that work (Crace-Calvert's "Dyeing and Calico Printing," by Stenhouse and Groves) with the "Manual" of Dr. Knecht and his colleagues. Other works have appeared since that time, some of real value, others mere compilations pandering to the examination fetish. It would be invidious to institute comparisons; suffice it to say that the present work will compare favourably with any treatise in this department of applied science.

R. MELDOLA.

A NEW MANUAL OF BACTERIOLOGY.

A Manual of Bacteriology. By George M. Sternberg, M.D., Deputy-Surgeon-General U.S. Army. (New York: William Wood and Co., 1892.)

A YOUNG and rapidly-growing science continually demands a series of new text-books for the use of those students who would keep themselves abreast of the times, and it is, perhaps, inevitable that, with the growth of knowledge, the text-books should assume more and more alarming proportions. The present work—a portly tome of nearly nine hundred pages—comes to us from across the Atlantic as the latest, the largest, and, let us add, the most complete manual of bacteriology which has yet appeared in the English language. The volume combines in itself not only an account of such facts as are already established in the science from a morphological, chemical, and pathological point of view, discussions on such abstruse subjects as susceptibility and immunity, but also full details of the means by which these results have been obtained, and practical directions for the carrying on of laboratory work. It is thus, as stated in the preface, at once a manual for reference, a text-book for students, and a handbook for the laboratory. And in the mind of the reader there may arise the question whether the attempt to combine the three has not resulted in a volume of somewhat too portentous a size.

Dr. Sternberg is well qualified for the task he has undertaken. Himself a well-known worker in bacteriology, and director of the Hoagland Laboratory in Brooklyn, his work is no mere compilation of the results of others, but embodies also the fruits of his own original thought and observation. The amount of labour involved in bringing together from the literature of different countries the facts necessary for a manual of this kind may be estimated from the fact that the bibliography alone fills over a hundred pages and contains 2582 references. The illustrations are numerous, clear, and accurate; many of them are printed in colours, and there are some good reproductions of microphotographs.

The work is practically divided into four parts, and of these the first is mainly occupied by an account of methods and of practical laboratory work, preceded by short sections on the history of the subject, on classification, and morphology. These are clear and concise, the basis of classification adopted being practically that of Baumgarten, in which the different genera are grouped under the three main headings of "micrococci," "bacilli," and "spirilla." The practical directions include staining methods, the preparation and sterilisation of culture media, and the various modes of cultivation, together with directions for experiments on animals. These subjects are dealt with very fully, and will be found to embrace all that can be required for laboratory work. A short section on microphotography concludes this part. Many English ears will resent the term "stick-culture," which is used as the equivalent of the German "stich-cultur"; and, indeed, in other instances it would have been possible to employ more euphonious translations of the original German terms. It may also be noted that in describing Chamberland's filter that gentleman's name is incorrectly spelt in every instance.

The second portion of the book deals with the biology and chemistry of bacteria, and the important subject of disinfection and antiseptics. Details are given of the modifications which may be artificially induced in the biological characters of bacteria, and especially of those by which attenuation of virulence can be produced in pathogenic species. The section on the products of vital activity contains an account of the various fermentations and decompositions known to depend on bacterial action, and is followed by one on the ptomaines and toxalbumins produced by certain species. The subject of disinfection is then treated at some length, embracing a description of the effects on micro-organisms of dry and moist heat of acids, alkalies, various salts, and coal-tar products, which is fully up to date and leaves little to be desired. The whole concludes with a useful summary of means of

practical disinfection, based mainly on the report of the Committee on Disinfectants of the American Public Health Association.

The third part, the most important division of the book, deals with pathogenic bacteria in detail, and is prefaced by a description of their modes of action, and of the ways in which they may gain access to the system. Here too we find a discussion on the difficult subjects of susceptibility and immunity, to which indeed Dr. Sternberg has elsewhere made important contributions. The discussion is lengthy and impartial, and well deserves careful reading. Relying on recent experimental evidence, the author reaches a guarded conclusion that acquired immunity depends on the formation of antitoxins in the bodies of immune animals. Subsidiary weight is given to the view, which he formerly upheld, that the cells of the body may acquire tolerance to the toxic products of pathogenic organisms, and also to the doctrine of phagocytosis, to which he gives a partial assent. A recent lecture by Metschnikoff on the latter subject is reproduced *in extenso*. It is impossible here to follow in detail the descriptions of the different pathogenic bacteria. The order in which they are discussed is necessarily somewhat arbitrary, but is convenient, and follows the broad grouping into micrococci, bacilli and spirilla. Amongst the pyogenic organisms Fehleisen's *Streptococcus erysipelatos* is frankly placed as identical with *Streptococcus pyogenes*, an arrangement with which many will not agree. Altogether no less than 158 organisms are described as pathogenic for man or the lower animals, and according to their relative importance the descriptions are in large or small print—an arrangement convenient for the student. A section follows on bacteria in diseases not clearly proved to be of bacterial origin, and the whole concludes with a classification of pathogenic organisms from a pathological standpoint.

The fourth part of the book deals with saprophytic bacteria, special chapters being devoted to bacteria in air, in water, in soil, in or on the human body, and in food. The total number of saprophytes described is 331. The merit of a work of this kind depends less on the number of species described than on the clearness and accuracy of the descriptions, and Dr. Sternberg has spared no pains to make these as complete as possible. To facilitate the recognition of species a chapter on bacteriological diagnosis has been added, in which the different organisms are grouped according to their form, cultural characters, and other peculiarities. This section will be an important aid to the student in identification. A lengthy and well-classified bibliography brings the work to a conclusion, and the whole is well indexed. The author is to be congratulated on the success with which he has accomplished a difficult and laborious task.

TEXT-BOOKS OF ZOOLOGY.

Lehrbuch der Zoologie. By Prof. Richard Hertwig, of Munich. (Jena: Gustav Fischer, 1891.)

Zoology of the Invertebrata. By Arthur O. Shipley, Fellow of Christ's College, Cambridge. (London: A. and C. Black, 1893.)

IT is a difficult matter to say much that is readable about text-books which are produced by teachers with a view to the limited requirements of their own pupils. Some text-books are, so to speak, obviously addressed to the world—are intended by their authors to be consulted both by the advanced student who is himself a teacher, and by all serious followers of the science dealt with. Others have their justification in being epitomes of a professor's or lecturer's teaching, suitable to his immediate pupils. The former class challenge criticism, and have a high standard of interest; the latter class are hardly fit subjects for appreciation, and possess a very limited importance.

Prof. Hertwig's text-book of Zoology is one which will no doubt be found serviceable by his pupils, and by the younger students of German universities. It is constructed on the usual lines, and contains nothing either in treatment or illustration which the author would probably wish to submit to his colleagues as novel or important. It has not the stamp of originality and freshness which gives a character and significance to Prof. Berthold Hatschek's unfinished text-book. It is well illustrated by the aid of the new "process" methods, and must be estimated as much by the judgment displayed in the omissions necessary in so condensed a work as by the actual statements which it embodies. The latter are, though not novel, sufficiently up to date.

Mr. Shipley's book on the Invertebrata appeals to an even more limited circle than Prof. Hertwig's. Professedly it is addressed to those who only wish to learn a very little about zoology, and who will be content to dispense with all bibliography, and even with reference to the names of authorities for the statements and for the systems of classification which Mr. Shipley incorporates as accepted fact. Presumably Mr. Shipley's book is intended for Cambridge students who take zoology in Part I. of the Tripos, and do not proceed to Part II. The book will no doubt prove useful to these students. To others, a more critical, more comprehensive, and more authoritative treatment of the subject must be recommended. To those who are not acquainted with special circumstances which may have determined the author's procedure, it must appear a matter for regret that when producing a volume so well printed and largely illustrated he did not make it more thorough. It is not possible to discuss the opinions adopted by Mr. Shipley upon several questions of interest, because he himself does not treat them argumentatively, but rather as matters of information to be accepted by the pupil from his tutor. Zoology, when deprived both of history and of argument, is singularly uninteresting, and will perhaps in this shape gain approval as a subject of school-education.

E. RAY LANKESTER.

OUR BOOK SHELF.

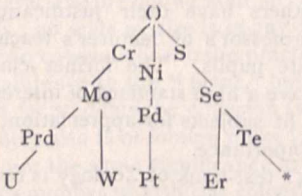
Das Genetische System der chemischen Elemente. Von W. Preyer. (Berlin: R. Friedländer und Sohn, 1893.)

THE treatment of the material contained in this book is based on the idea that the elements have been produced from hydrogen, or ether, or primordial matter, by a process of condensation.

The fourteen horizontal rows of the periodic table are regarded as representing fourteen different degrees of condensation of the initial substance, and the rows are then connected together so that they fall into five different groups, each of which group constitutes a generation.

The system works out in such a way that each element in the first row of the periodic table becomes the parent of all the elements in its own vertical series.

Oxygen, for instance, is the root of the following geneaogical tree:—



Chromium, nickel, and sulphur, in this way belong to the second generation. Molybdenum, paladium, and selenium to the third generation, and so on. The constants of the elements, such as atomic weights, densities, atomic volumes, specific heats, atomic heats, and their electrical and magnetic properties, their valency, &c., are then discussed with the view of justifying the mode of treatment adopted. It is here shown that on arranging the elements according to the author's system, besides the well-known relations between properties and atomic weights, additional simple numerical relations are traceable between the magnitudes of the atomic constants themselves, and also between these magnitudes and the numbers denoting the degree of condensation of the groups to which the elements belong. The use to which these may be put as a means of controlling the values of atomic weights and predicting the properties of undiscovered elements is indicated.

The second and not the least useful part of the book contains a collection of physical constants, from which the data used in the first part were chosen.

The book is a suggestive contribution to the literature on a subject which since the time of Prout has been prolific of speculation, but which even yet seems slow to condense and take a form sufficiently definite to warrant its being raised to the rank of a theory. J. W. R.

The Future of British Agriculture. By Prof. Sheldon. (London: W. H. Allen and Co., Ltd., 1893.)

THE opening chapters of this little book are devoted to the solution of the questions, "Will wheat-raising pay in Great Britain?" and "Is wheat to be no longer king?" After indicating the reasons which led to the enormous reduction of land under wheat—a decrease of something like 42 per cent. within the last twenty-five years—Prof. Sheldon comes to the conclusion, that, notwithstanding the importation of foreign wheat, and the fact that an ever-increasing demand for milk (of all farm products the least suitable for importation) necessitates larger areas of grass land, wheat-growing will not only continue, but may soon reach its former position, an event which he would not consider to be "a sign of unadulterated good." In connection with the question of wheat-production in the United States, there is one statement, made on the authority of leading American statistical experts, which we venture to think requires qualification, namely, "that in less than twenty years from 10 to 15 per cent. of the people's food will have to be *imported* into the United States." This is a point on which there may well be diversity of opinion, but, as pointed out by Messrs. Lawes and Gilbert in their recent paper on "Allotments and Small Holdings," the conditions will be quite changed with increased population, rotation will gradually become general, yielding various food products for home consumption; the soil will be better cultivated, yielding much larger crops of wheat where it is grown; straw and manure will no longer be burnt or wasted; and, lastly, there are still considerable areas of rich prairie land to be brought under the plough. So that it is probable that increased density of population will less rapidly diminish the capability of production for export than may, at first sight, be supposed.

Perhaps the most interesting chapters are those on dairy farming; and it will afford a good deal of consolation to the dairy farmers of this country to learn that Prof. Sheldon believes "the competition of the United States is within measurable distance of its limit."

The book concludes with a chapter on a most important subject—tenant farmers' interests. The author states his view of the matter in his usual clear and forcible manner, and incidentally refers to what he terms "exploded, impossible 'Protection'," and to "that new economic craze, 'Bimetallism'."

We welcome the book as a valuable contribution to our agricultural literature, and as a useful guide to those branches in which the author is especially qualified to instruct.

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.*]

Mr. H. O. Forbes's Discoveries in the Chatham Islands.

I WRITE a final line on this subject to express my regret that I should have misunderstood Prof. Newton and attributed to him (NATURE, p. 126 above) opinions in regard to the relationship between *Erythromachus* and *Aphanapteryx* which he does not hold.

On a point of accuracy, however, in regard to the "slight confusion of dates," allow me to say that I am sure no one will admit more readily than he that this had occurred, when I remind him of his letter to me of December 22, 1892 (now before me), in reply to a note of mine requesting him to be so good as to repeat his suggestion in regard to the name for the new genus, which I was about to describe, as I had mislaid his former note. "I have no memorandum," he says, "of what I suggested to you, but only an indistinct recollection that it was *Diaphorapteryx* . . . or something like that." This was, therefore, the date of the re-suggestion, and not my visit to Cambridge on February 23, 1893. *Diaphorapteryx* was described as a new genus in the Bull. Brit. Ornith. Cl., December 31, 1892.

HENRY O. FORBES.

The Fundamental Axioms of Dynamics.

A VERY brief reply to such of your correspondents as have favoured my paper with direct or indirect criticisms will at the present stage of the discussion be sufficient.

Referring first to Prof. Rücker's letter on p. 126, I acquiesce in the greater part of it—especially in its concluding paragraph, but it may clarify matters if I explain (1) that I do not contemplate *parts* of the ether, but regard it as an absolute *continuum*. Not the slightest advantage is gained by pushing action and distance back a step or two—it must be exterminated. (2) That I have no faith in "action at constant distance" other than distance zero. The reason such a phrase ever appeared in my papers is because that is all I am able to deduce from the assumption of the conservation of energy. It requires identity of energy to prove absolute contact. Hence I prefer to work backwards, and, assuming universal contact action or the denial of action at a distance, to deduce therefrom both the conservation and identity of energy.

Prof. McGregor contradicts three statements in the Report of the meeting of the Physical Society (p. 117), a report which is usually admirably done, and which was well done in this case. Though not responsible I reply to his three points categorically:

(1) He was *understood* to object to the Newtonian statement of the first law—not to the fact or law itself.

(2) A reference to the first two pages of his paper in the February *Phil. Mag.* will show him, I think, that he has now partially forgotten what he said on the second head.

(3) It is to be admitted at once that the phrase "equally well," not "well," was employed.

Now, turning to Mr. Dixon's letter (p. 149), it does not seem to me that he is perfectly candid. He accuses me in his concluding paragraph of an unfair practice by omitting the word "direct," but no such word occurred in his letter on p. 103, to which I was replying; nor is what he now says consistent with the surface meaning and intention of the second paragraph in his former epistle, so far as I can judge. A withdrawal of that hasty and misleading paragraph is what I had expected from him.

In the first paragraph to his recent letter he explains why he considers that the fact that potential energy belongs to a system is hostile to the idea of identity, but his proof does not appear to me valid unless the phrases "belongs to" and "has no local habitation within" are considered identical. If he can show that a given portion of potential energy "has no local habitation within a system," he will undoubtedly be usefully attacking the proposition that it possesses identity, but I do not see that he has even attempted such a proof at present.

OLIVER LODGE.

Popular Botany.

I VISITED Tyne Dock yesterday, in order to attempt to solve the question put by Mr. A. W. Bennett in your issue of the 1st inst.

The plants which caused the fatality grow in a small hollow close to a newly-opened road. The surviving child is but five years old, and therefore much too young for any evidence of hers to be convincing.

There seems little doubt, however, that the hemlock, *Conium maculatum*, brought about the death of the other two children. Large quantities of this, looking very attractive just now, are growing on the spot, together with smaller quantities of *Heracleum sphondylium*, *Anthriscus sylvestris*, and a very few plants of *Bunium flexuosum* at the margin of the hollow. No other umbelliferous plant is growing near. Yesterday, troops of children were gathering the young and pretty leaves of the hemlock, and making them up into bouquets with grasses and flowers.

The children, who died from the effects of eating the plant were aged respectively four and five years, and probably, in common with thousands of others in the district, would not recognise cabbage if they saw it growing, which very likely they never did. I have met many very much older children here who are as ignorant of common garden and field plants.

Gateshead-on-Tyne, June 12. JOHN BIDGOOD.

The Big and Little Monsoons of Ceylon.

IT is well known to all Anglo-Indians, even the least scientific, that the summer monsoon is ushered in by two periods of rain-burst, called respectively the chota and burra barsât. The former occurs sometimes in April or May, and the latter in June or July, the precise dates varying not only with the locality but with the year. The chota barsât only lasts a few days, and is looked upon as the advance guard of the burra barsât, or great rains.

The conditions which tend to produce the chota barsât have not, so far as I am aware, been studied in detail, but are probably similar in character though on a smaller scale, and more local than those which regulate the inception of the burst of the monsoon, as it is popularly termed. It can be readily understood that as soon as the solar rays are sufficiently powerful to heat up a portion of the land area, and by lowering the pressure to determine an inrush of surrounding marine air, condensation and precipitation will occur much in the same way as in the burra barsât when the air over the whole peninsula has become heated, and the saturated air from the equatorial Indian Ocean rushes in in a large and continuous stream towards the low pressure area thus formed. In the former case the conditions are not only more local and ephemeral owing to the small amount of vapour formed over a comparatively cool sea, but are mixed up with the residue of the cold weather disturbances, which are due to anti-monsoon conditions.

Mr. Blanford, in his admirable monograph on the rainfall of India, has compared the direct solar action which sets the monsoon in action to the pull of the trigger, by which the intrinsic latent energy of the resulting air-stream is shot forth. In the case of the chota barsât the comparison holds equally good only the resulting charge is feebler.

Now it has been recently maintained that while the distribution of temperature anomalies in the Indian peninsula regulates the inception of the little monsoon and its accompanying chota barsât, it is only when the central Asian plateaux become warmed up so as to produce an inflow beyond the Himalayan barrier, which must consequently affect the upper as well as the lower atmospheric strata, that any general deep movement of the equatorial vapour-laden air occurs on a scale sufficient to produce general monsoon rains. That in fact there are two movements, one in the lower air, and the other in the air above the first 5000 or 6000 feet, and that it is only when the two occur coincidently that we get the grander phenomena which accompany the burst of the big monsoon, as they term it in Ceylon. Some such theory appears necessary to account, not merely for the peculiar suddenness of the burst, but also for its variable date of arrival in different years. Until, however, we know more of the meteorological conditions of Central Asia and Thibet, this hypothesis must remain in a tentative state. Meanwhile, however, it is undoubtedly valuable to find that these two periods of rain-burst are not only distinct enough to be referred to under separate names over a large part of India, but in Ceylon are considered so important as to have their dates separately recorded by the Marine Master attendant at Colombo. In the excellent Ceylon *Mercantile and Planting Directory*, edited by the late Mr. A. M. Ferguson, and now carried on by his successor, Mr. J. Ferguson, a list is given of the dates of commencement of the little and big monsoons, from 1853 down o 1892 inclusive.

As a general result it is found that the average dates for the little and big monsoons are April 20 and May 19, and that when nothing particularly abnormal occurs, the big monsoon may be expected to follow the little one in about a month.

There are, however, considerable variations from this normal, the little monsoon date ranging through 52 days, and the big monsoon from May 1 to June 19.

On looking over these variations it struck me that they would probably be found to correspond to some extent with the rainfall of adjacent localities in India, especially the Carnatic. The result of a comparison of the anomalies is shown below—

	Ceylon.[1] Date of arrival of the big monsoon, before or after its average date, May 20. + Before − after days.	Carnatic.[2] Mean rainfall anomaly in inches (40 stations). Inches.
1864	+ 5	− 5
1865	− 11	− 5
1866	− 2	− 4
1867	− 30	− 9·4
1868	− 14	− 4·6
1869	− 28	− 0·3
1870	+ 9	+ 1·8
1871	+ 7	+ 5·5
1872	+ 18	+ 11·5
1873	− 4	− 0·1
1874	+ 15	+ 7·3
1875	− 8	− 5·2
1876	− 17	− 13·2
1877	+ 4	+ 8·3
1878	+ 1	0
1879	0	+ 2·3
1880	+ 5	+ 7·0
1881	− 9	− 2·1
1882	0	+ 4·4
1883	+ 10	+ 5·2
1884	+ 5	+ 11·6
1885	− 16	− 1·1

A mere glance at these figures shows at once a remarkable parallelism both in signs and numbers. Thus in eighteen years the signs are alike, neutral in three, and unlike only once. As it is well known that the rainfall of the Carnatic was found by Mr. Blanford to vary in a cycle of eleven years, closely corresponding with that of the sunspots,[3] the same ought to hold for the anomalies in the dates of arrival of the big monsoon at Colombo. As a matter of fact the relation appears to be still

[1] From the Ceylon Directory, 1892.

[2] From the Rainfall of India, Part II., Indian Meteorologieal Memoirs, 1887.

[3] Mr. Blanford computed the probability of such a cycle as compared to an invariable average to be as 655 : 1. Indian Meteorological Memoirs, vol. iii. part 2, p. 244.

stronger. Thus, excluding insignificant decimals from the sunspot figures, and taking the mean of three and a half cycles for the Ceylon dates from 1854 to 1891, and from 1864 to 1885 for the sunspots in pairs of years from Wolf's tables (the only sunspot data I have available) we get the following comparison :—

		Ceylon[1] monsoon dates. Mean abnormals.		Sunspots. Mean abnormals.
1856	1867–'78	− 7·5 min.		−38 min.
1857	,,	− 3·2 ,,		−34 ,,
1858	,,	− 1·0 ,,		−15 ,,
1859	,,	− 4·0 ,,		+27 ,,
1860	,,	+ 2·0 ,,		+44 max.
1861	,,	+10·0 max.		+37 ,,
1862	,,	+ 4·0 ,,		+26 ,,
1863	,,	+ 3·0 ,,		+ 9 ,,
1864	,,	+ 1·0 ,,		− 9 ,,
1865	,,	− 4·0 ,,		−21 ,,
1866	,,	± 0·0 ,,		−30 ,,

Better sunspot data would certainly not invalidate the connection. The lag behind the maximum sunspot data and the apparent tendency to precede the minimum has always been noticed in other phenomena. Moreover, from the analogy between the abnormals of the two elements compared both in quantity as well as sign the same remarks as to the reality of the cycle made by Mr. Blanford in his work (cited ante) p. 254 apply *pari passu* to that in the Ceylon dates.

A similar relation holds good for the little monsoon which may be put into words as early dates in years with increasing sunspot numbers and late dates in years with diminishing sunspot numbers, with a decided maximum of twelve days early in the year immediately succeeding that of maximum sunspots. Even the period between the two bursts shows symptoms of a similar relation to the sun's condition, the mean maximum interval, forty-three days, corresponding to the year of minimum sunspots, and the minimum twenty days occurring two years after that of maximum sunspots. The relation, however, is clearest in the figures for the burst of the big monsoon and seems to show that apart from all indirect influences such as accumulation of snows on the Himalayan outer ranges, and unusual winter rainfall on the plains or the reverse, there is a real fluctuation in the dates of the burst of the big monsoon or burra barsât connected with the sun's condition which appears to be more direct than that exhibited by the amount of rain which falls during its continuance and appears to indicate, as indeed is borne out by what we know from other sources, that in years of many spots the conditions which usher in the summer monsoon rains are earlier developed, and, as the amounts show, probably continue more regularly than in years of few spots.

Granting this as a working hypothesis two important results follow.

(1) The parallel march of the Ceylon dates and the rainfall of the Carnatic shows that the former could be employed to forecast the probable amount of monsoon rainfall about to be enjoyed in the latter district.

(2) That by using the mean abnormal of the year in its position in the sunspot cycle as the true mean instead of the mean of the whole period, the true abnormal for the year can be better estimated and the probable general character of the weather foretold.

As an example let us take the well-known diurnal variation of barometric pressure, whose amplitude in the tropics is so large that it bears a sensible ratio to the abnormal fluctuation produced by a passing disturbance.

In estimating the true abnormal at some particular hour of the day we must evidently compare the value with reference to the normal *at that hour*.

Similarly for the sunspot period in the case under consideration. If there is reason to believe that the period exists we ought to treat it as a reality, and in constructing graphic abnormals take the curve of the progressive cyclic normal as our abscissa axis instead of a straight line representing an endless repetition of the mean of the whole period. The principle is adopted as regards varying locality in drawing synoptic abnormal charts. It should be equally imperative in cases where the element of time is considered.

Thus in 1894, if the monsoon burst in Colombo twelve days before its time it would be abnormal to the extent of +2. On the other hand, if it were twelve days late, it would be abnormal to the existing mean to the extent of −22, and even to the new mean formed by incorporating this fresh value, to the extent of −16, and we might in such a case infer that some unusual cause was in operation which would certainly bode ill for the Madras agriculturists.

I have put these facts and considerations forward simply as a preliminary inspection of two phenomena which not only occur in Ceylon, but are more or less common to the Indian peninsula, and to show how conditions, the relations between which can at present only be exhibited in an empirical form, may yet be employed as a means of forecasting the character of a season, and also ultimately by further investigation help to elucidate the whole machinery by which the grand weather changes are produced by terrestrial physical conditions in conjunction with alterations in the state of the sun's surface as well as its varying declination. A large field on either side of the equator, embracing one-fourth of the entire area of the world, exists, from which observations are very much wanted to complete our knowledge of the causes of phenomena which, while they are evidently closely related to action-centres (using Teisserenc de Bort's significant expression) at some distance from the equator, are yet, probably to some considerable extent, dependent upon conditions prevailing over the entire equatorial belt, which may, for all we know, fluctuate in stricter unison with solar changes than those which occur in higher latitudes. E. DOUGLAS ARCHIBALD.

[1] These figures are simple means *unsmoothed*.

Singular Swarms of Flies.

WITH the writer's permission I send you herewith a letter which I have received concerning the subject of my letter which appeared in your issue of June 1.

During the week following the date of my letter I repeatedly saw swarms of similar kind ; but smaller and less marked, seldom visible much more than fifty yards away ; always under similar atmospheric conditions, which were chronic during the period in question. The swarms always showed much the same slant from vertical (some 30° or so), the direction of the slope in plan being towards such slight draft of air as was perceptible. R. E. FROUDE.

Gosport, June 12.

I FIND in NATURE, June 1, an inquiry you make about flies forming clouds, resembling smoke.

They are usually produced by the gnats called scientifically *Chironomus*, and have been often mentioned in entomological literature.

I give below several references I can lay my hand on, but there are probably many more recent ones, which I have not noticed—

German, Magazin für Entomologie (in German), vol. i. p. 134–140, 1813.

Clapton, J. C. Dale, in Magaz. Nat. Hist., 1833, p. 544. (In Ireland and England.)

Patterson, Ann. and Mag. of Nat. Hist., vol. x. 1842, p. 6–9.

I have seen such clouds myself more than once. Cases have occurred when the smoke-like appearance has caused a fire alarm to be sounded. C. R. OSTEN SACKEN.

Heidelberg, Germany, June 4.

OFFICIAL CATALOGUE OF THE EXHIBITION OF THE GERMAN EMPIRE AT THE COLUMBIAN UNIVERSAL EXHIBITION IN CHICAGO.

GERMANY, not unmindful that America is her best customer, will be worthily represented at Chicago. An elaborate catalogue, in the German language, has already appeared, and an English translation will shortly be published. We have been favoured with an advance copy of the latter, which is by no means a mere enumeration of exhibits. It contains a general introduction, and a number of original articles by leading experts, "intended to supply for each department a concisely descriptive survey of its development and present condition." There is also, in German and English, a special Guide to the collective exhibition of the German chemical

industry, containing historical and statistical notices of every exhibiting firm. Generally the effort of the editor, and the commission which he represents, has been to convey to the American people and to the world a faithful picture of a state of development of the industrial arts in Germany, which may well inspire,in the English reader, impressions of a mixed order, pleasure in the contemplation of a great national growth, based upon a true conception of the right methods, and regret that in our own country a similiar consummation still appears a great way off. The selection, as editor of this publication, of the eminent chemist, Dr. Otto N. Witt, professor of technology at the great Berlin Polytechnicum, is in itself a forecast of its scope and purpose, and an evidence of the position which the man of pure science occupies in official Germany. To summarise in the briefest manner the work which he and his collaborators have given to the world would carry us far beyond the limits of this article. There are two points, however, of paramount interest, to which we desire to call attention, the one social-political, not to say socialistic, the other industrial—both of national importance.

Among the provisions made and establishments created by the newly-founded empire avowedly in the interest of national industry and commerce, such as the Imperial Post Office, the Imperial Bank, the Imperial Patent Office, none bear the stamp of originality in the same degree as the great system of compulsory insurance, "the object being to secure for that portion of the population which is dependent upon the work of its hands, and is rarely in a position to save money or properly to administer its savings, a provision for the days when through accident, sickness, or advancing age the worker is incapacitated from further earnings. Insurance is applicable in three different forms. In assurance against illness, introduced in 1883, the means are provided, two-thirds by the insured and one-third by their employers, in weekly contributions, to an amount not exceeeding 3 per cent. of the average wage. It entitles the insured to free medical treatment and a fixed allowance over a given period. It includes 7,000,000 persons in more than 20,000 clubs, and involves an annual expenditure of more than 100 million marks. The system of insurance against accident, which came into existence in 1884, is intended *to transform the personal liability of the employer, in case of accident during the execution of work into an economical charge upon the entire trade concerned*, to secure to the worker an indemnity *in all cases*, and to put an end to troublesome lawsuits between employer and employed. At the present time 15 millions of persons are insured, and 10 millions of marks have been paid in indemnities. The insurance against incapacity for work, and the old-age pension fund, inaugurated in 1891, complete this system of workers' insurances. It insures an income to those unable to earn a living, without reference to age, and an old-age pension to septuagenarians, without reference to any capacity for earning which they may still retain. The necessary means, in addition to a yearly Imperial contribution of 50 marks per income, are supplied in equal proportions by the insured and their employers. This form of insurance includes 12 millions of persons, and has, up to the present time, involved an outlay of 30 millions of marks. On the whole, there has been, in connection with the objects of the operatives' insurance, an expenditure of well-nigh half a milliard of marks, which has exclusively benefited the working-classes."

Thus, in the course of eight years, the German Government and people have given practical form to these grave social problems, which, in our own country, are still waiting for solution. Whether the German system is based on sound principles it is not for the present writer to decide. It is admitted that it imposes a heavy burden upon industry, and yet most of the exhibiting firms appear to bear it with equanimity. Nay, it is refreshing to note that the obligations imposed upon manufacturers by the Legislature have not in any way dried up the springs of voluntary charitable effort. Most of the large firms, in addition to the requirements of the law, make generous provision for their workpeople in the shape of baths, refreshment-rooms, dormitories, supplies of fuel at cost price, model cottages at low rent, allotments, and various funds in cases of sickness and death, funds for widows and orphans, &c., &c. It must be borne in mind, as a set-off to all this benevolence, that wages are low. The average remuneration in chemical factories, for example, is something less than £1 per week for a ten hours day.

The other point suggested by a perusal of the catalogue is the rapid and, in some cases, triumphant progress of German industry. For our present purpose it will be sufficient to consider two departments of chemical manufacture—namely, the industry of general and fine chemicals and that of artificial colouring matters. They are typical of the spirit which pervades every branch of technical activity in Germany. The former, we are told, has developed to an extent unknown in any other country in the world. Imperial statistics show that in 1891 there were in Germany 521 factories engaged in the manufacture of chemico-pharmaceutical preparations, their 14,842 workpeople drawing 12,615,700 marks in wages. The exports in 1890 of chemical preparations, not specially named, exceeded the imports by 5000 tons, valued at more than 15,000,000 marks. If to these are added the chemicals quoted by name in the official list, we obtain a total excess of exports over imports amounting to 25,690,000 marks; and as the home consumption must at least be equal, we arrive at a grand total of 52,000,000 marks annually.

More remarkable still is the history of the great dye industry, which, as is well known, originated in England with the labours of Hofmann, Mansfield, and Perkin, closely followed in France by those of Verguin and Girard and de Laire. What has become of it? The chemical catalogue tells us that nine-tenths of the production of artificial dye-stuffs in the world must be credited to Germany.

There are altogether some 20 factories belonging to this industry in Germany, nearly all of which can claim to be important. Three of the largest are represented at Chicago. One of them, with a capital of 6,000,000 marks, employs 600 men and 90 women; another, with a capital of 12,000,000 marks, occupies 1600 men with a technical staff of 300, and produces nearly every known dye stuff, the alizarine dyes included. A third, with a capital of 16½ million marks, is said to be the largest chemical factory in the world. It began twenty-eight years ago with a staff of 30 men, and now employs 4000. These three factories have played a conspicuous part in the building up of the industry of artificial colouring matters.

To what causes must these great results be traced? Many minor causes are mentioned in the catalogue. Let us, however, go at once to the root of the matter. The two main factors are organisation and the consequent intimate connection between pure science and manufacture. When, at the beginning of the century, Germany lay crushed at the feet of Napoleon, it was felt by German patriots that nothing but the complete reorganisation of the country could lead to its emancipation. Since those days, side by side with the military forces, the scientific forces of the country have been carefully and patiently organised. At the instigation of Liebig, great State laboratories for pure scientific research were erected all over the country, and from these have issued an army of highly-trained workers, whose services manufacturers have vied with each other in securing. Nothing is more striking, in the special notices of the exhibiting firms, than the large number of competent and

often distinguished chemists employed in all the factories at all connected with the chemical trade.

Firms with 40 workmen sometimes employ as many as 5 or 6 chemists, and the three great colour firms referred to above employ together 178. In the words of Dr. Witt: "In chemical research the chemical industry of Germany possesses a never-failing helpmeet, and such is the intimacy between chemical research and chemical manufacture, that the periods of most rapid development of the one have always been epochs of prosperity with the other." And again: "It may be asserted that not only is the strength and productive power of German chemical industry based upon the intimate connection between science and practice above described, but that in that intimacy lies the surest safeguard that German industry will long continue to hold the prominent position which, with such strenuous exertion, it has ultimately achieved. When the question is asked why the chemical industry of other lands, still more favoured perhaps by nature, has in the end been surpassed by the German, the answer is that Germany has had the good fortune to call her own a number of the greatest intellects in the domain of pure scientific research, who have quickened the pace of theoretical chemistry. But, as before stated, it is the latter which constitutes the vital element of chemical manufacture. Only the country which, at any period, shall assume the leadership in pure scientific chemical investigation, will also be in a position to wrest from German chemical industry the palm to which it is at present entitled."

We do not shut our eyes to the fact that nations, like individuals, must work out their own character and destiny, nor do we for a moment inculcate a slavish copying of the German model. We have in this country a great deal of science and a great deal of industry, and many attempts have been made to bring about an effective cooperation of these two cardinal elements of productive energy. We cordially recognise that particular industries and individual firms have, by private enterprise, developed themselves upon a thoroughly scientific basis, and we also welcome the fact that substantial additions have been made in recent years to the laboratories and institutions where a scientific training can be obtained. At the same time we cannot escape from the admission that, in the friendly struggle for industrial supremacy, Germany has not only made astonishing progress both in the development of industries of long standing, and in the inception of new ones of enormous fruitfulness, but that she has been the first as a nation to solve the great problem of the cooperation of science and manufacture. We leave it to more competent hands to point out the course which now lies before us. In our own humble opinion the days of *laisser faire* have gone never to return, and the time has come when the Government of the country, backed by the country, must take—as is the case in Germany—a larger share than it has done hitherto in the systematic organisation of our scientific and industrial forces. A nobler and a more patriotic task could hardly be attempted.

THE REDE LECTURE.

AT Cambridge, on June 14, the Rede lecture was delivered by Prof. Michael Foster, Sec. R.S., his subject being "Weariness." The lecture was illustrated by experiments, conducted by Dr. Shore, with the assistance of Mr. Hardy. The following report of the lecture is from the *Times*:—

Prof. Foster said that among the many shortcomings which limited the power, and so the usefulness, of the machine which we call the human body, two stood out prominent among the rest: these were, on the one hand, inertia or laziness, the unwillingness to stir, and, on the other hand, weariness, the getting tired. He proposed to lay before his audience some account of such knowledge as the physiologists of to-day possessed, and it was but little, concerning the physical basis of this weariness, which so greatly shortened the power of man. He began with a simple yet illustrative case—the weariness which comes from the much repetition of a simple movement, a simple muscular act, as when a man lifts a weight with his hand. Analysing the act physiologically, he showed the changes which took place in the brain, the nerve, and the muscle. Taking the muscle first, he showed that weariness of muscle comes, in the first place, from too rapid expenditure of capital; secondly, from the accumulation in the muscle of the products of the muscle's own activity. There were many reasons for thinking that this latter cause of weariness was at least as potent as the former. The brute force of our food was the measure of our muscular strength, but the one could become the other only through the aid of many other things which might be wholly empty of energy, and the failure of these, no less than the absence of the former, entailed at first premature weariness, afterwards failure and death. The nerves and the brain shared in even the simplest and rudest muscular work. The nerves themselves, the mere bundles of fibres which carried the nervous impulses from the brain to the muscles, were never tired. Coming to the brain, the lecturer showed by a simple experiment a case of fatigue, demonstrating that the fatigue was in the brain and not in the muscle; a weariness of the particular part of the nervous system which was called into play.

By an illustration in colours he showed also how weariness not only lessened work but bred error. The study of the central nervous system had led, and was leading, physiologists to the conclusion that the material changes on which its activity depended were very analogous to those taking place in a muscle, only, of course, from a chemical point of view, not so massive. And all they knew went to show that in the brain, as in muscle, weariness was the result on the one hand of an expenditure of capital disproportionate to the accumulation, and on the other hand to a clogging of the machinery with the products of activity. The simple apparatus he had used might be successfully employed to illustrate general conditions as affecting weariness. If, taking always the same weight, they counted the number of times the weight was lifted and measured the height to which it was raised each time in succession before the movement was stopped by weariness, they could ascertain how much work had been done before the machine was so stopped. Proceeding in this way some interesting results as to what hastened or retarded fatigue had been obtained. Practice and habit, it was needless to say, were of prime influence. The depressing effects of a damp, muggy day, or the exhilarating effects of a bright, clear day, might in this way be measured in foot-pounds of power lost or gained, as might also the lowering influence of a cigar and the heightening effect of a glass of beer. One point perhaps he might dwell upon, and that was the influence of that part of the brain which was more immediately concerned with what was spoken of as mental work. An Italian professor determined, by means of the apparatus of which they were speaking, the amount of work which he could on a certain morning do before he was stopped by weariness. He then set himself to two hours' hard mental work, and the form of work he chose was that of examining candidates for their degree. The professor, as soon as the two hours' examination was over, went back to his apparatus and found that his power of bending his finger was enormously cut down. The nervous system was a candle which could not profitably be burnt at two ends at once. When the work done involved the activity, simultaneous or successive, of many muscles of many parts of the nervous system, the several

efforts by accumulation became prominent, and simple weariness passes into what was called "distress." Here the result depended not so much on the direct effects of the work on the parts which were actively employed, not so much on the changes wrought in the muscles or in the nervous machinery at work, as on the success with which other members of the body came to the aid of those actually engaged in labour. The internal life of the body, no less than the external life, was a struggle for existence, a struggle between the several members, a struggle the arena of which was the blood. And it would seem that the onset of distress was chiefly determined by the failure of the organs to keep the blood adequately pure. Something depended on the vigour of the muscles themselves, something on the breathing power of the individual, something also on the readiness with which the heart responded to the greater strain upon it; but beyond and above all these was the readiness with which the internal scavengers freed the blood from the poison which the muscles were pouring into it. Undue exertion was exertion in which the muscles worked too fast for the rest of the body. The hunted hare died not because he was choked for want of breath, not because his heart stood still, its store of energy having given out, but because a poisoned blood poisoned his brain and his whole body. So also the schoolboy, urged by pride to go on running beyond the earlier symptoms of distress, struggled on until the heaped up poison deadened his brain, and he fell dazed and giddy, as in a fit, rising again, it might be, and stumbling on unconscious, or half conscious only, by mere mechanical inertia of his nervous system, falling once more, poisoned by poisons of his own making. All our knowledge went to show that the work of the brain, like the work of the muscles, was accompanied by chemical change, and that the chemical changes were of the same order in the brain as in the muscle. If an adequate stream of pure blood were necessary for the life of the muscle, equally true, perhaps even more true, was this of the brain. Moreover, the struggle for existence had brought to the front a brain ever ready to outrun its more humble helpmates, and even in the best-regulated economy the period of most effective work between the moment when all the complex machinery has been got into working order and the moment when weariness began to tell was bounded by all too narrow limits. If there were any truth in what he had laid before them, the sound way to extend those limits was not so much to render the brain more agile as to encourage the humbler helpmates, so that their more efficient cooperation might defer the onset of weariness.

NOTES.

FROM the *Times* we learn that a volcanic outbreak has occurred at Fukushima, in Northern Japan. Large volumes of dust and vapour have been emitted, and the country for miles around has been covered with volcanic ash. Landslips of great extent have occurred in the same neighbourhood, and are supposed to be caused by the volcanic action.

DR. H. J. JOHNSTON-LAVIS sends us the following information:—After many years in which the crater of Etna has been in a solfataric state lava has again risen, and now occupies it. This is a very rare condition of things in that volcano. Earthquakes continue in the north of Sicily, but on the flanks of Etna there is marked quiescence, which might be expected when the main chimney is free.

ON June 13 a select committee of the House of Commons resumed the hearing of evidence in connection with sea fisheries. Prof. Ray Lankester urged that a proper survey should be instituted round the coasts, in order to ascertain the movements and habits of fish in the areas resorted to by fishermen. An adequate commercial return could be expected from such a survey, for new fishing grounds might be discovered. To carry on this work, the present Government Grant of £1000 a year, received by the Marine Biological Association, ought to be trebled, and a grant of £5000 should be made for a deep-sea vessel. Dr. Günther expressed the opinion that hatcheries should be established for the protection and extended cultivation of sea-fish, and Mr. Holt testified to the considerable depletion of the fisheries in the North Sea, to prevent which a size-limit for different kinds of fish was recommended, rather than an absolute close-time of four months in the year.

A PHOTOGRAPHIC exhibition usually includes mechanical appliances and improved outfits specially designed to catch the eye of the artless amateur photographer. But there is to be a new departure in this, as in many other customs. In October next an exhibition of photographic pictures, to be called the "Photographic Salon," will be held at the Dudley Gallery, Piccadilly, and it will be concerned, wholly and solely, with photographs of pictorial merit, leaving the means by which such results can be obtained to be otherwise advertised. Those who desire to have their pictures hung in this academy of photographic art should communicate with the secretary before the beginning of September.

A NUMBER of lectures will be delivered in connection with the Gilchrist Trust, from September to December, in the Great Assembly Hall, Bethnal Green. Prof. V. B. Lewes will open the series with a lecture on "The Atmosphere and its Relation to Life." He will be followed by Sir Robert Ball, on "Other Worlds," Dr. Andrew Wilson on "The Brain and Nerves," the Rev. Dr. Dallinger on "Spiders: their Work and their Wisdom," and Dr. J. A. Fleming on "Magnets and Electric Currents."

LOVERS of the piscatorial art will welcome the suggestion that the 300th anniversary of the birth of Izaak Walton, on August 9, shall be commemorated by some memorial. There is a marble bust of Walton at his birthplace, Stafford, and a statue at Winchester, where he is buried, but in London, the home of his adoption, his claim to have his name and work written on a memorial tablet has hitherto been neglected. Mr. Marston, of the *Fishing Gazette*, thinks St. Dunstan's Church, Fleet Street, would be an appropriate building whereon to affix a mural decoration. In commemoration of the tercentenary, a special edition of "The Complete Angler" will be published by Messrs. Bagster in September. Mr. J. E. Harting, librarian to the Linnean Society, is editing the volume, and adding to it notes from the point of view of a naturalist.

AN international anthropometrical congress will be held at Chicago, from August 28 to September 2, under the auspices of the World's Congress Auxiliary of the Columbian Exposition. It is requested that the titles and abstracts of papers on anthropology be forwarded as early as possible to Prof. C. Staniland Wake, Department of Ethnology, in order that the programme may be arranged.

MR. A. O. WALKER informs us that about 8.15 p.m. on June 15, three shocks in rapid succession were felt at Colwyn Bay. The shocks present the characteristic features of true earthquakes, but evidence from a wider area is required to decide the question.

THE thunderstorms which occurred in some parts of our islands about the middle of last week were accompanied generally by very little rain; in parts of Kent, for instance, the total rainfall since the beginning of March has only amounted to about three-quarters of an inch, or 13 per cent. of the normal amount. The temperatures have been exceptionally high, the

maxima ranging from 80° to 88° in many parts of the kingdom, while on Monday the 19th instant, the temperature reached 91° at Greenwich. This is the highest reading which has occurred there in June since the year 1858, and it has not been exceeded in any part of the summer during the last five years. In the early part of the present week shallow depressions passed over these islands causing the recurrence of thunderstorms in many parts. These were accompanied by smart showers in a few places, and by a considerable fall in the temperature, the maximum in London on Tuesday being 24° lower than on the previous day. The *Weekly Weather Report* of the 17th inst. showed that the mean excess of temperature ranged from 3° or 4° in England, to 6° in Scotland, and to 7° in the north of Ireland. There was no rainfall whatever over the greater part of England and Scotland.

THE Vatican Observatory has issued the third volume of its *Pubblicazioni*, containing xxiii + 442 quarto pages and thirty plates. The plan followed by Padre Denza is the same as in the previous volumes, and the work is produced in the same excellent style. After quoting some historical documents relating to the observatory, an account is given of the last general meeting of the superintending Council and of the principal astronomical and astrographic researches carried on at the observatory. Although the magnetical and geodynamical sections are not yet in order, several papers of special interest in these important subjects are published. The meteorological section contains hourly observations and results for the year 1891; in this branch we specially notice a paper on the classification of clouds by Sr. F. Mannucci, photographic assistant at the observatory, illustrated by fourteen photographs taken at the observatory and neatly printed by Dujardin of Paris. The classification adopted is that proposed by Messrs. Abercromby and Hildebrandsson, and consists of ten different kinds of clouds, divided into five principal groups, according to the heights at which the various forms are usually found. The last part of the work contains an account of the proceedings of the ordinary meetings held in the year 1892.

PROBABLY few people are aware that there still exists in this country a manufactory of gun and tinder-box flints, yet such is the case. Mr. Edward Lovett, in the *Illustrated Archæologist* for June, gives an interesting description of the flint industry which has been carried on at Brandon, situated on the borders of Suffolk and Norfolk, since the Stone Age. The methods employed in the mining and fashioning of flints at that remote period prevail, with little alteration, unto this day. In order to break flint into pieces of convenient size, the worker places the mass on his knee, and, by a dexterous blow with a hammer, shivers it into fragments as easily as if it were chocolate. The pieces are then split into flakes, and these, in turn, are fractured into little squares which, with very slight trimming, become the finished gun-flints. Most of the gun-flints are exported to Zanzibar and other ports in communication with the interior of Africa, but, besides these, large quantities of flints for tinder-boxes are still made at Brandon. Tinder-box flints chiefly go to Spain and Italy for use in isolated districts. It is a curious fact, however, that the flint-and-steel method employed by prehistoric man in making fire is better than matches in uncivilised regions, and very moist climates.

AT a recent meeting of the Société Française de Physique a note from Dr. Stephane Leduc was read, in which the correspondant points out that the physiological effects of alternating currents obtained from electrostatic machines are very different to those up to now observed with ordinary alternating currents of high tension and frequency. Thus, if the terminals are held in the hands nothing is felt, although a continuous stream of sparks is passing between the dischargers. If, however, the current is localised at one point on the skin by means of a rounded point, directly this point passes over a nerve, either sensory or motor, the nerve is excited throughout all its length beyond the electrode. The sensation felt in the sensory nerves allows of their distribution being accurately followed, while the least displacement of the electrode on the surface of the skin causes a cessation of all these effects. These currents can in this way be used to localise the seat of nervous excitation with much greater accuracy than has been hitherto possible.

THE results obtained by Blondlot in his extensive research on the capacity of polarisation have been confirmed by some recent experiments of M. Bouty (see Proceedings of the Société Française de Physique). M. Bouty has chiefly studied the case of melted electrolytes, of extremely dilute solutions of salts and of solid electrolytes, and his results have very conclusively shown that the initial capacity of polarisation (K) is independent of the direction of the polarising current. When a platinum electrode has been immersed in a melted electrolyte for twenty-four hours it possesses, for a given temperature, a constant initial capacity of polarisation, which increases rapidly with temperature, while the maximum polarisation decreases. In the case of electrodes of platinum in concentrated solutions of most salts (those of platinum excepted) the value of K is very nearly the same for all, and varies little on account of dilution, while there appears to be no connection between the value of K and the specific resistance of the solution.

A CURIOUS optical illusion is described by M. Bourdon in the *Revue Philosophique*. If an object moves before our eye, kept fixed, it undergoes, in passing from direct to indirect vision, an obscuration, a change of coloration; and the opposite effect occurs when the object comes into the field of direct vision. It is natural to suppose that this plays a part in the perception of motion, and one fact proving that it does so is, that if we render a slow-moving object suddenly invisible, *e.g.* by means of a shadow, its velocity of displacement seems much increased. M. Bourdon describes an arrangement in which a long pendulum with white thread is swung from a cross bar on a vertical support, which is illuminated from a lamp, while a screen is introduced to give a shadow (the order being, observer, lamp, screen, vertical support, pendulum, dark wall). The white thread in its swing passes into the shadow of the rod and screen, and each time it enters or reappears its velocity seems increased considerably. It seems as if attracted into the shadow, and as if it entered into the light with a sudden shock. It is necessary that the thread should cease to be visible when it enters the shadow. With a red thread the illusion also occurs, perhaps somewhat less vividly. A simpler plan than the above is to hang a pendulum from the ceiling, shading with a screen.

A NEW method of determining the hardness, or rather perhaps the friability of substances, has been described by Hr. August Rosiwal at a meeting of the Vienna Academy. The measurements consist in comparing the losses of weight sustained by the bodies under investigation by scratching them with a given weight of polishing material mounted on a metallic or glass base until the material loses its efficiency. The polishing materials used were dolomitic sand, emery, and pure corundum. The diamond was assigned its place in the scale of hardness by comparing its efficiency as a polishing material with that of corundum. It was found to be 140 times as hard as corundum. Tested by this method, the constituents of Mohs's scale have the following numerical values:—Diamond 140,000, corundum 1000, topaz 194, quartz 175, adularia 59·2, apatite 8·0, fluorspar 6·4, calcite 5·6, rocksalt 2·0, and talc 0·04. The great advantage of the method consists in the ease with which the hardness of mixtures of minerals in the various rocks is determined.

PROF. OBERBECK, of Greifswald, has been studying the spreading of oil on liquid surfaces on a larger scale than that of ordinary laboratory work. The experiments, which are described in the current number of *Wiedemann's Annalen*, were carried out in the Bay of Rügen, upon which the Prussian university town is situated. The professor sailed out into the bay for a distance of 2 km. or so, accompanied by an experienced mariner, and armed with bottles holding from one-tenth to half a litre of machine oil or rape-seed oil in measured quantities. Sitting in the stern of the vessel, he poured the contents of the bottles at intervals into the water in a thin continuous stream, the vessel meanwhile moving at a uniform rate in the same direction. After about an hour the oiled tracks were revisited. The brilliant colouring had disappeared, and the oil had spread out into well defined rectangular light-grey patches, easily distinguished from the rest of the sea by the absence of ripples and their consequent superior reflecting power. Their area was estimated, with the aid of the experienced mariner, by the time occupied in sailing past. In the case of the half-litre bottle the patch measured 300 by 30 metres, thus giving an area of 18,000 square metres corresponding to one litre of oil. A more accurate measurement was made subsequently by means of a line of buoys marking the deep-water channel. This gave an area of 18,857 square metres. Hence the thickness of the film of oil was 53 millionths of a mm. It is, of course, possible that the oil had spread still further and had only ceased to influence the ripples on the surface. In that case the film must have been even thinner.

THE applications of electricity to every-day life seem to be almost infinite; the latest development being an electrical horsewhip described in *Électricité*. This is said to be designed for the use of a "sportsman," and consists of a celluloid handle containing a small induction coil, together with a battery, the circuit being closed by means of a spring push. Two wires carry the current to the extremity of the whip, which is furnished with two small copper plates having points fixed to them of sufficient length to penetrate the coat of the horse, and yet not being sharp enough to inflict a wound.

IN a note contributed to the Accademia dei Lincei, Augusto Righi gives a short description of a form of apparatus he has used for producing Hertzian oscillations of short wave-length and exhibiting their properties to an audience. The oscillator consists of two rods furnished with balls at either end and placed between the discharger of a Holtz machine, leaving a gap of about 4 centimetres at each end, and one of about 3 mm. at the middle. The two rods pass through the sides of a glass vessel containing oil, so that the middle pair of knobs are surrounded by oil. The resonator consists of a nearly complete circle of wire, the gap being filled by a Geissler tube. With the above apparatus the author has carried on a series of experiments on the reflection, refraction, and interference of these electrical waves.

AN abstract of a paper by C. H. Morse appears in the *Electrician*, giving an account of the damage to the water-pipes in Cambridge (Mass.), caused by the electrolytic action of the return current from the electric cars. Pipes composed of lead, iron, galvanised iron, brass, and rustless iron were in turn tried and found to deteriorate quickly. Such an amount of current was found to be flowing along the pipes that, upon attempting to make a joint by putting oakum round the pipe, an electric arc was formed and set the oakum on fire. The damage has to a great extent been checked by connecting the gas and water-pipes together, and also to the negative pole of the dynamos which supply the power to the railway.

AT the beginning of this year (says the *Revue Scientifique*, June 17) there were 1168 submarine cables in existence, of which 880 belonged to different dominions and 288 to private companies. The former possessed a length of 16,652 miles, and the latter had a length of 144,743 miles, thus the total length was 161,395 miles. Fifty-four of these cables belong to the state in France, the length being 3979 miles; and Germany owns 46 cables, having a total length of 2025 miles. There are 14 Anglo-French cables, 10 Anglo-Belgian, 8 Anglo-Dutch, and 13 Anglo-German. Of the cables possessed by private companies the Eastern Extension, Australasia, and China Telegraph Co. head the list with 25 cables and a mileage of 18,205; the Great Northern Telegraph Co. follow with 24 cables, having a total length of 6948 miles; then come the West India and Panama Telegraph Co. with 22 cables extending through 5240 miles: and the Western and Brazilian Telegraph Co. with 15 cables stretching over 5408 miles. The French Society of Submarine Telegraphs possess 14 cables having a total length of 3754 miles.

THE "shell-beds," or shelly clays, in the north of Scotland—at Clavia near Inverness, and on the east coast of Aberdeenshire, have been investigated by Mr. Dugald Bell, and the results of his researches were communicated to the Glasgow Geological Society on May 25, under the title "The alleged proofs of submergence in Britain, during the Glacial Epoch." Mr. Bell holds that it is doubtful if this clay were really in place, as part of an ancient sea-bottom, during the glacial epoch. He thinks also that the "red clay" of East Aberdeenshire, described by Mr. Jamieson, cannot be accepted as a satisfactory proof of submergence, indeed, in some respects, its characteristics seem to be inconsistent with that theory.

FROM the *Pioneer Mail* we learn that Mrs. J. S. Mackay has a superb snow leopard at Kulu, in the Punjab. Though the animal is nearly full-grown, he is practically free and lies about the house all day like a huge cat, or romps with his mistress. His ultimate destination is the Zoological Gardens of London. Should he be brought over alive he will be the only animal of his kind in Europe.

IN a paper, "Sulla presenza di batteri patogeni nella saliva di alcuni animali domestici" (Fiocca: *Annali dell' Istituto d'Igiene Sperimentale della R. Università di Roma*), an examination of the saliva of numerous horses, dogs, and cats is recorded. The saliva of the horse was found to contain diverse bacilli, also streptococci, staphylococci, and one spirillum. Amongst these organisms three were discovered which possessed pathogenic properties; and one of these, a bacillus, was very frequently found, for out of fifteen different samples of saliva inoculated into guinea-pigs it was only once absent. This organism is distributed in soil, and it is very possibly also frequently present on grass and hay, and hence its prevalence in the saliva of horses. The saliva of the cat presented a very different appearance from that of the horse, being very rich in cocci and minute bacilli. A new bacillus (*Bacillus salivarius felis*), extremely characteristic of cats' saliva, was isolated and found to be specially pathogenic to rabbits and guinea-pigs, these animals dying from its effects in twenty-four hours. The dog's saliva was found to contain the largest variety of bacteria, amongst the pathogenic forms isolated being the *B. pseudo-œdematis maligni*, and the *Staphylococcus pyogenes aureus*.

SOME investigations on the antagonistic effect produced by the *Bacillus fluorescens liquefaciens* on other organisms have been made by Olitzky (*Ueber die antagonistischen Wirkungen des B. fluorescens liquefaciens und seine hygienische Bedeutung*, Bern, 1891). Cultures of this bacillus were either streaked on to nutritive agar-agar side by side with other organisms, or the latter were separately inoculated on to culture material in which this bacillus had grown, but which before

being used for the second time was re-sterilised, the growth being thus destroyed, but the *products* remaining. It was found that the tubercle bacillus and the pneumococcus of Fraenkel were quite unaffected, whilst the *B. prodigiosus* only refused to grow in the re-sterilised culture material. On the other hand the *Staphylococcus pyogenes aureus*, the anthrax bacillus, and the typhoid bacillus were greatly impeded in their development, and no growths whatever made their appearance in the re-sterilised culture material. The cholera bacillus and the *B. pyocyaneus* were also affected, but to a smaller extent.

SHORTLY before his death, Mr. Darwin informed Sir J. D. Hooker, F.R.S., that "the difficulties he had experienced in accurately designating the many plants which he had studied, and ascertaining their native countries, had suggested to him the compilation of an 'Index to the Names and Authorities of all Known Flowering Plants and their Countries' as a work of supreme importance to students of systematic and geographical botany, and to horticulturists." "At his request," adds Sir J. D. Hooker, "I undertook to direct and supervise such a work." The Clarendon Press announces that Part I. of this "Index Kewensis" is now ready, that Part II. is well advanced, and that the completion of the whole work may be expected next year.

THE first part of Prof. A. Newton's "Dictionary of Birds" has just been published by Messrs. A. and C. Black. It extends from aasvogel to the gare-fowl, or great auk, and runs into 304 pages. The work is founded upon a series of articles contributed by Prof. Newton to the ninth edition of the "Encyclopædia Britannica." Important additions have been furnished by Dr. Hans Gadow, and for other contributions Mr. R. Lydekker, Prof. C. S. Roy (who has written an interesting article on "Flight"), and Dr. R. W. Shufeldt are responsible. A commendable feature is the inclusion of many names of birds, such as the *caracara*, *koel*, and *mollymawk*, which are frequently found in books of travel but are not explained in an ordinary dictionary. Compound names of the *crow-shrike* and *thrush-titmouse* kind have, however, been omitted.

MR. R. L. JACK, the Government Geologist of Queensland, has prepared a report on the Russell River Gold Field. The report is accompanied by a geological map of the district.

WE have received a dissertation by Mr. E. M. Blake, in which he discusses the application of the method of indeterminate co-efficients and exponents to the formal determination of those integrals, of certain systems of differential equations, which are expressible as series.

THE Harvard University Bulletin for May is a long list of accessions to the University Library. This list includes, in addition to recently-published books and pamphlets, a number of extensive and important works of earlier date. Nearly one hundred and fifty books in the list are concerned with science and the arts.

MESSRS. MACMILLAN AND CO. have published a second edition of "Lessons in Elementary Biology," by Prof. T. Jeffery Parker. The whole of the book has been thoroughly revised, and two of the lessons have been largely rewritten. A number of new figures have also been added.

MR. W. H. HUDSON, the author of "Idle Days in Patagonia," recently reviewed in these columns, has completed a book called "Birds in a Village," which will be published in a few days by Messrs. Chapman and Hall. The book does not profess to be a serious contribution to ornithology, but is intended rather for the general reader. Among other chapters of interest is one on the introduction of exotic birds, and another on bird-life in London. In the concluding portions of the book the subject of bird-protection is dealt with at considerable length.

A REFERENCE list of the land and freshwater mollusca of New Zealand has been prepared by Messrs. C. Hedley and H. Suter, and appears in the "Proceedings of the Linnean Society of New South Wales," vol. vii., December, 1892. The authors are of the opinion that as the New Zealand fauna becomes better known, its insular character stands out more prominently. Foreign genera, which have been imposed on the fauna, have been eliminated one by one, and many genera which might have been expected to occur, since they are prevalent in neighbouring countries, have not yet been detected. Crosse remarked that "The terrestrial and fluviatile molluscan fauna of New Zealand approximates more to that of New Caledonia, in spite of the considerable distance that separates the two countries, than to that of Australia" (*Jour. de Conch.* xxviii. p. 37), and the authors think his idea has hardly received the attention which it merits.

THE "Tourist Guide to the Continent," published for the Great Eastern Railway Company, has reached its fourteenth year of issue. It is edited by Mr. Percy Lindley, and includes descriptions of things and places of interest in Holland, Germany, Belgium, and Switzerland.

AFTER Mr. Francis Galton, F.R.S., had completed his work on "Finger Prints" he came into possession of the impressions of the fore and middle fingers of the right hand of eight different persons at Hooghly, Bengal, made in the first instance in 1878, and secondly in 1892. These prints have afforded the text for a discussion as to the persistence of patterns, and the result of the decipherment is now published as a supplementary chapter to the above-named book. Though the prints were not obtained by the best means, a comparison of the reproductions of them shows clearly that the "sign-manual" furnishes unquestionable evidence as to a person's identity, and further, the testimony is of such a character that any juryman would be able to appreciate its weight.

WE have received a communication from "Waterdale," in which he calls attention to the fact that he subsequently corrected many of the errors pointed out in the review of his researches which appeared in vol. xlvii. p. 601.

A CORRESPONDENT desires to know where to find any celebrated and artistic hedgerows of elms within about thirty or forty miles of London. Perhaps one of our readers will furnish the required information.

MESSRS. FUNK AND WAGNALL, New York, have just issued a complete prospectus of "A Standard Dictionary of the English Language," a work that has been in preparation for several years, and is now nearly completed. The dictionary will contain 280,000 words in about 2200 pages of medium quarto, and will be embellished with more than 4000 illustrations specially prepared for it. One of the many distinguishing features is the comprehensive provision that has been made for definitions by specialists in various arts and sciences. Handicraft terms have been gathered with great completeness and grouped under the different trades, and by applying a similar system of grouping to the names of fruits, flowers, weights, measures, stars, &c., the facts concerning this class of words are given in a very complete manner. For example, under *constellation* are given the names of all the constellations, and under *apple* are found the names of nearly four hundred varieties. Judging from the specimen pages, and the list of men eminent in science and literature who are concerned in the compilation, the dictionary will be the handiest, simplest, and most trustworthy publication of its kind.

THE *Johns Hopkins University Circular*, No. 106, is chiefly taken up with morphological notes from the biological laboratory of the Johns Hopkins University. Prof. William K. Brooks contributes two important notes on the Salpa embryo, and Mr. M. M. Metcalf describes an apparently new species of Octacnemus, a deep-sea, Salpa-like tunicate. A memoir on the genus Salpa, by Prof. Brooks, will shortly be published. It will contain about three hundred and fifty quarto pages, with sixty coloured plates. The memoir is based for the most part upon material collected by the United States Fish Commission.

"ELECTRIC Light Installations and the Management of Accumulators," by Sir David Salomons, Bart., has reached a seventh edition. This edition has been, to a large extent, rewritten, and is now published by Messrs. Whittaker and Co. under the title "The Management of Accumulators," as the first volume of a series dealing with electric light installations.

TWO further papers upon azoimide, N_3H, are contributed to the current number of the *Berichte* by Prof. Curtius. In the first, a brief but important communication, it is shown that azoimide may be prepared directly from hydrazine, $\begin{matrix}NH_2\\|\\NH_2\end{matrix}$, by the action of nitrous acid.

$$\begin{matrix}NH_2\\|\\NH_2\end{matrix} + ON\cdot OH = \begin{matrix}N\\\|\\N\end{matrix}\!\!\diagdown\!\!NH + 2H_2O.$$

It is only necessary to lead the red oxides of nitrogen evolved from a mixture of nitric acid and arsenious oxide into an ice-cold aqueous solution of hydrazine hydrate until a vigorous evolution of gas, due to decomposition, commences. A dilute aqueous solution of azoimide is thus obtained with which most of the reactions of the substance can be performed. It is preferable, however, to first condense the red gaseous mixture by means of ice and salt, and to pour the blue liquid, a few drops at a time, into the cold hydrazine solution until the evolution of gas begins. The experiment is unattended by any danger, and is therefore admirably adapted for lecture purposes. Now that hydrazine is so well known and so readily obtained, the sulphate being already a commercial article, this mode of obtaining azoimide will doubtless be adopted by most lecturers for class demonstration, especially as the reaction is one of such fundamental theoretical importance.

IN the second communication Prof. Curtius describes an interesting new organic synthesis of azoimide. When hydrazine hydrate is caused to act upon a salt of diazobenzene, a fugitive compound is obtained of the constitution indicated by the formula $C_6H_5N : N.NH.NH_2$. This compound might be expected to decompose in two ways, breaking up either at the double linkage or at the single linkage between the NH and NH_2 groups. According to the former mode there would be a migration of two hydrogen atoms from two different nitrogen atoms to a third nitrogen atom with production of aniline and azoimide, $C_6H_5N : N.NH.NH_2 = C_6H_5NH_2 + N_3H$. According to the latter mode of decomposition one hydrogen atom would migrate and form ammonia with the last amido group, leaving diazobenzene imide, thus: $C_6H_5N : N.NH.NH_2 = C_6H_5N_3 + NH_3$. As a matter of fact both decompositions occur, the latter somewhat predominating. It is quite easy, however, to isolate 10 per cent. of the theoretical yield of azoimide. Equi-molecular saturated aqueous solutions of hydrazine sulphate and diazobenzene sulphate are mixed and poured into a 3 per cent. solution of sodium hydrate. A turbidity is at once produced, which eventually coalesces into an oil. This is extracted with ether and ammonia, expelled from the aqueous solution by boiling. The liquid, which contains the sodium salt of azoimide, is then rendered slightly acid with sulphuric acid and distilled, when azomide passes over along with the steam. The ethereal extract contains the aniline together with diazobenzene imide produced according to the second mode of decomposition.

NOTES from the Marine Biological Station, Plymouth.—The arrival of Midsummer renders desirable a summary of the records which have been made in this paragraph during the past six months of the breeding seasons of marine animals at Plymouth. The records have approximately indicated the *commencement* of the breeding seasons; but it should be premised that in the great majority of instances the period of reproduction is prolonged throughout the summer months, and is already at an end only in a few isolated cases. The following have been recorded:—The Gymnoblastic Hydroids *Tubularia bellis*, *Clava multicornis* and *cornea*, *Eudendrium ramosum* and *capillare*, together with the Anthomedusæ *Rathkea octopunctata* (now over), *Bougainvillea ramosa*, *Amphinema Titania*, *Sarsia prolifera* and *tubulosa*, *Podocoryne carnea* and *Corymorpha nutans*; the Calyptoblastic Hydroids *Halecium* (*halecinum* and *Beanii*), *Plumularia setacea* and *pinnata*, *Antennularia ramosa* and *antennina*, *Sertularella* (*Gayi*), *Sertularia argentea* and *pumila*, *Hydrallmania* (*falcata*), *Gonothyræa Lovéni*, together with the Leptomedusæ *Obelia lucifera*, *Clytia Johnstoni*, *Irene pellucida*, *Phialidium variabile*, *Laodice cruciata*, *Thaumantias octona*, *Forbesii*, and *Thompsoni*; the Ctenophore *Hormiphora plumosa*; the Actinians *Cereanthus* (*Arachnactis*,—now over), *Halcampa chrysanthellum*, *Cereus pedunculatus*, *Bunodes verrucosa*, *Urticina felina* and *Actinia equina*; the Nemertines *Cephalothrix linearis* and *bioculata*, *Amphiporus dissimulans*, Riches (= *pulcher* of previous record, March 30), *Nemertes Neesii*, and *Lineus obscurus*; the Polychæta *Phyllodoce maculata*, *Cirratulus cirratus*, *Polydora* (*flava* ?), *Sabellaria spinulosa*, and various *Terebellidæ* and *Serpulidæ*. The Polynoïd larvæ which swarmed in the Sound in the early Spring are no longer to be obtained. The Mollusca, Crustacea, Echinodermata and Chordata will be summarised next week.

THE additions to the Zoological Society's Gardens during the past week include three Peba Armadillos (*Tatusia peba*, ♂ ♂ ♀) from South America, presented by Mr. Woodbine Parish; two Brazilian Cariamas (*Cariama cristata*) from Paraguay, presented by Mr. A. E. Macalister Hadwen; five Spotted-billed Ducks (*Anas pœcilorhyncha*, 4 ♂ 1 ♀) from India, presented by Sir E. C. Buck, C.M.Z.S.; a Guillemot (*Lomvia troile*) British, presented by Mr. T. A. Cotton, F.Z.S.; two Chiff-chaffs (*Phylloscopus rufus*), two Yellow Wagtails (*Motacilla flava*) British, presented by Miss McGill; a Naked-necked Iguana (*Iguana delicatissima*) from the Caicas Islands, West Indies, presented by Lady Blake; a Lobed Chameleon (*Chamæleon parvilobus*) from Barberton, Transvaal, presented by Dr. Percy Rendall; two Capybaras (*Hydrochærus capybara*) from South America, purchased; an English Wild Bull (*Bos taurus*, var.), a Burrhel Wild Sheep (*Ovis burrhel*, ♀), a Derbian Wallaby (*Halmaturus derbianus*, ♀) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

A NEW VARIABLE *u* CYGNUS.—In photographing the region of α Cygni, Dr. Max Wolf (*Astronomischen Nachrichten*, No. 3168), on examining the plates, has found a new variable, its position for 1893·0 being R.A. 20h. 47·2m., Decl. + 45° 49′. The star, he says, is very easy to find, lying as it does in the south right-angle corner of a right-angled triangle, the stars in the other corners being B.D. stars + 45°·3300 and + 45°·3302.

The brightness, as obtained from the plates, gave the following numbers:—

				m.
1890	...	Dec. 12	...	13
1891	...	June 1	...	12
1891	...	Sept. 7	...	12
1893	...	May 14	...	12·5

FINLAY'S COMET (1886 VII.).—The following ephemeris for this comet is continued from *Astronomischen Nachrichten*, No. 3164:—

12*h*. *M.T. Paris.*

1893.	R.A. app. h. m. s.	Decl. app. ° ′
June 22 ...	2 19 1 ...	+11 14·5
23 ...	23 47 ...	11 40·6
24 ...	28 33 ...	12 6·3
25 ...	33 19 ...	12 31·6
26 ...	38 4 ...	12 56·5
27 ...	42 50 ...	13 21·0
28 ...	47 35 ...	13 45·1
29 ...	52 20 ...	14 8·7

The comet during this week lies towards the southern part o the constellation of Aries, passing near Aries 38 on the 26th.

A BRIGHT COMET?—A telegram which we have received from Kiel contains the following data obtained on June 5 and 12 with regard to a probable comet:—

1893.	R.A. h. m.	Decl. ° ′
June 5 ...	9 57·1 ...	+14 21
12 ...	10 4·3 ...	+20 56

This object lies somewhere in the region of η Leonis.

OBSERVATIONS OF NEBULÆ.—In *Astronomischen Nachrichten*, No. 3167-68, Dr. Rudolf Spitaler communicates the observations of nebulæ that he has recently made with the 27-inch Grubb refractor of the Observatory in Vienna. He also compares the brightnesses obtained by him with those in Dreyer's new General Catalogue of Nebulæ and Clusters. In addition to the mean places of these objects and of the comparison stars employed for the years 1891 and 1892, he gives several notes and a plate illustrating many of the nebulæ.

THE YERKES TELESCOPE.—*Astronomy and Astrophysics* for June gives some particulars about the Yerkes telescope, from which we make the following few notes. The great tube pier and clockwork are being built by Messrs. Warner and Swasey, the makers of the Lick 36-inch. The column will be made in five sections, each section except the base one (which will weigh about 18 tons), weighing about 5½ tons each. The column rises 31 feet 4 inches from the base. The pier head weighs 5½ tons; thus the total weight of the column and head reaches about 45 tons. The polar axis, which is of steel, is 15 inches in diameter, 13 feet long, and weighs about 3½ tons, the declination axis measuring 12 inches in diameter and weighs 1¾ tons. The length of the sheet steel tube (exclusive of eye end) measures 62½ feet, its greatest diameter reaching 52 inches, and weighs 6 tons. The focal length of the objective is about 64 feet. All quick and slow motions and clamps can be operated either from the balcony, eye end, or floor, by hand or by electricity as may be required. The floor will be an elevating one like that at the Lick. The telescope weighs in all 75 tons, and an idea of its size may be gathered from the fact that "when the telescope is pointed to the zenith, the object glass will be 72 feet in the air, or about as high as a seven-story house."

THE SMITHSONIAN REPORT FOR YEAR ENDING 1892.—Among the many interesting points to which Mr. S. P. Langley, the secretary of the Smithsonian Institution, refers to in this report, we note the following: The Smithsonian Astrophysical Observatory still occupies the "temporary wooden shelter on the grounds." Although the money for the permanent building is in hand, the Institution is only waiting for the action of Congress to provide a site. With respect to the work that is being done and is proposed for the future, Mr. Langley makes a special reference. The branch of astronomy to which the resources of the Observatory will be devoted will be that of exploring the great unknown region in the infra-red end of the spectrum by the method recently improved by Mr.. Langley himself. The secretary refers also at some length to the recent gift of 200,000 dollars to the Institution by Mr. Thomas George Hodgkins, of Setauket, N.Y., the interest on 100,000 dollars of which is to be used for the general purposes of the Institution on the "increase and diffusion of knowledge among men," provided that the interest on the remainder be used in the investigation of the properties of atmospheric air considered in its very widest relationship to all branches of that science. The report contains the result of several communications on the subject. At some length are treated also reports on the National Zoological Park, which, by the way, seems to be in a not very flourishing condition, on the financial aid given to Research, the National Museum, Bureau of Ethnology, &c., which we must pass over, as they do not appertain directly to the subject of this column. One point we must refer to is the proposed plan of publishing a work on the moon which shall represent the present knowledge of her physical features. The Institution is already in communication with some of the leading observatories of the world, and it is hoped that "a series of photographic representations of hitherto unequalled size and definition, which shall represent the moon's surface as far as possible on a definite scale, and *entirely* without the intervention of the draughtsman." We heartily wish the co-workers in this scheme success, for have we not now, with the present state of photography and fine instruments, a good basis to work upon.

THE MORPHOLOGY OF THE VERTEBRATE EAR.[1]

I. THIS elaborate and important monograph monopolizes the first two parts of the sixth volume of the *Journal of Morphology*. It is the second of a projected series on "Vertebrate Cephalogenesis." Its predecessor was published in the same journal two years ago, and the instalment now under consideration has been anticipated by three shorter communications (Nos. 5, 7, and 8 of the literature cited) of a distinctly sensational character. The 320 pages of contents are illustrated by 26 simple woodcuts; and by 12 magnificent folding plates, printed in colour, and bearing the charmed names of Werner and Winter.

The monograph is subdivided into six sections, with a recapitulatory one, and is based upon the morphological study of the ears of adequate representatives of leading classes and orders of vertebrates, and upon experimental observations chiefly involving the pig and cat. The author's work bears every trace of extreme caution in manipulation, and he lays much stress upon deceptive effects produced by the action of reagents—for example, the knobbing and apparent collar-formation met with in the hair-cells of the avian basilar organ. In seeking to correct certain kindred errors which have arisen during the work of his predecessors, the author concludes (i.) that Retzius' "nerve plates" of the avian labyrinth are "products of the maceration process"; (ii.) that the "horseshoe figure," which the same investigator attributed to the mammalian hair-cell, is an "optical effect"; (iii.) that the continuity between the pillar-fibres and basilar membrane described by Noel "does not exist"; and (iv.) that the basilar membrane itself—defined as "a modified portion of the skin of the head which forms first and last the floor upon which the sense organs rest"—is not elastic enough "to serve for the transmission of the delicate undulations which it has been supposed to transmit." While denying the presence of "spiral nerves" in the cochlea, he concludes that they "exist in the living condition as delicate walled but relatively large lymph channels"; and concerning the very involved question of relationship between the nerve fibres and hair-cells, he asserts that the ultimate filaments are "continuations of the nerve into the hair processes." The "membrana tectoria" of the mammal is said to be but a "cupula terminalis-like structure produced by the gluing together of the hairs of the sensory cells of the organ of Corti, and the breaking away of the whole from the cells which bear them"; and it is incidentally remarked that as found in ordinary preparations it is but "an artifact produced by the use of reagents." However much disposed to accept this very revolutionary deduction, we await confirmation of certain of the author's detailed observations, before fully acquiescing in the belief that "the membrana tectoria, the membrana reticularis, Loewenberg's net, and the three or four main trunks of the system of spiral nerves of the cochlea" so-called, are one and all pure artifacts.

In the course of his inquiry the author has been led into a re-examination of the detailed relationships of the auditory nerves; and in this department he has done a lasting service by sufficiently emphasizing Breschet's long-recorded discovery that the auditory nerve of man is "divided into two branches, each of which supplies semicircular canal organs" (*i.e.* that

[1] "A Contribution to the Morphology of the Vertebrate Ear, with a Reconsideration of its Functions." By Howard Ayers, Director of the Lake Laboratory, Milwaukee, Wis., U.S.A.

the posterior ampulla is innervated from the cochlear nerve), the unfortunate bearings of which upon certain much more recent physiological speculations he is not slow to point out (p. 148). The thanks of all teachers are similarly due to the author, for having introduced the peculiarly appropriate term "ama" for that second and non-sensiferous enlargement of the canals met with in the lower and the highest classes of vertebrates, and for the substitution of "external" for the misleading "horizontal" canal.

One very remarkable discovery, which the author deals with only too casually, is that "in many forms of Elasmobranchs the ear contains scarcely any crystals, and not unfrequently sand grains." The interest of this, by analogy to Hensen's well-known experimental observations upon the Decapod Crustacea, will sufficiently appeal to all zoologists; and we sincerely hope the author will early furnish us with particulars concerning it.

II. Revolutionary as may be some of the author's conclusions above cited, the refrain of the major part of his morphological inquiry is, on the whole, no less so. It runs as follows:—"There can be no doubt that the internal ear develops from superficial canal organs"; that it is primarily subdivided into anterior and posterior portions; and that a "fateful distortion," under which the great development of the cochlea drags the posterior half downwards, has "perhaps more than anything else" deceived us and "retarded our progress in the knowledge of the significance" of its parts. Thus it is that the author gives definiteness to a view which, although it unconsciously dawned with Leydig's recognition of structural similarity between the auditory and tegumental-canal sense-organs of the Ichthyopsida, was first definitely formulated by Beard. He takes his stand upon Beard's brilliant generalization, as modified by the acceptance of Froriep's interesting correction (p. 314), and by certain considerations arising out of his own inquiry. In the performance of this task the author has been shoulder to shoulder with Mr. Allis, co-editor and joint founder of the *Journal of Morphology*, and author of one of the most remarkable papers which its pages have yet borne, viz. that upon "The Anatomy and Development of the Lateral Line System in Amia Calva," duly noted in these pages (NATURE, Aug. 29, 1889), and nothing is more apparent than that he has sought to extend the laws of growth which Allis discovered for the lateral line organs to the internal auditory one. His leading deduction that the last named structure consists of "a symmetrical group" of the organs in question chiefly rests upon the following discoveries and allegations, apart from any question of general structural resemblance between the two, viz. (i.) the lineally recurring (antero-posterior) symmetry of the parts of the labyrinth; (ii.) the duplication of the endolymphatic ducts in Cyclostomes and some Elasmobranchs; (iii.) the double and repetitional nature of the auditory nerve—that being regarded as a derivative of "two distinct cranial nerves," consisting of an anterior (utricular) fasciculus in anastomosis with the facial, and a posterior (cochlear) one, either in astomosis with the glossopharyngeal, or totally independent; and (iv.) an attempt to show that the *macula acoustica neglecta* is an "abortive second horizontal canal organ." Although inclined to accept the general tenor of the author's broader morphological conclusions, we cannot concur in the last cited one. He formulates it almost entirely upon the study of nerve distribution; and, by his own showing (pp. 28, 29) the sensiferous area in question might well have had an independent origin. The conclusion does not, however, materially affect the author's dictum, and in respect to it he seems to have been carried away by a bias in favour of Allis, which elsewhere reappears (pp. 275, 277, and 283), and culminates in the unwarrantable assertion (p. 308) that "the semicircular canals of the ear are simply remnants of the canal system of the surface" (p. 318) "not known to have any other function than the one inherited from their ancestors, viz. that of serving as mechanical protectors of the sense organs," and that they are to be classed with such structures as valves in the horizontal veins . . . the vermiform appendix . . . and atavistic muscles" (*sic*). Having sought to show that the "canal organ has been gradually losing ground" during the progress of descent with modification, the author argues (p. 235) that the future human ear "will not retain much else than the cochlea"! What of the adherents to the bagpipe? We would recommend a periodical examination of their ears to the author's notice. Statements of the order here commented upon are indicative of haste and over-enthusiasm, while others, to the effect that (p. 47) "the cells involuted with the sensory structures "merely" serve as a lining of the auditory canal chambers," and that the otoliths, which they secrete (p. 309) "are to be considered as essentially foreign bodies . . . tolerated because of the impossibility of getting rid of them . . . and the result of the secretive action of the ectoderm cells, which in ancestral forms produced the surface scales," are little short of nonsensical.

With Fritsch, the author regards the Savi's vesicles of the *Batoidei* as derivatives of "the widespread open canal type" of organ; and by no means the least striking portions of his treatise are those in which he attempts to prove (i.) that the semicircular arch of *Myxine* is "composed of the anterior and posterior vertical canals of the Gnathostome vertebrate ear"—deducing an argument in favour of the non-degeneracy of the *Marsipobranchii*, and (ii.) "that a comparison of the ears of Myxine, Petronnyzon, Dasyatis, Torpedo, and Man clearly shows the connection of the [endolymphatic] duct with the utricular and sacular chambers to be a fundamental condition, and not a secondary acquirement."

III. That the physiological aspects of the author's inquiry might be expected to be no less sensational than the morphological ones, is sufficiently clear from his earlier surmise (pamphlet No. 7 of literature cited) that (p. 8) "when one considers the truly wonderful auditory powers" of the mocking bird, "it becomes evident that we must seek for some explanation which does not involve the piano-string hypothesis," and that (p. 9) "it is perfectly obvious that we do not need an internal ear in the vertebrate organization for the perfect exercise of the function of equilibration, since in Amphioxus the organ is absent, and in higher forms the auditory nerves may be destroyed without destroying this function." Little wonder, then, that the author should denounce both the "statical" theory of Goltz, and the more recent "dynamical" one of Cyon, Crum-Brown, and later experimentalists. His attitude towards the majority of his predecessors is best expressed in his remark that "all the phenomena following canal section in mammals and in birds are nothing more than the results of brain lesions such as are entirely inadequate to explain" them.

Availing himself of the observations of Munk, that, whereas in the dog, destruction of the ear, which may lead up to fatty degeneration of its inner constituent, is "always followed by dizziness and equilibrative disturbances, such disturbances do not appear when the cochlea is preserved," and of others akin to them he concludes that, provided the semi-circular canals "have a function, it is not either statically or dynamically equilibrative." Reference is made to Steiner's important observation that whether (in the shark) "the semicircular canals were removed or not," disturbance of the otoliths covering the utricular sense organ, invariably instituted rolling movements, usually towards the side disturbed; but the author is silent concerning Engelmann's attempt to assign distinct functions to the cristæ and maculæ with their associated otolithic masses. Indeed, his opening statement (p. 237) that "we have very slender foundation for forming final judgments of the functional relations of any parts of the internal ear, and that at present what we imperatively need is not speculation, but *experimentation*," well defines our position to-day, when the sum of the author's own experimental observations are taken into account. The physiological section of his work is much weaker and less extensive than its morphological ally.

IV. The author is to be congratulated upon an unusually speculative treatise, embodying a substratum of solid work. As a "paper" it is, in its bulkiness, a sort of awful example fit to rank with that of his countryman Mark on the egg of *Limax campestris* (*Bull. Mus. Comp. Zoöl.*, vol. vi., 445 pages in all). The publication of such voluminous treatises in any but book form, provided with an analytical index, is unjust to both author and reader. It is a gross mistake, and the author has but himself to thank if he escapes proper recognition in consequence. Much of the said bulkiness of the present treatise is due to the incorporation of needlessly lengthy citations from foreign writers, which, permissible in a book, are out of place in a "paper" intended for specialists possessing a full knowledge of current literature. We could have wished, instead of these, a recognition and an explanation of topics untouched; for example, of the circular condition of the posterior canal among the depressed Batoidei, which the author's remarks on pp. 13, 16, 222, and 223 by no means sufficiently express, and which is inexplicable on his belief that "the mechanical forms active in the modelling of the ear are

for the most part the inherited tendencies of cell growth acquired as legacy from the canal organs of the surface." Among important topics which the author ignores, and upon which we could have wished his opinion, are Chatin's alleged discovery of all intermediate stages between the rod-bearing and ciliated cells of the Batrachian auditory epithelium, and the views of Engelmann, Chun, and Yves Delage, arising from the experimental study of the otoliths in Ctenophora, Mollusca, and Crustacea. The latter are by no means reconcilable with the author's bold assertion that "the functions of the otoliths are entirely unknown." In dealing with the "chalk-sacs" of the amphibia, the author remarks (p. 21) that their "morphological as well as physiological significance" is still unknown. He ignores the fact that Lenhossek has shown them to be tubular glands and named them; and this is very remarkable, as, while he makes no mention of that author's paper, he acknowledges one by Coggi, in which it receives ample recognition. G. B. H.

PERSPECTIVE AND COLOUR.

IN *Brain*, Parts LXI. and LXII., which have just been published, occurs an interesting article by Prof. Einthoven (of Leyden) on the production of shadow and perspective effects by difference of colour. The following is an account of the phenomena:—

Difference of colour may, under certain circumstances, be the cause of an apparent difference in distance.[1] To observe the phenomenon, it is only necessary to glue different coloured figures, such as letters of blue and of red paper, to a screen of black velvet and to look at them from a suitable distance. In the experiment about to be described, Roman capital letters of about eight by four centimeters were used, the screen being placed at about three meters distance from the observer.[2]

Under these conditions it appeared, both to Prof. Einthoven and to others who he interrogated, that the red letters were nearer than the blue. Obviously, the phenomenon might be explained by difference in accommodation. In order to see the red letters distinctly, a greater amount of accommodation is necessary than in focussing the blue ones, and the greater sense of effort might account for the notion of the red letters being nearer. This accommodation hypothesis, plausible as it seems, cannot however be accepted as a satisfactory explanation of the phenomenon. Several observations tell against it, notably this: that there are about as many persons who see the blue letters before the red, as there are those who see red before blue. In the second place, the apparent difference in distance—so distinct to binocular vision—disappears almost wholly with the closure of one eye. Looked at with one eye only, and for some length of time, the letters appeared to be lying in the same plane, but each time that the other eye was opened the difference in distance obtruded itself irresistibly.

The amount of difference remains constant, and can be estimated with considerable accuracy, in the same way as in making a stereoscopical observation. The question therefore suggested itself, whether we had not here to deal with real stereoscopy? The answer to this question is an affirmative. Brücke[3] has shown by means of a simple experiment that the retinal images of differently coloured points are shifted with respect to one another. Looking with one eye at a narrow vertical strip on a black background, the upper and lower thirds of the strip being red and the middle third blue, Brücke observed that the blue part deviated to one side, the two red parts to the other side. By covering either eye alternately, a deviation of the blue and red parts in opposite directions will be observed; and, on both eyes being used, the notion of a difference in distance is proved by the combination of the two images in such a way that the parts that deviate to the nasal side constitute the nearer image; the parts that deviate to the temporal side, the further image. The stereoscopical effect is, however, more distinct and convincing with the coloured letters than with the strip used by Brücke.

The cause of the relative removal of the differently coloured images lies in the eccentricity of the pupil, as may be demonstrated experimentally. The pupils may be made highly eccentric by covering them partially. Partial covering on the nasal side is equivalent to a removal of the pupil to the temporal side, and conversely, covering the temporal side is equivalent to removal to the nasal side. With a nasal eccentric pupil a shifting of the differently coloured images in one direction will be observed; with a temporal eccentric pupil the shifting will be in the other direction.

The effect of an artificial eccentricity of the pupil is surprising when both eyes are used. Anyone who sees the red letters before the blue has only to cover his pupils symmetrically on the temporal side, when he will observe the red letters retreat and soon appear to be behind the blue. On covering his pupils symmetrically on the nasal side, the red letters come forward more and more, and seem at last (experimenting at a distance of four or five meters) to remain several decimeters in front of the blue. A person who sees the blue letters before the red, has only to cover his pupils on the nasal side, when he will observe that the distances change, the red coming forward and the blue shrinking back.

Lately, however, Dr. A. D. Waller has found that on repeating the experiment with a seemingly slight modification, he obtained the same effects with one eye alone. He used as a test object rings of blue paper on a red ground, or of red paper on a blue ground, and found that the nasal pupil of the left eye gives the same appearance of circular trenches or hillocks as does the temporal pupil of the right eye.

This observation has been the motive to a more thorough study of the phenomenon.

On looking with the right eye and a temporal pupil at red rings on a blue paper, the rings appear as circular hillocks when the paper is held to the left, and also sloping in that direction. One seems to be looking against the dark edges of a thick red ring fixed upon the blue paper. With a nasal pupil the red rings appear as circular trenches.

The phenomenon is the more striking in proportion to the purity of the colours used. The pupil must be made sufficiently eccentric and in a suitable direction by means of a black screen that covers it from one side, or better still, by means of a stenopæic apparatus. The pupil must not be too narrow, and the whole eye should be wide open and well-directed, so as to avoid any partial covering by the nose, eyelid, or lashes. Lastly, it is not desirable to keep the eccentricity of the pupil constant for more than a brief period. For if one stares at the rings a long time with unmoved pupils, all appreciation of distance is lost, as in so many cases where only one eye is used, and the rings may even seem to lie in a plane that intersects the plane of the blue paper perpendicularly. If, on the contrary, one shifts the screen or the stenopæic apparatus now and then the rings appear to rise and sink, and, under the above-mentioned conditions the rising will be with temporal pupil, the sinking with nasal pupil, and in a way almost as striking as if they were seen stereoscopically.

Prof. Einthoven proves mathematically that the explanation of the phenomenon is found in the appearance of shadows.

[1] Donders. *Wetensch. bijbladen. Med. Gasth. v. Ooglijders*, 1868.
[2] W. Einthoven, "Stéreoscopie dépendant d'une différence de couleur." *Archives Néerlandaises*. t. 20.
[3] Vorlesungen über Physiologie Wien, 1884, 3 Aufl. B. 2, S. 95.

THE FLORA OF GREENLAND.

IN 1891 Dr. William H. Burk accompanied, as botanist, the party which escorted Lieut. Peary to his winter quarters in McCormick Bay. A number of plants were collected and taken to America, but they had barely been determined before an expedition was organised to search for Lieut. Peary, and Mr. William G. Meehan was appointed botanist to it. This was just a year ago. Mr. Meehan was also fortunate enough to obtain specimens, and a catalogue of the plants collected in both cases was communicated to the Academy of Natural Sciences of Philadelphia on April 11. Some idea as to the character of the catalogue will be obtained from the following introduction to it:—

The range of territory covered by Dr. Burk and Mr. Meehan was between about latitude 63° and above 78° or between Godthaab and Littleton Island.

As nearly the whole collection was repeated by each collector, it may be taken as a fairly complete flora of that portion of the territory of Greenland.

Before starting in their respective journeys, both Dr. Burk and Mr. Meehan were instructed to examine as far as possible

the influence of ice sheets on the geographical distribution of plants. Prof. Thomas Meehan, the father of the latter, in a "Catalogue of Plants collected in July, 1883, during an Excursion along the Pacific Coast in South-eastern Alaska,"[1] had given reasons for believing that plants did not merely advance in the wake of retreating glaciers, or push into growth from material brought down in their advance, but that when caught under the mass of flowing ice, would remain for an indefinite period, retaining vitality, and push again into growth when the ice retreated. Prof. Meehan was led to this conclusion from finding no annual plants among those collected in the immediate wake of retreating glaciers in Alaska, while the actual number of species of perennials collected in such locations would be as great as if much time had been given for a floral advance. He had but little opportunity for actual observation as to the plants brought down with the earth carried on the ice, but so far as this went only *Epilobium latifolium* and *Dryas octopetela* were found in this condition, and scarcely any plants were observed on recently deposited moraines. These and some other facts led to the hypothesis that the plants were not migratory, but had held their position through the whole icy period.

These facts were supported by the determination of the existence of much the same flora in isolated spots of land recently bared by the névé of the inland ice, as grow away from the margins of the ice sheet, while the finding of living willow trunks, grass, and perennial plants of many years' growth close to the edges of retreating glaciers, seem to place the point beyond any reasonable doubt, especially when, after careful survey, through the construction and positions of the glaciers, there was the absolute certainty that the plants could not have been deposited by lateral, medial, or terminal moraines, though they might have been by ground moraines—a circumstance which would settle Prof. Meehan's position affirmatively beyond dispute, since the ground moraines are borne under the flowing ice rivers. Abundant vegetation was also found in nunataks—peaks of land projecting above the glaciers or ice cap—but little significance was placed on this circumstance, since all such nunataks visited were within a reasonably close proximity to the main land masses, and the vegetation might readily have sprung from seeds blown there by the winds or brought by mud on the feet of birds. But the demonstration of aged living plants in the other situations named must have a strong bearing on the discussions involved as to the influence of the ice age on the distribution of plants over the surface of the earth.

The abundance of lichens is characteristic of the flora of Greenland. Rocks supposed from a distance to be naturally coloured are found on closer inspection to derive their hue from a complete investiture of some lichen. In this particular the crimson cliffs, beginning at Cape York and extending many miles northward, are a conspicuous example. These cliffs, rising sheer from the water's edge to heights of from seventeen hundred to two thousand feet or more, though of grey granite, show no spot of the intrinsic colour even on being nearly approached, but present a uniform red appearance over their whole surface from a large orange red lichen which covers them.

In view of Schwendener's theory that lichens are but symbiotic forms of algæ and fungi, it is to be regretted that the probably rich fields afforded by the latter named great families in this region have yet to be investigated.

Mosses are even more abundant than lichens. They grow in such vast quantities in spots, that their light or dark greens are visible often for some miles away, brightening the otherwise bleak shores wonderfully. Their persistence in growth under apparently adverse circumstances is also remarkable. No obstacle save the sea seems sufficient to stop their progress. Even dead glaciers have been and are being buried under the steady march of these cryptogamous plants. Mosses fulfil the same duty in Greenland that other forms of plant life perform in more favoured climes, and the amount of rich vegetable matter being deposited by them may be of great value in the future of that great arctic island.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Rev. Bartholomew Price, Master of Pembroke College, has been added to the electors to the Savillian Chair of Astronomy on the present occasion.

[1] Proceedings of the Academy of Natural Sciences of Philadelphia, 1884.

SIR HENRY HOWORTH, F.R.S., has had the honorary degree of D.C.L. conferred upon him by Durham University.

OXFORD has conferred the degree of M.A. upon Dr. W. B. Benham, Aldrichian Demonstrator.

MR. W. FISHER, late Conservator of Forests in the North-West Provinces of India, has been appointed Assistant Professor of Forestry at Cooper's Hill.

SCIENTIFIC SERIALS.

American Journal of Science, June.—Electro-chemical effects due to magnetisation, by George Owen Squier.—Nikitin on the quaternary deposits of Russia and their relations to prehistoric man, by A. A. Wright. A summary of the views laid before the International Congress of Archæology in Moscow, 1892, by the Russian geologist, Mr. S. Nikitin, regarding the palæolithic and neolithic epochs in European Russia, and their coincidence with the geological divisions of pleistocene and modern.—Rigidity not to be relied upon in estimating the earth's age, by Osmond Fisher. A criticism of Mr. Clarence King's estimate of the probable age of the earth on the ground of its assumed rigidity not being an established fact. The argument derived from tidal action is fully discussed. Had the solid part of the earth so little rigidity as to allow it to yield in its own figure very nearly as much as if it were fluid, there would be very nearly nothing of what we call tides—that is to say, rise and fall of the sea relatively to the land—but sea and land together would rise or fall a few feet every twelve lunar hours. This would be the case if the geological hypothesis of a thin crust were true. This is the argument for tidal rigidity as enunciated by Kelvin. But this does not take into account the horizontal motion of the water. It rests upon the equilibrium theory of tides as against the canal theory. The latter has been symbolically worked out by Prof. G. H. Darwin. If the earth's interior be assumed to be a liquid of small viscosity, the bodily tide at its equilibrium value will have a height of $1\frac{3}{4}$ feet. This will diminish the hydrodynamical tide by not more than a fifth of its value, and it is quite possible that the tides we actually experience may be tides thus diminished by the fluidity of the earth's interior.—On the treatment of barium sulphate in analysis, by J. I. Phinney. The author shows that alkaline chlorides contaminate barium sulphate thrown down in the presence of an excess of sulphuric acid, and that the process of purifying by hydrochloric acid is inefficient. The only good method for purification is either to fuse, according to Fresenius, with sodium carbonate, extracting and reprecipitating as sulphate, or to evaporate from solution in concentrated sulphuric acid according to Mar.—On the nature of certain solutions and on a new means of investigating them, by M. Carey Lea. The solutions in question are those of sulphates which were tested for free sulphuric acid by a solution of iodoquinia, a very delicate and trustworthy test. Solutions of heavy metallic sulphates, with the exception of ferrous sulphate, contain no free acid. All sesquisulphates examined were dissociated in solution. So were acid salts and alums, with the exception of chrome alum.—Also papers by Messrs. Fairbanks, Moses, Penfield, Johnson, and Pupin.

Bulletin of the New York Mathematical Society, vol. ii. No. 8 [May, 1893, New York]. This number opens (pp. 175–178), with a review by Miss C. A. Scott of Prof. W. B. Smith's "Introductory Modern Geometry of Point, Ray, and Circle" (see NATURE, vol. xlvii. p. 532). We endorse her closing remarks that the usefulness of the book would be greatly increased if he were to translate his work into ordinary mathematical English.—Prof. Echols contributes an interesting note, biographical and otherwise, entitled Wronski's expansion (pp. 178–184). The expansion was presented by Höené Wronski in 1810, to the French Academy of Sciences, and is as follows:—$f(x)=a_0+a_1\omega_1+a_2\omega_2+\ldots ad\ infinitum$, where $f(x)$, ω_1, ω_2,...are arbitrary functions of x, and a_0, a_1,...are independent of x. The law of formation of the coefficients he calls "la loi suprême."—Dr. Cole, in a note on the substitution groups of 6, 7, and 8 letters (pp. 184-190), furnishes a list of over forty omitted groups supplementary to the lists given by Messrs. Askwith and Cayley in vol. xxiv. of the *Quarterly Journal of Mathematics*.—The *Mathematical Bibliography*, by A. Ziwet (pp. 190–192) gives in some detail an account of the new *Revue Semestrielle des Publications Mathématiques*, &c., issued by the Mathematical Society of

Amsterdam, to which attention has been drawn in our columns. The notice is on the whole favourable to this new venture.—The notes and new publications are well up to date.

Meteorologische Zeitschrift, April.—On the hypotheses of the oscillations of the so-called maximum zone of the aurora, and the peculiarities of the development of the aurora in this zone, by A. Paulsen. In 1872 Prof. Fritz asserted that the winter minimum of the aurora diminished with increase of latitude, and in 1880 M. Tromholt endeavoured to show that the maximum zone is in a state of continual oscillation, as it makes not only a yearly and eleven-yearly movement, but also a daily periodical change of position. Also that auroræ are more frequent in the morning hours than in the evening, and therefore that the maximum zone shifts to the northward during the night. The object of Dr. Paulsen's paper is to refute these assertions, and he quotes observations to show that the movement of the zone of greatest auroral display during the course of the night is not towards the north, and states that no single phenomenon exists that can be explained by a daily oscillation of the maximum zone, but that, on the contrary, all that we know about the daily range of the aurora points to the fact that no such movement can exist.—Relations of daily synoptic weather charts to the general circulation of the atmosphere, by E. Herrmann. Starting from the point of view that the resultants of the forces of the earth's rotation and of centrifugal force, in a stationary condition of the atmosphere, must be normal to the areas of equal pressure, the author shows how the normal distribution of pressure is solely a result of the difference of rotation of the atmosphere round the earth's axis, and of the rotation of the earth itself. On the basis of the distribution of pressure acccording to Maury's zones, there result three zones in each hemisphere:—An equatorial zone of easterly winds, a zone of westerly winds, and a polar zone of easterly winds, with corresponding changes of pressure. It follows from the decrease of temperature towards the pole that at a certain height the zone of westerly winds extends over the zone of easterly winds. The daily positions and extent of the zones are determined by the distribution of pressure in all latitudes, and their existence is a necessary consequence of the principle of the preservation of areas, but applied to the whole atmosphere, and not to individual particles as Ferrel has done. The author urges the importance of the continuance of synoptic charts, and of the desirability of telegraphic reports from Iceland and the Azores.

Bulletin de l'Académie Royale de Belgique, No. 4.—The most interesting paper is one by G. Van der Mensbrugghe on negative hydrostatic pressure. It is well known that any horizontal layer of a liquid in equilibrium supports a hydrostatic pressure equal to the weight of a column of liquid, whose base is equal to the area of the layer considered, and whose height is the vertical distance of the layer from the surface. The author investigates the pressures existing in layers lifted up *above* the level, whether by atmospheric pressure, capillarity, or otherwise. In this case the hydrostatic pressure will be similarly calculated, but will be negative, so that it must be subtracted from the external pressure upon the surface of the liquid in order to obtain the true pressure on the layer. This conclusion is illustrated by a series of striking experiments. A test-tube was filled with water and withdrawn, mouth downwards, from the tank, leaving the mouth an inch or so below the level. A U-tube was closed with the thumb at one end, while the other was inserted in the test-tube. On releasing it, air was sucked into the test tube and the liquid reduced to the exterior level. A long cylindrical tube of paper, similarly filled with water and withdrawn, was flattened more and more towards the top, owing to the atmospheric pressure exceeding that of the liquid inside. The same reasoning applied to cases where the liquid was raised by capillary action, the distribution of pressure being the same as if the tubes had been closed at the capillary surfaces. A wide tube was provided with a closely-fitting cork, through which was passed a very fine tube. The liquid was held suspended in the wide tube owing to the capillary action of the surface in the thin tube, which was 4 cm. above the level. On introducing a U-tube as before, the water was again expelled by the air rushing in, and reduced to the external level.

Bulletin de la Société des Naturalistes de Moscou, 1892, No. 3.—Sources for the flora of the Kieff educational district (Kieff, Volhynia, Podolia, Tchernigov, and Poltava), by Comte Bourdelle de Montrésor, being a full bibliography of all publications relative to the subject.—Contributions to the ornithology of the Transcaspian region, according to the researches of M. Thomas Barey, by J. Stolzmann. M. Barey travelled in the region in 1889-91 for the Branicki Museum of Warsaw. Of the 230 species mentioned in the detailed list now given, 17 are new for the region.—On the alkalies of the blood and the lymph, by J. M. Syechenov. Blood being not only the store for the food materials of the organism, but also the medium for breathing, it is desirable to ascertain the means of maintaining the composition of blood which is necessary for that purpose. The fact that the carbonate of sodium from the pancreatic and intestine juice enters the blood, is considered as a process for feeding the blood with necessary alkalies.—The Upper Tithonic deposits of Central Russia; note by N. Krischtafowitch.—Glaciers in Russia, by H. Trautschold. Remarks against the glaciation of middle Russia, based upon the old conception of only mountain glaciers being able to produce glacial effects.—The *Oleostephanus nodiger* zone near Milkovo in Podolsk, government of Moscow, by D. Stremoukhoff. New species, *O. milkovensis*, described.—Note on some special cases of the problem of several bodies, by Th. Sloudsky.—Short report upon geological and botanical excursions in Yaroslav and Vologda, by Dr. Zickendrath.—On the neurokeratin, by Dr. J. Ogneff. This substance, in the sense established by Kühne and his followers, does not exist either in the peripheral nerves or in the brain; when obtained from the brain it represents a varied mixture of unsoluble remainders from the tissues composing the brain; the molecular substance (retina, brain) on the one side, and the neurokeratin-net in the peripheral nerves on the other side, cannot be considered as homological formations.—(*id.* No. 4). A list of the mammals and birds from the Aral steppes, by A. M. Nikolsky.—New species, *Astragalus uralensis*, by Dr. Litvinov.—Note on the cold of January, 1893, by B. Sresnewskij.—To the memory of N. J. Kokscharoff and A. W. Gadolin, by V. Vernadsky.

SOCIETIES AND ACADEMIES.

LONDON.

Mathematical Society, June 8.—Mr. A. B. Basset, F.R.S., vice-president, in the chair.—The chairman announced that the Council had unanimously made the fourth award of its De-Morgan gold medal to Prof. F. Klein, of Göttingen, on the ground of his many contributions to the advance of mathematical science. The following communications were made:—Complex integers derived from $\theta^3 - 2 = 0$, and on the algebraical integers derived from an irreducible cubic equation, by Prof. G. B. Mathews.—Pseudo-elliptic integrals and their dynamical applications, by A. G. Greenhill, F.R.S. Writing the Elliptic Integral of the Third Kind in the canonical form—

$$I = \int \frac{Pz + nx}{(z + x)\sqrt{Z}}\,dz,$$

where

$$Z = 4z(z + x)^2 - \{(y + 1)z + xy\}^2,$$

then x and y are the quantities employed by Halphen in his "Fonctions Elliptiques," t. i. p. 103. Putting

$$z + x = pu - pv,$$

where

$$12pv = -(y + 1)^2 - 4x,$$

and

$$z_m + x = pmv - pv,$$

then

$$z_1 + x = 0,$$
$$z_2 + x = x,$$
$$z_3 + x = y,$$
$$z_4 + x = \frac{x(y - x)}{y^2},$$

and so on; and generally $z_m + x$ is the same as Abel's $\frac{1}{2}q_{m-1}$ if we replace Abel's x by $\frac{fx}{4b^3}$, and $\frac{16b^3}{p^2}$ and $1 + \frac{4ab}{p}$ by Halphen's $-x$ and $-y$ (Abel's "Œuvres Complètes," t. ii. pp. 157, 163). Abel's recurring equation for q_m is now only another form of this elliptic function formula—

$$p(u + v) + p(u - v) = 2pv + \frac{p'^2v}{(pu - pv)^2} + \frac{p''v}{pu - pv},$$

with $u = (m-1)v$; and the continued fraction expansion employed by Abel is not required, except, perhaps, for the determination of P. The integral I is *pseudo elliptic* when the parameter v is an aliquot part n of a period; and then

$$p(n-1)v = pv, \text{ or } p(n-m)v = pmv,$$

expressed by

$$z_{n-1} + x = 0,\ z_{n-1} = z_1,\ q_{n-2} = 0,$$

or

$$z_{n-m} = z_m,\ q_{n-m-2} = q_m.$$

The integral I can now, for odd values of n, be expressed in the form

$$2(z+x)^{\frac{1}{2}n}e^{\frac{1}{2}i\,I} = \{z^{\frac{1}{2}(n-3)} + Bz^{\frac{1}{2}(n-5)} + Cz^{\frac{1}{2}(n-7)} + \ldots\}\sqrt{Z} + i\{Pz^{\frac{1}{2}(n-1)} + Qz^{\frac{1}{2}(n-1)} + Rz^{\frac{1}{2}(n-5} + \ldots\} = H\sqrt{Z} + iK,$$

where H and K are rational integral functions of z; the circular form of the integral being chosen on account of its dynamical applications. When n is even, a factor $z-a$ of Z can be inferred by forming $z^{\frac{1}{2}n} + x$; and then if $z-b$, $z-c$ denote the other factors of Z, the value of I can be expressed in the form

$$(z+x)^{\frac{1}{2}n}e^{\frac{1}{2}i\,I} = \{z^{\frac{1}{2}(n-2)} + Bz^{\frac{1}{2}(n-4)} + \ldots\}\sqrt{\{(z-b)(z-c)} + i\{Pz^{\frac{1}{2}(n-2)} + Qz^{\frac{1}{2}(n-4)} + \ldots\}\sqrt{(z-a)}.$$

The results for $n = 3, 5, 7, 9$ have been already given in the Proc. London Math. Society, vol. xxiv. pp. 7–10; thus for

$n = 3$, $x = 0$; $n = 4$, $y = 0$; $n = 5$, $y = x = -c$;
$n = 6$, $y = -c$, $x = -c(1+c)$;
$n = 7$, $y = -c(1+c)$, $n = -c(1+c)^2$;

$$n = 8,\ y = -c\frac{1+2c}{1+c},\ x = -c(1+2c);$$

$$n = 9,\ y = -c(1+c)^2,\ x = -c(1+c)^2(1+c+c^2);$$

$$n = 10,\ y = \frac{-c(1+c)}{(2+c)(1-c-c^2)},\ x = \frac{-c(1+c)}{(2+c)(1-c-c^2)^2}.$$

But the next case of $n = 11$ presented difficulties, which were only overcome by the kind assistance of Dr. Robert Fricke, of Göttingen, and a reference to his article in the *Math. Annalen.* t. 40, p. 478. It was found that the relation

$$z_{11} + x = 0, \text{ or } z_5 = z_6,$$

equivalent to Halphen's $\gamma_{11} = 0$, or

$$(xy - x^2 - y^3)(y-x)^3 - xy(y-x-y^2)^3 = 0,$$

could be satisfied by

$$x = -c(1+c)(1+c+q),\ y = -c(1+c) - \frac{cq}{1+c},$$

where

$$q(q+1) = c(1+c)^3,$$

or

$$1 + 2q = \sqrt{(1+4c+8c^2+4c^3)}.$$

The relation between this c and the parameters τ and τ' employed by Klein and Fricke ("Modulfunctionen, t. ii. p. 440) or the parameters η and W employed by Dr. Kiepert (*Math. Ann.* t. xxxii. p. 96), was finally found to be

$$\frac{1+4c+2c^2-5c^3-2c^4+c^5}{c^2(1+c)^2} = \frac{1-10\tau+\tau'}{2\tau^2} = \tfrac{1}{2}(\eta^2+6\eta-16+W).$$

Given τ and τ', or η and W, the five roots of the quintic in c will correspond to the five parameters,

$$(2, 4, 6, 8, 10)\frac{\omega}{11}.$$

Conversely, given c the values of

$$p(2, 4, 6, 8, 10)\frac{\omega}{11}$$

can be found; as also the values of τ and τ', or η and W. According to Dr. Fricke's theory (*Math. Ann.* t. 40) the case of $n = 19$ should have a solution similar to that of $n = 11$. The general problem of the *pseudo-elliptic* integral is thus reduced to the determination of x and y, considered as the coordinates of a point on the curve

$$z_n + x = 0, \text{ or } z_{n-m} = z_m,$$

or

$$\gamma_n = 0 \text{ (Halphen)},$$

as functions of a parameter c; and when this is effected the values of $p\frac{2s\omega}{n}$ can be found; and thence, in the manner of Kiepert, Klein, and Fricke, the various corresponding modular functions can be determined. In the dynamical applications to the motion of a top or gyrostat, the azimuth ψ can be divided into two parts, ψ_1 and ψ_2, where, according to the notation of Routh's "Rigid Dynamics,"

$$\psi_1 = \tfrac{1}{2}\frac{G+Cr}{A}\int\frac{dt}{1+\cos\theta},\ \psi_2 = \tfrac{1}{2}\frac{G-Cr}{A}\int\frac{dt}{1-\cos\theta},$$

θ denoting the angular distance of the axis of the body from its highest position; and ψ_1, ψ_2 are thus two elliptic integrals of the third kind, having their poles at the lowest and highest positions of the axis, the positions of stable and unstable equilibrium. In ψ_1 we may put the parameter $a = p\omega_3$, where ω_3 denotes the imaginary half-period, and p is a proper fraction; also ψ_1 is pseudo-elliptic when $p = \frac{2r}{n}$, where r and n are integers. When n is an odd integer, the value of ψ_1 can be expressed in the form

$$(1+\cos\theta)^{\frac{1}{2}n}e^{in(\psi_1 - p_1 t} = H\sqrt{\Theta} + iK,$$

where H and K are rational integral functions of $\cos\theta$, of the degree $\frac{1}{2}(n-3)$ and $\frac{1}{2}(n-1)$, and

$$\Theta \text{ denotes } \sin\theta\frac{d\theta}{dt}.$$

But in ψ_2 the parameter is of the form

$$b = \omega_1 + q\omega_3,$$

where ω_1 is the real half-period; and to deduce a pseudo-elliptic expression for ψ_2 corresponding to $q = \frac{2r}{n}$, the factors of Θ must be known; say

$$\cos\theta - \cos\alpha,\ \cos\theta - \cos\beta,\ \cos\theta - \cosh\gamma,$$

α and β being the inclinations between which θ oscillates. Then, when ψ_2 is pseudo-elliptic,

$$(1-\cos\theta)^{\frac{1}{2}n}e^{in(\psi_2 - p_2 t)} = H'\sqrt{\{(\cos\beta - \cos\theta)(\cos\theta - \cos\alpha)\}} + iK'\sqrt{(\cosh\gamma - \cos\theta)},$$

or

$$= H'\sqrt{\{(\cosh\gamma - \cos\theta)(\cos\theta - \cos\alpha)\}} + iK'\sqrt{(\cos\beta - \cos\theta)},$$

where H′ and K′ are rational integral functions of $\cos\theta$. By multiplication of these two equations for ψ_1 and ψ_2, we find an expression for

$$(\sin\theta)^n e^{in(\psi - pt)}$$

where $p = p_1 + p_2$; the values of the *secular terms* p_1 and p_2 being most readily determined by a differentiation and verification. Changing the sign of i in ψ_2, and denoting $\psi_1 - \psi_2$ by χ, $p_1 - p_2$ by q, we should find, as a verification,

$$(\sin\theta)^n e^{in(\chi - qt)} =$$

$$[L\sqrt{\{(\cos\beta - \cos\theta)(\cos\theta - \cos\alpha)\}} + iM\sqrt{(\cosh\gamma - \cos\theta)}]^n,$$

where L and M are constants, corresponding to an elliptic integral of the third kind, with a parameter

$$b - a = \omega_1.$$

The cases of $n = 3$ and 5 are worked out at length in the paper. The pseudo-elliptic expressions for ψ_2 are immediately available for the construction of *algebraical herpolhodes*, as the parameter in this mechanical problem is always of the form

$$\omega_1 + q\omega_3;$$

while the pseudo-elliptic expressions for ψ_1 can be utilised in the construction of solvable cases of the tortuous curve assumed by a revolving chain. In the herpolhode the case of $n = 3$ is realised when "the focal ellipse of the momental ellipsoid rolls on a plane at a distance from the centre equal to the difference of its semi-axes;" and when $n = 4$, "the distance of the fixed plane is equal to the distance from centre to focus of this focal ellipse." By Prof. Sylvester's theorems on correlated bodies, the motion of the bodies having momental ellipsoids confocal to this focal ellipse, can be inferred immediately. In the equations of the Precession and Nutation of the earth, or of the motion of an elongated projectile in an infinite frictionless liquid, the function Θ will be composed of four linear factors; so that in the construction of pseudo-elliptic algebraical cases of this motion, a return to Abel's original method may prove preferable, especially when n is an even number.—On the expansion of certain infinite products (II.), by Prof. J. L.

Rogers.—Note on some properties of Gauche cubics, by Mr. T. R. Lee. There are two principal theorems in the note, one being an analogue of the theorem of Desargues, and the other affording a test by which it may be determined whether a given line is a chord of a cubic or not.—Note on the centres of similitude of a triangle of constant form *circumscribed* to a given triangle, by Mr. J. Griffiths.

Physical Society, June 9.—Prof. J. Perry, F.R.S., Vice-President, in the chair.—Mr. A. P. Trotter read a paper on a new photometer. The author has modified his illumination photometer, described Proc. I.C.E., vol. cx. paper No. 2619, so as to adapt it to the measurement of candle-power. The principle employed is to view a screen illuminated by one source through an aperture in a second screen illuminated by the other light, the aperture becoming invisible when the illuminations are equal. After using perforations of various patterns, a series of narrow slits cut in thin paper were found to give the best result. The plain screen is mounted behind the slotted one in a box sliding on the photometer bench, and they are arranged so that the light falls on them at equal angles. The screens are viewed from a distance of 6 or 7 feet through an opening in the front of the box, cords being provided for producing the traversing motion. Two "sights" set respectively at the middle of the length of the plain screen, and on the lower edge of the front opening, serve to show when the middle of the band of equal illumination is vertically above the pointer on the carriage. The photometer is found to be particularly valuable when it is desired to determine the maximum power of a variable source. When lights of different colour are being compared—say a gas flame and an arc—one end of the screen shows blue strips on a yellow ground, and the other end yellow strips on a blue ground; at the centre the colours seem to blend. To facilitate the comparison of such lights, Mr. Crompton, who has been working at the subject simultaneously with the author, uses one screen tinted pale yellow and the other pale blue. Details of construction of the new photometer are given in the paper, and the accuracy attainable when comparing two equal lights of about eight candles, stated to be about 1 per cent.—Prof. S. P. Thompson, F.R.S., read some notes on photometry. The first note relates to the use of two overlapping screens as an isophotal, and describes the evolution of the Thompson-Starling photometer. In this instrument a prismatic block with apex upwards rests crosswise on the photometer bench, and the inclined sides are respectively illuminated by the two sources to be compared. In testing differently-coloured lights, coloured stuffs were placed over the surfaces of the wedge. In some cases notched and overlapping cards were used to form the overlapping surfaces; an inclination of about 70° between the two surfaces was found convenient. The second note refers to the periodic principle in photometry, and in it the author discusses the various methods which have been, or may be, used for producing small differences of decreasing amount between the two sides of a photometer screen. By employing a device of this kind much greater accuracy of adjustment is possible. In one form of vibration-photometer worked out by the author, the paraffin blocks of a Jolly's photometer are mounted at one end of a spring, the other end being fixed to the carriage. The act of moving the carriage starts the blocks vibrating, thus producing the desired variations. In a third note the question of using the electric arc as a standard of light is dealt with. Since 1878 the positive crater has been used as a standard of whiteness, and last year both the author and Mr. Swinburne suggested that a given area of crater might be used as a standard of light. This proposal has since been carried out by M. Blondel. Since the intrinsic brilliancy of the crater is high, it necessitates very small apertures, or else the use of standards of large candle-power. Advantages of using powerful standards are pointed out in the paper. With a circular hole 1 m/m in diameter, a standard of about fifty-five candles could be obtained; with such a source, benches longer than usual would be preferable. At the end of the note, the errors which may be introduced by using as an arc standard a hole in a plate of sensible thickness, when viewed obliquely, are investigated, as well as those due to inaccuracy of setting the plane of a hole made in foil, perpendicular to the photometer bench. Major-General Festing, in opening the discussion on both papers, said reflection from the sides of the hole in a thick plate would tend to lessen the error calculated by Prof. Thompson. The ordinary impurities in carbon were not likely to alter the brilliancy of the crater. Capt. Abney and himself had no reason to distrust its constancy. Both the vibrating photometer and Mr. Trotter's arrangement would be very useful.—Dr. Sumpner said his photometric experience had been obtained with the Bunsen, Jolly, and Lummer-Brodhun types. With the two former the inaccuracy arising from uncertainty of adjustment was about ½ per cent. Changes of about 0·4 per cent. (average) resulted from reversing the screens. The Lummer-Brodhun instrument (which he described) was better than either of the other two, the average error being about ¼ per cent. Mr. Frank Wright thought scientific men gave too little attention to the question of light standards. Photometers could be relied on much more than any standard at present in use. The Methven screen was the most practical standard yet devised, but in his opinion no gaseous flame could be a real standard on account of the influence of the surrounding atmosphere. Prof. Ayrton saw difficulties in using long benches as suggested by Dr. Thompson, on account of the serious atmospheric absorption which occurs with light from arcs. Decreasing the intensity by dispersion or otherwise was preferable. In some tests on glow lamps now being carried out at the Central Institution, a Bernstein lamp used as a standard was mounted on a spring and vibrated. Mr. Medley showed the vibrating standard referred to by Prof. Ayrton, and gave a series of numbers showing that with this device in conjunction with the Lummer-Brodhun photometer accuracies of about ⅛ per cent. were obtainable. Mr. Swinburne thought Mr. Trotter's arrangement was better than the "wobbling" photometer. As to the best length of bench, he was inclined to think the shorter the better, provided its dimensions were large compared with those of the standard light. He concurred with Mr. Wright in his remarks about the desirability of obtaining a better standard. Speaking of the arc as a standard, he said that only impurities less volatile than carbon would influence the brightness. An important factor was the emmisivity of the carbon, which might not be constant. Mr. Blakesley thought the accuracy obtainable with Mr. Trotter's photometer had been underrated, and pointed out that by using quadrant-shaped screens intersecting orthogonally on the axis of the photometer instead of straight ones, the width of the neutral band could be greatly diminished. Mr. Trotter, referring to Dr. Thompson's paper, said he had found considerable difficulty in making pinholes suitable for arc standards. It was not an easy matter to accurately measure the hole when made. In photometric measurements he had found it very important to reverse his screens. Curved screens as suggested by Mr. Blakesley had been tried, but with little advantage. They also destroyed the approximate direct-reading property of the photometer. The subject of changing the length of a bench and its effect on the gradient of illumination was discussed. With short benches one had to guard against the departure from the inverse-square law, due to appreciable size of the standard. Recent experiments had shown that the light given out by 1 square m/m of crater surface differed considerably from 70 candles.—A paper on "The Magnetic Field close to the Surface of a Wire conveying an Electrical Current," by Prof. G. M. Minchin was taken as read. In this paper the author applies the solution he gave in March last for the conical angle subtended by a circle at any point in space to determine the magnetic potential at a point near the surface of a ring of wire of finite cross section. The shapes of the lines of force near the surface, for several laws of current distribution across the section, have also been worked out.

Chemical Society, May 18.—Dr. H. E. Armstrong, President, in the chair.—The following papers were read:—Studies on the formation of ozone (ii.), by W. A. Shenstone and M. Priest. Using an ozone generator of the Brodie pattern, the authors have studied the effect of discharges of varying difference of potential upon the quantity of ozone produced. The maximum proportion of ozone that can be produced at a given temperature is nearly independent of the potential difference employed, provided that this be within 33 and 69 C.G.S. units and that the path of the discharge be not very short at any point in the generator. When this latter case occurs the maximum quantity of ozone that can be obtained has an inverse relation to the difference of potential employed. The rapidity of ozonisation is greater with a high potential difference than with a low one, and the maximum proportion of ozone is produced with a low rate of discharge. A generator made of very thin glass, the

two tubes of which fit rather closely, gives the greatest yield of ozone; for the same potential difference an induction coil ozonises a larger proportion of oxygen than either a Wimshurst or a Voss machine. The authors conclude from their experiments that the silent discharge acts by decomposing oxygen molecules into their atoms, which subsequently re-combine, to a greater or less extent, according to the conditions, to form the triatomic ozone molecules; it would hence seem that ozone is not formed by the direct action of the discharge.—The relative strengths or "avidities" of some compounds of weak acid character, by J. Shields. The author has calculated the relative strengths of a number of compounds of weak acid character, such as biboric and carbonic acids, hydrogen cyanide and phenol, from the rates at which salt solutions hydrolyse ethyl acetate.—The boiling points of homologous compounds. Part I.: Simple and mixed ethers, by J. Walker. The author finds that the boiling points of members of many homologous series may be very closely expressed by the relation $T = aM^b$, where T is the absolute boiling point, M the molecular weight, and a and b are constants peculiar to each series. The formula may be stated in the following form:—The logarithm of the ratio of the absolute boiling points of any two members of a homologous series, divided by the logarithm of the ratio of their molecular weights, is constant.—The conditions determinative of chemical change, by H. E. Armstrong.—The nature of depolarisers, by the same author.

Geological Society, June 7.—W. H. Hudleston, F.R.S., President, in the chair.—Dr. Johnston-Lavis, in referring to specimens and microscopic slides showing eozoonal structure in the ejected blocks of Monte Somma, exhibited by him, said that all the criticisms of *Eozoon* have so far been destructive, no analogous structure having been found in other localities under conditions that could explain the origin of so curious an arrangement of different minerals. These altered limestones from Monte Somma correspond in all details with those of the original Canadian specimens, and in many cases, on account of their freshness, exhibit some of the pseudo-organic structural details, such as the stolon-tubes, in far greater perfection than does the true so-called *Eozoon canadense*. He had been working at the subject in conjunction with Mr. J. W. Gregory. The following communications were read:—The bajocian of the Sherborne district: its relations to subjacent and superjacent deposits, by S. S. Buckman. This paper is partly the result of excavations made by Mr. Hudleston, F.R.S., and the author at Sherborne, to determine the position of the so-called "*Sowerbyi*-zone." The author used the term "bajocian" to denote the lower beds of what has been called "upper part of the inferior oolite." He introduced a term emar (ἦμαρ) as a chronological subdivision of an "age," and considered that the beds dealt with in the paper were deposited during 12 emata, which he called, in descending order, *fuscum zigzag*, *Truellii*, *Garantianum*, *niortense*, *Humphriesianum*, *Sauzei*, *Witchellia* sp., *discites*, *concavum*, *bradfordense*, and *Murchisonæ*. A line from Stoford, Somerset, through North Dorset to Milborne Wick, Somerset, is the base-line of the district reviewed. Seventeen sections of places close to this line were given to show the relations of the beds, with the different amounts of strata deposited during successive emata, and during the same emar at different places. By means of tables it was shown that the area of maximum accumulation receded eastwards in the earlier emata, and then proceeded westwards during the later emata. A similar and corresponding faunal recession and progression was pointed out, though the faunal headquarters always remain west of the great accumulation of deposit. Adding the various maximum deposits together, the author found as much as 130 feet of strata deposited during the twelve emata = (practically) the "Inferior Oolite of Dorset." This is a far greater thickness than had hitherto been allowed to beds of this age in the district, but the fault lay partly in incorrect correlation. The Dorset strata are correlated with strata in other districts—namely, with those of Dundry and Leckhampton Hills in this country. Of these the author gave sections, and pointed out the emata during which the strata of those localities were deposited, and made some alterations in their correlation. Passing to Württemberg, the author showed that the equivalent of Waagen's *Sowerbyi*-zone is exactly represented at Sherborne. Returning to Normandy, the results were compared with the recent work done by Munier-Chalmas, who in some respects has made an even more detailed subdivision of the strata. The corrrespondence between the divisions for Dorset and those of Munier-Chalmas in Normandy and Haug in Southern France was shown in a table. The President, Prof. Blake, the Rev. H. H. Winwood, and Mr. Marr took part in the discussion that followed.—On raised beaches and rolled stones at high levels in Jersey, by Dr. Andrew Dunlop. An account was given of the higher raised beaches examined by the author on the south-eastern and eastern coast, but probably found in other parts of the island also, as indicated by the existence of rolled stones, &c. These beaches seem to prove submergence (in the case of that at South Hill, to a depth of at least 130 feet below the present level) at the end of the "first glacier period." The brick clay often lying on raised beach, and containing pebbles, was compared to loess by the author. He believed that Prof. Prestwich's theory of sudden and rapid upheaval, with a resulting tumultuous sweep of water, may be applied to Jersey; but also, if the sinking took place at the end of the Glacial Period, the peculiar conditions produced by melting ice may have played their part in producing the brick-clays. Subsequent upheaval above the present sea-level is indicated by submerged forests, sometimes lying on the brick clay. No fossils have hitherto been found in the raised beaches; but a bone of *Bos primigenius* (?) has been extracted from the brick-clay. The President, the Rev. H. H. Winwood, and Mr. Monckton spoke on the subject of the paper.

Entomological Society, June 7.—Mr. H. J. Elwes, President, in the chair.—Mr. A. Cowper Field exhibited varieties of *Smerinthus tiliæ*, bred between 1890 and 1893, under varying conditions of temperature, those which had been exposed to a lower temperature being much darker than those which had been exposed to a higher. Mr. Merrifield made some observations on the subject, and remarked that, as far as his experience went, no hard and fast rule could be laid down with regard to the production of the lighter or darker colourings, as a high temperature sometimes produced dark forms.—Mr. W. M. Christy exhibited a series *Zygæna trifolii*, including very many yellow forms, all, with one exception taken at one spot during the latter half of May, 1893, and belonging to one colony. Some of the specimens were more or less incomplete, both in structure and colour, and Mr. Barrett stated as his opinion that this was due to their having been forced by the unusually fine weather. Lord Walsingham, Mr. Merrifield, and others took part in the discussion which followed.—The President remarked on the great abundance of *Coleophora laricella* in Gloucestershire, and stated that they were committing great ravages among young larches. Lord Walsingham stated that he had seen young larches at Carlsbad completely bleached by this moth.—It was suggested by several Fellows of the Society that care should be taken to observe the occurrence of second broods of insects during the year.—Mons. Wailly exhibited cocoons of various silk-producing Lepidoptera, and stated that the larva of *Attacus pernyi*, whose food-plant is oak, had been reared in Trinidad on *Terminalia latifolia*.

Linnean Society, June 15.—Prof. Stewart, President, in the chair.—Mr. A. W. Bennett exhibited some curious examples of revivification in plants, and made some remarks on the tentacles of *Drosera rotundifolia* and *longifolia*, specimens of which were exhibited under the microscope.—Dr. Stapf read a paper on the botany of Mount Kiua Balu, North Borneo, and exhibited some of the most characteristic plants. His remarks were criticised by Mr. W. T. Thiselton Dyer, who regarded the paper as a valuable contribution to geographical botany.—Prof. W. A. Herdman, in continuation of a former paper printed in the Society's journal, gave an interesting account of several species of British *Tunicata*, some of which were previously undescribed, his remarks being illustrated by figures projected on the screen by means of the oxy-hydrogen lantern.—On behalf of Miss A. L. Smith, Mr. George Murray gave an abstract of a paper on the anatomy of a plant brought from Senegambia by Mr. G. F. Scott Elliot, the affinities of which had not been precisely determined, but which was referred either to the *Melastomaceæ* or *Gentianaceæ*. The author's views, which were illustrated by means of the oxy-hydrogen lantern, were criticised by Dr. D. H. Scott.—In the absence of Mr. Scott Elliott, a paper was read on his behalf by the secretary, on the African species of the genus *Ficus*.—Prof. F. W. Oliver, on behalf of Miss M. Benson, gave an abstract of a paper entitled contributions to the embryology of the *Amentiferæ*, illustrated by diagrams of sections made by the author.—With this meeting the session of 1892–93 was brought to a close.

PARIS.

Academy of Sciences, June 12.—M. Lœwy in the chair.—Baron von Nordenskiöld was elected Foreign Associate.—On the theory of flow over weirs without lateral contraction, taking into account the variations undergone by the inferior contraction of the falling sheet according to the height of fall, by M. J. Boussinesq.—On the heat of combustion of the principal gaseous hydrocarbons. by MM. Berthelot and Matignon.—The differences of the heat of combustion in the homologues of the formene series are sensibly constant and amount to about 157.—On the modulus function $\chi\infty$, by M. A. Cayley.—Photographic study of some sources of light, by M. A. Crova.—Presentation of an iconographic monograph upon *Bubalus antiquus*, Duvernay, by M. A. Pomel.—On a class of surfaces with rational generators, by M. G. Humbert.—On some surfaces with several modes of generation, by M. G. Scheffers.—A general property of any field not admitting of a potential, by M. Vaschy. The distribution of the force (or vector) f at the various points of the field is identical with the distribution of the resultant of two fictitious forces f_1 and f_2 defined as follows:—The force f_1 would be developed by a system of masses acting at a distance according to the law of universal gravitation; f_2 would be developed by a system of "vectorial masses" acting according to Laplace's law. The density ρ of the first masses and the components μ_x, μ_y, μ_z, of the density μ of the vectorial masses would be given by

$$4\pi\rho = \frac{\partial X}{\partial x} + \frac{\partial Y}{\partial y} + \frac{\partial Z}{\partial z},$$

and equations of the type

$$4\pi\mu_x = \frac{\partial Y}{\partial z} - \frac{\partial Z}{\partial y},$$

where X, Y, Z, are the components of f, and the "vectorial mass" contained in an infinitely small volume $d\infty$ is $\mu\, d\infty$, where μ is the "density."—On terms of a superior order in the deviation of the compass, by M. E. Guyon.—On a remark of M. Guyon relative to the calculus of stability of vessels, by M. Ch. Doyère.—On the photographic properties of the salts of cobalt. Hydrated peroxide of cobalt dissolved in oxalic acid gives a solution of very unstable cobaltic oxalate, which is easily reduced to the cobaltous state by the action of light. This action may be utilised to produce photographic prints. A cobaltous salt is precipitated with sodium peroxide; the cobaltic hydrate formed is carefully washed in hot water, collected, and treated in the cold with a saturated solution of oxalic acid; the reaction, which must take place in the presence of an excess of cobaltic hydrate, is finished in several hours, and gives a green solution with which gelatinised paper may be impregnated. Printing is done very quickly. After sufficient exposure the proof is developed by means of a 5 per cent. solution of potassium ferricyanide, and fixed by simple washing. The image obtained is pale red. It is intensified and given a more agreeable colour by treating with an alkaline sulphide, which converts the ferricyanide of cobalt into the sulphide. The process is distinguished by its simplicity, rapidity and cheapness.—On Stas's atomic weights, by M. J. D. van der Plaats.—On chromodisulphuric, chromotrisulphuric, and chromosulphochromic acids, by M. A. Recoura.—Action of oxygen upon sodammonium and potassammonium, by M. A. Joannis.—On soft sulphur moistened in the state of vapour, by M. Jules Gal.—On the estimation of manganese by the oxydimetric methods, by M. Adolphe Carnot.—On the product of asymetry, by M. Ph. A. Guye.—On the alcoholic fermentation of Jerusalem artichokes under the influence of pure yeasts, by M. Lucien Lévy.—On a new series of colouring matters, by M. A. Trillat.—On the assimilation of the gaseous nitrogen of the atmosphere by microbes, by M. S. Winogradsky.—Observations thereon, by M. Berthelot.—On the doubling of carbonic acid under the influence of solar radiation, by M. A. Bach.—On *Micronereis variegata*, by M. Émile G. Racovitza.—On the oil of the eggs of the Algerian Pilgrim Cricket (*Acridium peregrinum*), by M. Raphael Dubois.—Influence of moisture on the development of the nodosities of the Leguminosæ, by M. Edmond Gain.—On the concordance of the phenomena of cellular division in the lilies and in Spirogyras, and on the identity of the causes producing them, by M. Ch. Degagny.—On the specific gravities of isomorphous crystals, by M. Georges Woulf.—On the axinite of Oisans, by MM. Albert Offret and Ferdinand Gonnard.—On the eruptive rocks of Servia, by M. J. M. Lugovic.—On *Polygonum sakhalinense*, regarded as fodder for cattle, by M. Doumet-Adanson.—On the toxicity of stereoisomeric acid tartrates, and a general formula for measuring their toxic power, by M. C. Chabrié.—The electric brush discharge as a treatment for refractory cutaneous pruritus, by M. H. Leloir.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Semi-azimuths; a New Method of Navigation, Part 1: E. W. Buller (Norie and Wilson).—A Dictionary of Birds. Part 1: A. Newton (Black).—Lehrbuch der Petrographie, Erster Band: Dr F. Zirkel (Leipzig, Engelmann).—Grundzüge der Physiologischen Psychologie, Erster Band: W. Wundt (Leipzig, Engelmann).—Lessons in Elementary Biology, 2nd edition: Prof. T. J. Parker (Macmillan).—The Protection of Woodlands: H. Fürst, translated by J. Nisbet (Edinburgh, Douglas).—An Introduction to the study of Geology: Dr. E. Aveling (Sonnenschein).—The Great Eastern Railway Company's Tourist Guide to the Continent, new edition (London).—Electric Light Installations. Vol. 1: The Management of Accumulators, 7th edition: Sir D. Salomons (Whittaker).—The Dynamo: C. C. Hawkins and F. Wallis (Whittaker).—Étude sur les Tremblements de Terre: L. Vinot (Paris, Berger-Levrault).—Enunciations in Arithmetic, Algebra, Euclid, and Trigonometry: P. A. Thomas (Macmillan).—Decipherment of Blurred Finger Prints: F. Galton (Macmilan).—An Elementary Treatise on Analytical Geometry: W. J. Johnston (Oxford, Clarendon Press).—Census of the Colony of Tasmania, 1891, Parts 1-8 (Hobart, Grahame).

PAMPHLETS.—Les Astronomes: A. Tischner (Leipzig, Fock).—Prehistoric Naval Architecture of the North of Europe: G. H. Boehmer (Washington).—Report on the Bendigo Gold-Field: E. J. Dunn (Melbourne, Brain).—Société d'Encouragement pour l'Industrie Nationale: Annuaire pour l'Année 1893 (Paris)—Sul Magnetismo di Monte Dr. E. Oddone e S. Franchi (Roma).—Ergebnisse der Meteorologischen Beobachtungen im Reichsland Elsass-Lothringen im Jahre 1891 (Strassburg).—Lines on the View from Peter-ham Hill, Richmond: W. H. Oxley and E. Kirk (Richmond).—Ueber die Entwickelung der Theerfarben-Industrie: Dr. H. Caro (Berlin, Friedländer).

SERIALS.—Journal of the Institution of Electrical Engineers, No. 106, vol. xxii. (Spon).—Bulletin of the Geographical Club of Philadelphia, Vol. 1, No. 1 (Philadelphia).—Astronomy and Astro-Physics June (Northfield, Minn.).—Rendiconto dell'Accademie delle Scienze Fisiche e Matematische, serie 2ª, vol. vii. fasc 5° (Napoli).—The Illustrated Archæologist, No. 1 (C. J. Clark).—Journal of the Franklin Institute, June (Philadelphia).—Economic Journal, June (Macmillan).—Transactions of the Leicester Literary and Philosophical Society, July and October, 1892, and January, 1893 (Leicester).—Lucifer, Vol. xii. No. 70 (London).

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