THURSDAY, JUNE 1, 1905.

## PUBLIC HEALTH AND SEWAGE PURIFICATION.

*Sanitary Law and Practice.* A Handbook for Students. By W. Robertson, M.D. (Glas.), D.P.H., and Charles Porter, M.D., B.Sc. (Public Health), M.R.C.P. Edin. Pp. xiii+756. (London: Sanitary Publishing Co., Ltd., 1905.) Price 10*s.* 6*d.* net.

*The Sewage Problem.* A Review of the Evidence Collected by the Royal Commission on Sewage Disposal. By Arthur J. Martin, Assoc.M.Inst.C.E., M.R.San.I. Pp. xvi+363. (London: Sanitary Publishing Co., Ltd.) Price 8*s.* 6*d.* net.

*Simple Methods of Testing Sewage Effluents.* For Works Managers, Surveyors, &c. By George Thudicum, F.I.C. Pp. 60. (London: Sanitary Publishing Co., Ltd., n.d.) Price 2*s.* 6*d.* net.

THE official responsibility for the safeguarding of the public health rests mainly with the representatives of four professions, viz. the medical officer, with his colleague the sanitary inspector, the bacteriologist, the engineer, and the chemist. A study of the volumes under review has strengthened the belief that it is desirable that members of each profession, while working cordially together for a common end, should severally recognise their respective limitations.

The text-book on "Sanitary Law and Practice" by Drs. Robertson and Porter is written in sections, each section referring to some special branch of public health work. A considerable portion of each section is occupied by a digest of the legal enactments affecting the subject, this being followed by paragraphs dealing, by description and advice, with the practical duties of the health officer. The condensation of legal information, so far as can be estimated by references to special points coming under the experience of the reviewer, is done with judgment, and constitutes a feature of the book, of great value alike to the student and to the practitioner.

Many useful hints from the wide experience of the authors are to be found in the descriptive portions of the book. Their experience, however, is naturally not all-embracing, and it is not difficult to note where their information is derived from the statements of others.

The subject of destructors, although coming within the province of the engineer, is evidently one with which the authors are familiar. The descriptions are clearly written, and the essential points in construction, choice of site, and proper management well brought out.

In the section on food and drugs no attempt is made to instruct the medical officer in duties which properly belong to the public analyst. This is satisfactory in view of the attempt frequently made by small authorities to combine the offices of public analyst and medical officer. Even in such a comparatively simple matter as the analysis of a sample of water, which in the chapter on water supply (p. 433) is referred to as part of the medical officer's duties, unsuspected pitfalls may lurk. It is doubtful whether bacteriological examinations should ever be undertaken by any but a trained bacteriologist, at any rate where identification of a given species is required.

In the section on disinfection a questionable prominence is given to the use of sulphur. The authors themselves, in a later paragraph, deprecate the use of superheated steam as being "no better than a gas," and in view of the obvious disadvantages in the use of sulphur, which have given rise to serious complaint of destruction of fabrics and fittings, especially on board ship, it can hardly be compared with liquid disinfectants such as formalin. No reference is made to the use of hypochlorites, which in certain circumstances have been found to give excellent results.

A wise reserve is maintained on the vexed question of sewer ventilation, a qualified approval being given to upcast shafts. It is unfortunate that a similar reserve has not been exercised in the chapter on sewage purification. In a book intended for students it is unwise to select, even for description, any form of patented appliance which is not thoroughly established. The choice for special commendation of one particular patented apparatus, concerning the merits of which competent opinion can at least be said to be divided, is certainly to be deprecated. A clear exposition of general principles of sewage treatment would have been more valuable.

This leads to the consideration of the able condensation of the bulky volumes of evidence given before the Royal Commission on Sewage Disposal which is to be found in Mr. Martin's book on the "Sewage Problem." Mr. Martin has provided a book which will be eagerly sought after by members of sewage committees and others who are appalled at the mass of matter in the numerous blue-books published by the commission. He is to be congratulated upon the impartial way in which he has marshalled the evidence. Possibly because of this impartiality the impression left upon the reader is that in spite of the great amount of work that has been done on the subject, sewage purification is still rather an art than a science.

The Royal Commission has been criticised for the slowness of its methods. A more just criticism would be that it might have devoted more energy to questions affecting the theory of the processes in use. As it is, a mass of empirical and sometimes conflicting information has been accumulated, from which it is extremely difficult to extract underlying certainties. While fully realising that a large part of the sewage problem is concerned with purely practical questions of cost and local conditions, yet ultimately the economic solution must depend on a full knowledge of the changes taking place in the course of various methods of treatment; and these are as yet by no means perfectly understood. It is curious, *e.g.*, that no witness deals in any detail with the purely physical effects produced by contact with the filtering medium, although many observers, especially on the Continent, believe that these play a very large part in connection with the changes produced. It is by no means

certain even yet that anaërobic action is absolutely necessary at any stage of sewage purification. Many other equally important questions might be instanced on which knowledge is still extremely limited.

The outstanding result of the Royal Commission's labours which will most appeal to local authorities is the statement that adequate purification can be effected without land treatment, which, if recognised by the Local Government Board, will remove what is, in many cases, an impossible restriction. Their recommendation in regard to a central controlling and advisory authority, if resulting in the creation of a department similar to the Massachusetts Board of Health, may prevent great waste of public money. Such a board might exercise wise discretion as to the amount of purification necessary under given conditions. No central control, however, can be effective without efficient local management, and Mr. Thudicum's little book of simple methods of sewage analysis will be of great assistance to local engineers and intelligent works managers, and will help to lighten the work of the trained specialist, with whom the solution of difficulties ultimately rests. G. J. F.

## *AN AMERICAN CONTRIBUTION TO ARCHÆOLOGY.*

*University of Pennsylvania: Transactions of the Department of Archaeology: Free Museum of Science and Art.* Vol. i. Parts i. and ii. Pp. 125. (Published by the Department of Archæology, 1904.)

THE most important article in this volume is the description of the American excavations at Gournià, in Crete, which have already been referred to in the pages of NATURE (September 15, 1904, p. 482). Miss Harriet A. Boyd, the leader of the expedition, gives a full and very interesting description of her work, illustrated by photographs which give the reader a very good idea of the beautiful scenery of the Gulf of Mirabello (well bestowed name!), on the shores of which she found her work. No more delightful spot for archæological exploration could be imagined. Leaving the rather arid and uninteresting Candiote shore, near which Knossos lies, dominated by the towering hill of Iuktas, on the top of which, so legend says, the god Zeus died and was buried, the traveller skirts the base of the Lasithiote mountain-mass and reaches the narrow isthmus of Hierápetra (the ancient Hierapytna). Before him rises a magnificent rocky wall of mountain, Thriphte by name, behind which is the peak called the Aphendi, or Lord of, Kavoúsi, the village which lies at its foot. This wall is rent by a mighty cleft, the chasm of Thriphte, which is one of the dominating features of the landscape. Along the base of the wall runs the high-road from Kavoúsi to Hierápetra across the isthmus, which is low-lying land, forming a complete break in the mountain-backbone of Crete. On the northern shore of the isthmus is a good beach, Pachyammos ("Deep-sand") by name; in the centre of it the traveller will see a large white house.

This was Miss Boyd's headquarters. All around are splendid mountains and "a coast-line as picturesque as any in Southern Europe," to quote her description, which is not exaggerated; she might have said "more picturesque than," with reason. Away to the left are the snowy heights of Lasíthi, the hills above the *skála* or landing-place of Ayios Nikólas, and distant rocky Spinalonga, still the home of a peculiar race of Mohammedan fishermen—corsairs not so very long ago. To the right is the little isle of Psyrà, swimming in the blue water. One would think that the excavators on the monotonous plains of Babylonia, whose doings are chronicled by Prof. Hilprecht in the last contribution to this volume,[1] would have given much sometimes to have been able to transport themselves for a brief space to such goodly surroundings!

Pachyammos lies a mile or so beyond, and east of, the scene of Miss Boyd's work, the low hill of Gournià, on which she has discovered the remains of a "Mycenæan," or more correctly "Minoan," town, a Bronze age settlement. It is a small Pompeii. One can walk up the sinuously curving little main street and look right and left into the ruined houses of the Bronze age "Minoans." There is even a sort of court-house or "palace," to give it the stereotyped appellation, with its right-angle of low steps quite on the model of the splendid right-angled stairways of Knossos and Phaistos, which Dr. Evans considers to have been theatres, the prototypes of the stepped Greek theatres of the classical period. This "palace" must have been the official centre of the town. Formerly, judging from classical analogies, one talked of a prince or "dynast" ruling from every one of these little palaces over his own little πόλις or city-state; but it will probably eventually be found that the ruler who lived in such a "palace" as that of Gournià was no more than a mere mayor or demarch, a member of an official bureaucracy analogous to that of ancient Egypt, dependent upon the metropolitan authorities at Knossos. It becomes more and more probable that Crete in Minoan days was a homogeneous and highly organised State like Egypt, not a mere congeries of a hundred warring villages, as in classical times.

The official centre was not the religious centre of the town. The cathedral of Gournià stood in the middle of the town, and was approached by a special street of its own.

"Not imposing as a piece of architecture," writes Miss Boyd (p. 41), "it is yet of unique importance as being the first 'Mycenæan' or 'Minoan' shrine discovered intact. The worshipper ascended three steps and through a doorway 1.50 m. wide entered an enclosure, about 3 m. square, surrounded by walls half a metre thick and 50 to 60 cm. high. The floor is of beaten earth."

The more noteworthy of its contents are

"a low earthen table, covered with a thin coating of plaster, which stands on three legs and possibly served as an altar, four cultus vases bearing symbols of Minoan worship, the disc, consecrated horns and double-headed axe of Zeus, a terra-cotta female idol entwined with a snake, two heads of the same type as

[1] Very curiously described as "A Lecture delivered before German Court and University Circles, by H. V. Hilprecht." In it Prof. Hilprecht tells us little or nothing about the excavations at Nippur that has not already appeared in his "Explorations in Bible Lands," and the photographs published are already well known to archæologists.

the idol, several small clay doves and serpents' heads, all of coarse terra-cotta, and a fragment of a pithos, on which a double-axe and disc are modelled in relief."

This important find has since been paralleled by Dr. Evans's discovery at Knossos of a similar shrine of the snake-goddess with fine glazed faïence figures, referred to in NATURE (vol. lxx. p. 482). But Miss Boyd was the first to discover the Minoan snake-goddess, of whose existence we had no inkling before the excavations at Gournià.

Another good find, of which Miss Boyd gives a fine facsimile plate, was the head of a bull in terra-cotta, a typically "Mycenæan" object, paralleled by the famous silver bull's head found by Schliemann at Mycenæ, and the Egyptian representations of golden *protomae* of bulls being brought as gifts to the court of Thothmes III. by the Mycenæan (or rather "Minoan") ambassadors from "Kefti" (Crete).

Miss Boyd's work has contributed results to Mycenæan lore which are of the highest importance, results upon which the officers of the American Exploration Society at Philadelphia, which dispatched her expedition, are to be heartily congratulated.

H. R. HALL.

## *ELECTRICAL THEORY AND PRACTICE.*

*Maxwell's Theory and Wireless Telegraphy.* By H. Poincaré and F. K. Vreeland. Pp. xi+255. (London: A. Constable and Co., Ltd., 1904.) Price 10*s.* 6*d.* net.

*Alternating Currents.* Vol. i. By A. Russell. Pp. xii+407. (Cambridge: The University Press, 1904.) Price 12*s.* net.

*What Do We Know Concerning Electricity?* By Antonia Zimmern. Pp. vii+140. (London: Methuen and Co., n.d.) Price 1*s.* 6*d.* net.

*Modern Electricity.* By J. Henry and K. J. Hora. Pp. 355. (London: Hodder and Stoughton, 1905.) Price 5*s.* net.

*Modern Electric Practice.* Vol. v. Edited by M. Maclean, Pp. vi+287. (London: The Gresham Publishing Co., 1904.) Price 9*s.* net.

*Electricity Control: A Treatise on Electric Switch-Gear Systems of Electric Transmission.* By Leonard Andrews. Pp. xv+231. (London: Chas. Griffin and Co., Ltd., 1904.)

THE electrical engineer who wishes to keep pace with the development of his profession and desires to know something more than that which concerns only the particular branch in which he is engaged has a very hard task before him at the present day. He must, in the first instance, endeavour to keep an eye on the technical literature—the innumerable journals and proceedings, the monthly magazines, and the weekly papers—of at least four countries in three different languages. This is in itself a task of no mean difficulty, which is heightened rather than diminished by the various "abstracts" available. So rapid is the multiplication of journals and papers that one is tempted to think that the best advice to give a student would be to read nothing, as if he tries to read much he will waste more time over what is of no value to him than he will spend wisely on the one useful article in a thousand; one is tempted still more to wish that a rigorous technical censorship might be instituted which would allow nothing to find its way into print but that which was of permanent value to the world. In this way the amount of technical literature might be brought within reasonable limits by being reduced to, say, one-tenth of its present volume.

If this is true of the matter which is published in journals—which has, at least as a rule, the merit of originality—it is still more true of the matter which appears in the form of technical text-books. We imagine these books find a ready sale, else we cannot account for their publication; yet we do not know by whom they are read except the reviewers. This is exemplified by the six volumes before us, all of which have appeared within the last few months. With the exception of the first two, we would venture to say that it would have been just as well, and possibly even better, had they not been published. We do not mean thereby that they are bad books, though one of them we think, should not be left about where young electricians might see it; but they are not of merit enough to justify the expense of their publication or purchase.

Take, for example, Miss Zimmern's little volume; it is tastefully bound and clearly printed on good paper—there is something in its appearance strongly suggestive of a book of minor poetry. Add to this that it is pleasantly written and that there is nothing very seriously wrong with its statements, and its merits are summed up. On the other hand, we are confident that it would fail in its object of explaining the complex theories of modern electricity to the "general reader"; he might put down the book with the feeling that his knowledge had been increased, but it would be a mistaken notion. It requires genius of a very rare kind, such as was shown by Faraday in his "Chemical History of a Candle," or by Prof. Perry in his "Spinning Tops," to write a book of this kind; we intend no disparagement to the writer of this volume by saying that such genius is not shown in it.

Messrs. Henry and Hora's volume is of another stamp; in a preface which reads like a publisher's advertisement, the authors state that "the work will be found eminently practical, scientific, and accurate." We have found it quite the reverse, and feel sorry for the "apprentice" or "artisan" who "gains a complete knowledge of the fundamental principles of electricity" from its pages. This is a book which no self-respecting electrical censor, however lenient, would have allowed to appear in print.

The two last books on the list are not without merit or value, but it is at best of an ephemeral kind. Of "Modern Electric Practice" we have already expressed our views in writing of the previous volumes; the present one does not depart from the same high standard in production, and the three articles in section iv., dealing with boilers, engines, and auxiliary plant, are well written and well illustrated. The article on electrochemistry and electrometallurgy is less satisfactory. We must confess, however, that the inaccuracies noticed in previous volumes make us, unjustly perhaps, suspicious of the figures and data in the one be-

fore us. Mr. Andrews's book on "Electrical Control" is a descriptive treatise on switch-gear. It possesses the same disadvantages as "Modern Electric Practice"; one cannot learn electrical practice from a book; there is only one school—the practical school—in which one can learn the principles and details of construction of apparatus in one-tenth of the time and ten times as thoroughly as by means of written descriptions. Practical men are apt to complain that text-books are valueless, as they are written by theorists; we have read a great many text-books of late written by practical men, and have come to the conclusion that it is only the theorist who should write them. He can describe the underlying principles which persist when the fashion of their application alters; the practical man describes the methods of his practice which even as he writes become antiquated.

We have reserved to the last the two volumes which head our list. Messrs. Poincaré and Vreeland's book deserves a place in any electrical library on account of its remarkably simple and lucid explanation of Maxwell's theory and of the work of Hertz, Lodge, and others which led to the development of Hertzian telegraphy. This is from the pen of M. Poincaré, translated by Mr. Vreeland, and forms the first part of the book. The second part, written by Mr. Vreeland, deals with the problems presented by the practice of wireless telegraphy, and the writer, by wisely confining himself to principles rather than details, has succeeded in writing a worthy sequel to M. Poincaré's work.

Mr. Russell's book is the first volume of a mathematical treatise on alternating currents. Alternating current machinery is growing so steadily in importance, and the mathematical theory in connection with it is so complex, that there is plenty of room for a thorough and comprehensive work of this kind. The present volume deals with the general theorems, and the second will be devoted to the more specific theory of alternating current machines and the transmission of power. MAURICE SOLOMON.

## OUR BOOK SHELF.

*Vegetationsbilder.* Edited by Dr. G. Karsten and H. Schenck. Second series. Parts i.—viii. (Jena: Gustav Fischer, 1904.)

THE first series of the "Vegetationsbilder" met with well-merited success, and a second series has been appearing at intervals during the past year. Of the contributors to the first series, Drs. G. Karsten and E. Stahl have again supplied material, the former taking up a never-failing source of interest in the mangrove vegetation, whilst Dr. Stahl, in a double part, deals with the xerophytes and conifers of Mexico; amongst the latter the primeval Taxodium trees growing in the park of Chapultepec and the sombre cypresses on the road to the sacred mount of Amecameca bear the impress of historic antiquity. Another number, consisting of parts v. to vii., is devoted to the representation of mid-European forest trees, in accordance with an expressed desire for subjects taken from native sources. The photographs taken by Dr. L. Klein include typical specimens of conifers and beeches in the Schwarzwald and Switzerland, and others showing the changes wrought by browsing animals and devastating winds; many of them are excellent, notably a scene of wind-blown pines which have been entirely cleared of branches except to leeward, but similar subjects are accessible to most botanists, and for this reason they do not possess the interest attaching to photographs from less accessible countries. The names of several new contributors are announced, among them Mr. E. Ule, whose character sketches of epiphytes in the Amazon region of Peru appear in the first part of this series. Of the Cactaceæ, which are widely spread through South America, a number of genera include epiphytic species, and in this region Cereus is predominant. *Cereus megalanthus,* a species which might be called a climbing epiphyte, is shown perched on a Ficus tree. Another curious condition is that of a flourishing bromeliad, *Streptocalyx angustifolius,* where, according to the writer, the exuberance of vegetation is so directly traceable to ants that he compares the phenomenon with the fungus gardens described a few years ago by Dr. A. Moeller. The last part of the series contains photographs taken in the Italian colony of Eritraea by Dr. Schweinfurth. *Hyphaene thebaica,* the doum palm, familiar on account of its branching habit, the sycomore fig, and an arboreous Euphorbia are among the characteristic specimens chosen to illustrate different regions in the country.

*Author and Printer. An Attempt to Codify the best Typographical Practices of the Present Day.* By F. Howard Collins. Pp. xv+408. (London: Henry Frowde, 1905.) Price 5*s.* net.

THE want of uniformity of spelling, capitalisation, punctuation, and use of italic type causes continual trouble to all who are responsible for the editorial supervision of scientific literature in any form. Some authors are more German than the Germans in their use of capitals, while others underline their manuscripts as freely as ladies do their correspondence. It is frequently difficult to decide questions of orthography, and to reduce individual practice to the consistent style, which is desirable in the columns of a periodical, but is not always maintained. Mr. Collins has prepared his book to help in this end, as a standard guide for "Authors, Editors, Printers, Correctors of the Press, Compositors, and Typists."

The volume contains more than twenty thousand separate entries of words arranged alphabetically. Included among these are abbreviations, disputed spellings, foreign words and phrases, divisions of words, and various rules and explanations which should prove of service to authors and editors. The proofs of the work have been read by many writers and others who can give authoritative opinions as to what is correct or customary, so that the book does not contain merely Mr. Collins's decisions, but a consensus of opinion edited by him.

*Highways and Byways in Derbyshire.* By J. B. Firth. With illustrations by Nelly Erichsen. (London: Macmillan and Co., Ltd.) Price 6*s.*

WITH this book as a guide, a tourist could spend many pleasant weeks in Derbyshire, and he would learn that every part of the county has literary and historical associations of great interest. But while the human side is so well represented, little notice is taken of nature, except from the æsthetic point of view. "Of natural history and geology," says the author, "there is frankly nothing in this book, of science nothing, of sport nothing."

Notwithstanding this confession of what we may be permitted to describe as sins of omission, notes and descriptions of places in which scientific readers are particularly interested occur here and there. For instance, a short account is given of the stone circle of Arborlow, the Stonehenge of the Midlands. The monument consists of a circular enclosure in which are a number of blocks of limestone, all lying flat on

the ground in a rude circle, while at the centre are large blocks which probably formed the central dolmen. "There are two entrances to the enclosure, a northern and a southern, and on the east side of the latter is a large detached mound. Four hundred yards west of the main enclosure is a still larger mound, known as Gib Hill, connected with it by a low rampart of earth, now nearly worn away." Buxton and Matlock lead Mr. Firth to make some quotations from Erasmus Darwin's poetical references to them in his "Botanic Garden: Economy of Vegetation," and "Loves of the Plants." Dr. Darwin knew and loved the scenes he described, whatever opinion may be held as to his possession of the divine afflatus. There are a few other references to people and scenes of especial interest to the scientific world, but the book will not be valued for these so much as for its bright narrative of literary and historical centres of Derbyshire, and its fine illustrations.

*The Tower of Pelée. New Studies of the Great Volcano of Martinique.* By Prof. Angelo Heilprin. Pp. 62+xxii plates. (Philadelphia and London: Lippincott, 1904.)

PROF. HEILPRIN'S latest volume on Martinique is chiefly remarkable for the beautiful photographic plates with which it is illustrated; they give an excellent idea of the features of the great tower of solid lava which for nearly three years has been the centre of interest in the crater of Pelée. One of these plates, however (No. xi), seems to have been accidentally printed upside down. In the accompanying text there is an account of the author's fourth visit to the volcano in June, 1903, and a good deal of somewhat discursive matter regarding the lessons to be learnt from the recent eruptions. The number of points which are still unsettled concerning the mechanism of the explosions and the concomitant phenomena is very large, and the author shows a wise caution in dealing with some of them. He advances the opinion that the tower of Pelée is a volcanic core of ancient consolidation, and not an extrusion of solidified new lava, as the French observers believe. We cannot believe this is at all likely to obtain general acceptance. J. S. F.

*Experimental Researches on the Flow of Steam Through Nozzles and Orifices.* By A. Rateau. Translated by H. Boyd Brydon. Pp. iv+76. (London: Constable and Co., Ltd., 1905.) Price 4*s.* 6*d.* net.

THE laws of flow of steam are of much importance in the design of turbines. A clear sketch is given of the theory, and then an account of an excellent experimental research to determine the values of the constants. Amongst previous experiments, those of Napier are English, not American as the author states. The novelty in M. Rateau's method is the use of an ejector condenser for condensing the steam. The rise of temperature, which is easily measured, gives the quantity of steam condensed. The errors of the method, especially that due to entrained water, are carefully examined. Convergent nozzles and a thin plate orifice were used. The results are compared with those by Hirn on air, and close agreement is found. In a note, the complex phenomenon of the discharge of hot water just on the point of evaporating is examined.

The translation is clear. It is, however, a defect, for English readers, that the principal formulæ are left as given by the author in foreign units. The book is essentially one for practical use, and it would have added much to the convenience of engineers if other formulæ than the one on p. 6 had been given in English units.

*Introductory Mathematics.* By R. B. Morgan. Pp. vi+151. (London: Blackie and Son, Ltd., 1905.) Price 2*s.*

IN Mr. Morgan's "Introductory Mathematics" the view of the author is that as soon as a boy knows decimal and vulgar fractions he should begin a mixed course of elementary practical mathematics comprising algebra, geometry, and squared-paper work, developed as a whole in mutual dependence, leading up through the manipulation of formulæ to the solution of problems involving simultaneous simple equations and giving a knowledge of the fundamental facts of geometry with a training in practical applications such as the plotting of graphs and of figures to scale, and the finding of simple areas and volumes. This scheme, ignoring the old water-tight compartment system, is a good one. The chapters on algebra and geometry usually alternate, and the work progresses on natural and easy lines, with illustrations of every-day interest. The author might with advantage have carried the idea still further and have brought in computations from quantitative experimental work in the laboratory, involving the use of the balance and measuring flask, and perhaps an investigation of the action of forces at a point. There are some minor defects, such as an occasional lack of precision in a statement, bad perspective in several of the figures, the use of a graph to give a forecast of population fifty years hence, &c. But the treatment of the subject as a whole is very satisfactory; there is a good collection of exercises, and the book is well suited to its purpose.

## LETTERS TO THE EDITOR.

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

### The Dynamical Theory of Gases and of Radiation.

LORD RAYLEIGH, in a letter which appears in NATURE of May 18, opens up the general question of the applicability of the theorem of equipartition to the energy of the ether. As the discussion has arisen out of my "Theory of Gases," may I, by way of personal explanation, say that although I was fully alive to the questions referred to in this letter when writing my book, yet it seemed to me better not to drag the whole subject of radiation into a book on gases, but to reserve it for subsequent discussion? Since then I have written two papers in which questions similar to those raised by Lord Rayleigh are discussed from different aspects, but as neither of these papers is yet in print, I ask for space for a short reply explaining how my contentions bear on the special points raised by Lord Rayleigh's letter.

May I, in the first place, suggest that the slowness with which energy is transferred to the quicker modes of ether-vibration is a matter of calculation, and not of speculation? If the average time of collision of two molecules in a gas is a great multiple N of the period of a vibration, whether of matter or of ether, then the average transfer of energy to the vibration per collision can be shown to contain a factor of the order of smallness of $e^{-N}$. The calculations will be found in §§ 236–244 of my book. It is on these that I base my position, not on a mere speculation that the rate of transfer *may* be slow. Lord Rayleigh's example of a stretched string, say a piano wire, will illustrate the physical principle involved. If a piano hammer is heavily felted, the impact is of long duration compared with the shortest periods of vibration, so that the quickest vibrations are left with very little energy after the impact, and the higher harmonics are not heard. If the felting is worn away, the impact is of shorter duration, the higher harmonics are sounded, and the tone of the wire is "metallic."

The factor $e^{-N}$ is so small for most of the ether-vibrations as to be negligible. There is no sharp line of demarcation between those vibrations which acquire energy

very slowly and those for which the rate is appreciable; but as $e^{-N}$ varies rapidly with N when N is large, there will be but few vibrations near the border, so that it seems legitimate, for purposes of a general discussion, to divide the vibrations into the two distinct classes, quick and slow, relatively to the scale of time provided by molecular collisions.

When the material bodies are solid, the physical principle is the same, the relatively slow motions of the atoms affecting the "quick" vibrations of the ether only by raising a sort of "equilibrium tide."

The number of "slow" vibrations of the ether in any finite enclosure is finite. These quickly receive the energy allotted to them by the theorem of equipartition. Thus they form the medium of transfer of radiant energy between two bodies at different temperatures. After a moderate time the slow vibrations have each, on the average, energy equal to that of two degrees of translational freedom of one molecule; the quick vibrations have no appreciable energy, while the intermediate vibrations possess some energy, but not their full share. It is easily seen that the number of slow vibrations is approximately proportional to the volume of the enclosure, so that roughly the energy of ether must be measured per unit volume in order to be independent of the size of the enclosure. For air under normal conditions, I find as the result of a brief calculation that this value is of the order of $5\times10^{-9}$ times that of the matter. The law of distribution of this energy will be

$$\theta\lambda^{-4}d\lambda$$

until we arrive at values of $\lambda$ which are so small as to be comparable with

$$\text{radius of molecule}\times\frac{\text{velocity of light}}{\text{velocity of molecule}}.$$

After these values of $\lambda$ are passed, the formula must be modified by the introduction of a multiplying factor which falls off very rapidly as $\lambda$ decreases, and which involves the time during which the gas has been shut up. It is easily found (*cf.* "The Dynamical Theory of Gases," § 247) that at 0° C. the spectrum of radiant energy is entirely in the infra-red; at 28,000° C. it certainly extends to the ultra-violet, and probably does so at lower temperatures.

Finally, Lord Rayleigh asks:—

"Does the postulated slowness of transformation really obtain? Red light falling upon the blackened face of a thermopile is absorbed, and the instrument rapidly indicates a rise of temperature. Vibrational energy is readily converted into translational energy. Why, then, does the thermopile itself not shine in the dark?"

Before trying to answer this, I wish to emphasise that my position does not require the *forces* of interaction between matter and ether to be small. Considering a gas for simplicity, the transfer of energy per collision to a vibration of frequency $p$ is found to be proportional to the square of the modulus of an integral of the form (*cf.* "The Dynamical Theory of Gases," § 237)

$$\int f(t)e^{ipt}dt,$$

where $f(t)$ is a generalised force between matter and ether. The integral may be very small either through the smallness of $f(t)$ or the largeness of $p$. I rely entirely on the largeness of $p$, because calculation shows this to be adequate. The thermopile experiment gives evidence as to the magnitude of $f(t)$, but this does not alter the fact that the integral is small for large values of $p$.

This being so, I am afraid I do not very clearly understand why the thermopile should be expected to shine in the dark. If the red light is a plane monochromatic wave, its energy represents only two coordinates of the ether, and has to be shared between the great number of coordinates, six for each atom, which belong to the thermopile. If the red light comes from a large mass of red-hot matter inside the same enclosure as the thermopile, then the thermopile will soon be raised to the temperature of this mass, and *may* shine in the dark. If the hot mass consists of iron, say at 600° C., the atomic motions in the iron must be sufficiently rapid to excite the red vibrations in the ether. But if the face of the thermopile is of lampblack, the atomic motions in lampblack at 600° C. may not be of sufficient rapidity (mainly, so far as can be seen, on account of the lower elasticity of the material) to excite red vibrations except as a kind of "equilibrium tide," in which case the lampblack will not emit red radiation.

I cannot ask for further space in which to answer Lord Rayleigh's point as to the enclosure with a hole in it, but I have discussed a similar question in a paper which I hope will soon be published, in connection with Bartoli's proof of Stefan's law. I hope that this paper, and a second one which is at present in the hands of the printer, will explain my position more clearly than I have been able to in the short limits of a letter.

May 20. J. H. JEANS.

## Fictitious Problems in Mathematics.

I HAVE to thank your reviewer for so readily supplying (NATURE, May 18, p. 56) the example to prove his contention—and which appears (to me) to disprove it.

The man who set that example did so in order to test (*inter alia*) whether the pupil knew that, for any friction to arise, both the surfaces must be rough; your reviewer originally wrote:—"What the average college don forgets is that roughness or smoothness are matters which concern *two surfaces* not *one body*." The italics are your reviewer's; and this is the statement which I called (and still call) in question.

It is no part of my book to uphold the verbiage in which the example is couched; by chance, in my former letter, I explained in anticipation the terms used in it. I do not see, however, why your reviewer applies the favourite word inaccurate to these terms. Perfect smoothness may not occur in nature; still, in considering the pendulum, I probably begin by assuming no friction on the axis of suspension, and, if I try afterwards to apply a correction for this friction, I probably make an assumption which is inaccurate. Friction = pressure × a constant is inaccurate, statically and dynamically.

C. B. CLARKE.

As I take it, the mathematician's "perfectly rough body" means a body which never by any chance slips on any other body with which it is placed in contact, similarly the "perfectly smooth body" is supposed never to offer any tangential resistance to any other body which it touches. The inconsistency of this nomenclature is evident when we imagine the two bodies placed in contact with each other, as in the case of the perfectly rough plank resting on the smooth horizontal plane. The subsequent course of events cannot at the same time be compatible with the assumed perfect roughness of the one body and the assumed perfect smoothness of the other. The coefficient of friction between two bodies depends essentially on the nature of the parts of the surfaces of both bodies which are in contact as well as on their lubrication, and neither body can be said to have a coefficient of friction apart from the other. It is equally incorrect to speak of perfect smoothness or perfect roughness as attributes of a single body. Moreover, this misleading language is quite unnecessary; it is very easy to frame questions in a way that is free from objection. For instance, "A man walks without slipping along a plank which can slip without friction on a horizontal table." Or again, "A sphere is placed in perfectly rough contact with the slanting face of a wedge whose base rests in perfectly smooth contact with a horizontal plane." G. H. BRYAN.

## A New Slide Rule.

IN the article which appeared on p. 45 of NATURE, May 11, describing the Jackson-Davis double slide rule, you notice one little fault in the rule sent for examination.

We desire to exonerate the designer of the instrument, Mr. C. S. Jackson, from responsibility for the very obvious fault to which you allude, viz. that the scale on the feather edge is divided into inches and sixteenths, and that the continuation scale which is read below the ordinary slide

is in millimetres. The rules can be supplied with the plain scales either in inches or millimetres, and in the specimen submitted to you the mix up is the result of accident, and not perversity.

JOHN DAVIS AND SON.

All Saints' Works, Derby, May 20.

## THE LOWER VERTEBRATES.[1]

"EVERYTHING comes to him who waits"! Certainly the patience of many has been sorely tried by the long advent which has preceded the appearance of this last volume of the Cambridge Natural History. Students of the lower vertebrates will be naturally predisposed to accord it a favourable reception, inasmuch as its predecessors have presented such a high standard of excellence. If in some respects a closer acquaintance reveals some cause for complaint it will be admitted that, surveyed as a whole, both authors and editors alike are to be congratulated on having produced a work of sterling merit.

The groups dealt with in this volume are not only of the highest scientific interest and importance, but they present more than ordinary difficulties to be investigated, and these difficulties are materially increased when stern necessity compels the several contributors to condense their work within the smallest possible limits. Happily this task has fallen on the right shoulders, and all must admire the way in which it has been performed.

The first chapter of this book has been written by Dr. S. F. Harmer, and deals with the Hemichordata, a group which includes creatures of the existence of which the layman has never heard! Yet their importance in the scheme of evolution is of the highest, inasmuch as they bridge the gap for us between vertebrates and invertebrates.

The true nature of these worm-like and tubicolous animals has been determined only after the most laborious and painstaking research, in which Dr. Harmer, the author of this chapter has borne a very conspicuous share. Though the vertebrate affinities of the worm-like Balanoglossus were first hinted at by Kowalewsky in 1866, it was not until 1886 that this relationship was really demonstrated: a triumph achieved by Bateson. Forming at first a branch by itself of the vertebrate phylum, Balanoglossus has since lost something of its unique character by the discovery that certain other tubicolous forms—Rhabdopleura and Cephalodiscus—would have to be promoted to share this position, though to the ordinary observer nothing could be less like a vertebrate in appearance! This advance in our knowledge was made by the author of this chapter; and he has now still further extended the boundaries of this group so as to include Phoronis, an animal hitherto referred both to the Gephyrea and to the Polyzoa.

Although our knowledge of the Tunicates—those "common objects of the sea-shore," known as the "sea-squirts"—has been accumulating for something more than two thousand years, it was not until the middle of the eighteenth century that any real progress in the study of these creatures was made. And yet a century passed before the appearance of Kowalewsky's epoch-making work, which showed conclusively the astonishing fact that these shapeless jelly-bags were really kith and kin of the vertebrates—but degenerates!

No other group of animals is so all-embracing in the nature of the phenomena it displays. As the author remarks, "They demonstrate both stable and variable species, monophyletic and polyphyletic groups. They exhibit the phenomena of gemmation and of embryonic fission, of polymorphism, hibernation, alternation of generations, and change of function. They have long been known as a stock example of degeneration; but in fact they lend themselves admirably to the exposition of more than one 'chapter of Darwinism.'"

Prof. Herdman has made this group peculiarly his own, and the editors are to be congratulated in having secured him to write this chapter. Nowhere else will the student find so complete and altogether admirable a summary of this most difficult and puzzling group of animals.

In dealing with amphioxus Prof. Herdman has been hampered by lack of space. This seems evident, not from the absence of any essential facts in his account, but from the condensed fashion in which the facts are presented. To the majority of those who will use this book this is perhaps of no great moment, but others, we imagine, will fail to appreciate the full

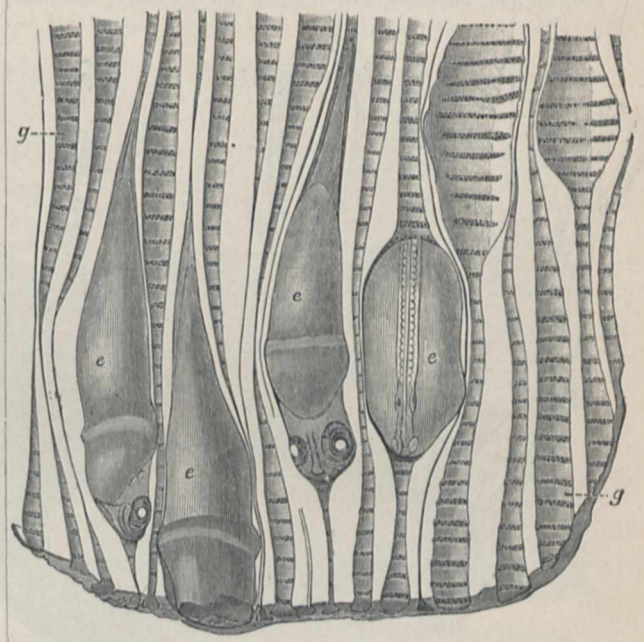



FIG. 1.—Embryos of *Rhodeus amarus* in the gill-cavities of Unio. *e*, Embryos; *g*, inter-lamellar cavities. From the "Cambridge Natural History."

importance of some phases in the life history of this "weed in the vertebrate garden."

The remarkable ciliated condition of the embryonic and early larval stages is, for example, all too lightly passed over. Attention is not called to the importance of the fact that in the free-swimming, ciliated larva we have a connecting link between vertebrates and invertebrates. His reference to the existence of cilia is of the briefest. He remarks simply, that "the embryonic stages being passed through during the night . . . the larva hatched in the early morning," and then, on the next page, continues, "The epiblast cells become ciliated all over the surface, so that the embryo rotates within the thin covering which still surrounds it." Passing on to describe the metamorphosis of the embryo he goes on to say that "When it has (developed) about five pairs of mesoblastic somites, it breaks out of its covering, and becomes a free swimming larva." Probably no living biologist knows more of amphioxus than Prof. Herdman. Thus, then, this lack of emphasis of a really important feature must be attributed to the fact that he had to

[1] "Hemichordata, Ascidians and Amphioxus, Fishes." By Drs. Harmer, Herdman, Bridge and G. S. Boulenger. The Cambridge Natural History, vol. vii. Pp. xvii+760. (London: Macmillan and Co., Ltd., 1904.) Price 17s. net.

compress his account unduly. As a matter of fact the whole history has been crowded into something less than eight and twenty pages, including illustrations!

This condensation is evident throughout each of the chapters so far noticed, and probably accounts for the absence of anything in the shape of an historical review of the evolution of our knowledge of these obscure groups. Surely this is to be regretted, inasmuch as this is a volume which will serve as the main source of information for many generations of students; and it would be well to place before them some idea of the laborious and patient work which has been spent by others in building up the knowledge which is theirs to-day. Such a review would serve a double purpose. It would keep alive the memory of those whose names are all too soon forgotten, and it would serve as an incentive to further work.

Probably this survey would not have been wanting, but for the fact that some two hundred and eighty of the seven hundred and twenty-seven pages which make up the book are devoted to the introduction on fishes! This is not as it should be; on this account serious injury has been done both to the chapters which precede it and those which follow. Much of this introduction could have been dispensed with, inasmuch as matters of a purely physiological import are now included, and these are outside the scope of this volume. Lengthy as it is, it is yet incomplete. Morphological questions that should have found a place here are either ignored or dismissed in a few lines. If these had taken the room of the matter to which we object some justification might have been pleaded for the condensation of the exceedingly valuable chapters which we have just noticed. Yet, in spite of these drawbacks, this introduction will prove most valuable to those who use this volume as a text-book, and there is no doubt but that it will be widely read and highly valued in the various science schools throughout the kingdom.

It is a pity that more figures of larval fishes were not given in this introduction, designed to illustrate the remarkable transformations which some species especially undergo from the time of hatching to maturity.

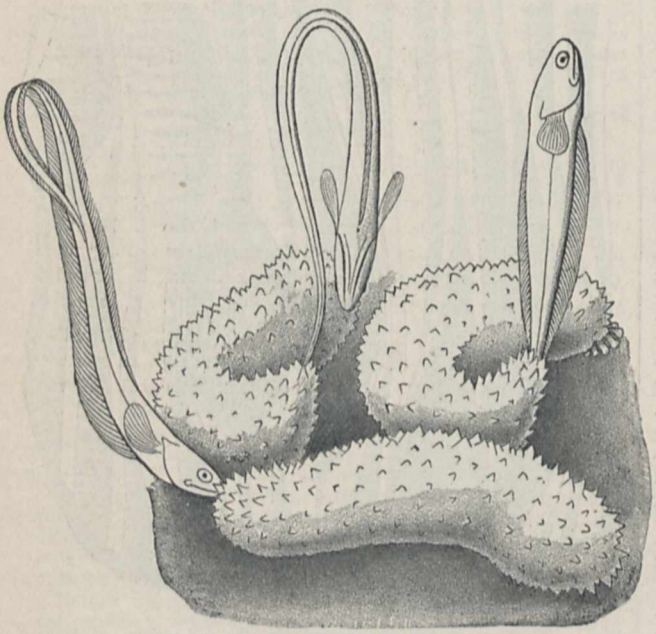


FIG. 2.—*Fierasfer acus* penetrating into Holothurians; two-fifths natural size. From the "Cambridge Natural History."

In regard to the Cyclostomata it is curious that no mention is made of the extraordinary slime-secreting powers of the Myxinoids. True, he refers to "a row of mucous secreting sacs along each side of the body," but this scarcely does justice to the case; inasmuch as an instance is on record of a single individual which, placed in three or four cubic feet of water, converted the whole into a jelly-like mass, which could be lifted out with a stick! The specific name of *Myxine glutinosa* has reference to the old belief that the fish possessed the power of turning water into glue.

Prof. Bridge solves the difficulty as to the systematic position of Palæospondylus by placing them in a sort of limbo designated an "appendix to the fishes."

In this same appendix it is somewhat surprising to find not only the Ostracoderms, but the Arthrodira! As touching the former Prof. Bridge may claim that he errs, if erring he is, in good company, since so eminent an authority as Dr. Smith Woodward refuses to admit these "bones of contention" into the class Pisces. But we object to the hesitancy displayed by Prof. Bridge; he will neither call them fishes nor allow them to rank as a separate class (Agnatha), as Dr. Woodward has done. But surely there can be no question as to the class, at least, to which the Arthrodira belong? According to the most recent views they are to be regarded as Dipnoans.

In spite of these drawbacks Prof. Bridge's contribution to this volume is a valuable one. He has brought together a vast amount of information, much of which is the result of his own researches. Where he has had to draw upon the work of others he has for the most part selected of the best. Our chief complaint is that he is so meticulously exact.

The Teleostei, from a systematic point of view, are described by Mr. E. A. Boulenger, and he has brought to bear upon this most difficult task an unrivalled knowledge, tempered with rare skill and judgment. The classification which has been generally in use in this country for the last thirty years is now replaced by one which aims at being phylogenetic—the true basis of all systematic work. Although we believe Mr. Boulenger has improved on this arrangement in some minor details since passing the final proofs of his work some three years ago, it may be accepted as practically representing his views on this subject.

As he remarks, "Out of some 12,000 well-established species of fishes known to exist at the present day, about 11,500 belong to this order (Teleostei). The classification of such an array of forms is, of course, a matter of great difficulty, and gives scope for much difference of opinion among those who have attempted to grapple with the subject." The basis of this classification differs from that usually employed in other groups of vertebrates, inasmuch as it rests on osteological characters, in so far as families and higher groups are concerned.

The reader of this notice may imagine, from our ominous reference to dry bones, that Mr. Boulenger's contribution is of the nature of a dull and tiresome catalogue. We hasten to remark, therefore, that this element is effectually masked by the introduction of all the more important facts concerning the life-histories of the various species which have come within the author's province. These facts form most fascinating reading, and will appeal to a large number of people other than professed students of zoology. Do fishes sleep? is a question often asked. Although answered in the affirmative some eight and thirty years ago by Mobius, the fact has remained ever since practically buried in the German publication in which it appeared. Mr. Boulenger is apparently the first to give it circulation in a text-book. A species of Wrasse

confined in an aquarium, he points out, was observed by Mobius to seek a sleeping place at night, and to lay itself down to rest on one side. The psychologist and the student of evolution will find in these chapters of Mr. Boulenger a perfect mine of information. No more instructive lessons in adaptation can be gathered than from the descriptions and figures illustrating this part and certain sections of Prof. Bridge's work—as witness the text cuts given herewith.

## *ABORIGINAL INDIA.*[1]

MR. BRADLEY-BIRT'S book dealing with the Santal Parganas merits the success achieved by his former volume on Chota Nagpore. This time, he lays his scene in the mountainous, forest-clad outlier of the Vindhyan range, which stands like an island in the midst of the great Gangetic plain. Dominating the great waterway which leads from the borders of the Punjab to the Bay of Bengal, it has for centuries been the stronghold of the aboriginal tribe who sought refuge in it from the Aryan flood descending from the north-west on the fertile plains of Bengal. From his almost inaccessible stronghold, the Paharia looked down upon the coming and going of the Hindu, the Pathan, and the Moghul. Empires rose and fell before his very eyes whilst he, hating the foreigner of every race and creed, remained wrapped in his primitive barbarism, a hunter living on the produce of the surrounding forest, not to be starved into submission, because he had no need of the produce of the plains. His only dealings with successive invaders were when he swooped on the villages below, killing and robbing their inhabitants, or cutting off travellers and the camp followers of passing armies. Neither Hindu nor Mahomedan could subdue him by main force without extravagant loss.

Attempts to bribe the mountaineer with land around the mountain failed, for he did not care to cultivate, and the keeping of a bargain with the hated foreigner formed no part of his moral code.

At last appeared the British, whose fair complexion impressed the Paharia with an idea that they were of higher origin than the earlier conquerors. In Augustus Cleveland came a man who found a way to tame the savage, to enlist his sympathy, and to offer an outlet for his martial instincts. Some of the Paharias were enlisted as an irregular force, whilst an endeavour was made to isolate the rest in a ring of neutral territory, from which the Hindu and the Mahomedan of the plains were to be excluded. Much of Cleveland's good work was undone by a successor of sterner and less considerate temperament. The solution of the difficulty was finally found, about 1830, when a wandering branch of the Santals, another aboriginal tribe, appeared upon the scene and eagerly accepted the land below the hills which the Paharia, refusing for himself, made untenable for the plainsman. The Santal, an enthusiastic though uncivilised cultivator, recognised as a kinsman by the Paharia, formed an efficient buffer between the hillman and the inhabitants of the surrounding plain. The Santal, in turn, gave trouble in 1856, when he broke into rebellion directed against the peaceful penetration of the moneylender and the landgrabber.

It is with these two aboriginal tribes that Mr. Bradley-Birt chiefly deals. As men, they are perhaps more interesting to the ethnologist and the philologist than to the ordinary student of human nature, but the author has succeeded in enlisting such interest as we can spare to one tribe still in the purely agricultural stage, and to another which has scarcely as yet progressed beyond that of the hunter.

His picture of village life on, and at the foot of, the Rajmahal hills glows with local colour and swims in the atmosphere of the jungle and the plain. It was scarcely necessary for him to assure his reader that most of the book was written in camp, in the midst of the Paharias and the Santals. As one reads, one seems to inhale the fresh, crisp air of an Indian cold weather morning, or to pant in the heavy atmosphere of the forest as the line of Paharia hunters presses,

FIG. 1.—A Primitive Mode of Irrigation. From Bradley-Birt's "Story of an Indian Upland.

shouting and slaying, through the dense undergrowth.

Much that Mr. Bradley-Birt describes, or depicts in his photographs, is not peculiar to the Santal Parganas. The primitive mode of irrigation, with basket swung by two men, which forms the subject of the illustration here reproduced, is still practised by millions who have never heard of the Santals, or been within a thousand miles of their home. All over India the cultivator watches his crops at night from a rough platform raised on a ricketty scaffolding of bamboos. Sometimes it happens, in regions not unlike the Rajmahal hills, that the vigil ends in a tragedy, when the sleepy watcher is torn from his post by the man-eating leopard. But the inclusion of these incidents in no way detracts from the charm of the picture of simple village life, a life of agricultural labour tempered by feasting and dancing in seasons when there is no labour to be performed.

The Paharias' rude religion has drawn nothing from Hinduism or Islam. The Santal equally professes his separation from those creeds, but his love of pleasure has induced him to adopt some of the Hindu festivals, for instance the Jatra, which he celebrates in February.

[1] "The Story of an Indian Upland." By F. B. Bradley-Birt. Pp. xvi + 354. (London: Smith, Elder and Co., 1905.) Price 12*s.* 6*d.* net.

The history of British administration in this wild tract, up to the time of the Santal rebellion of 1856, can scarcely be held up as a great example. As to the patriarchal system which still prevails, Mr. Risley, in an introduction which, from the pen of so great an ethnological authority, is somewhat disappointing, throws some doubts on its superiority to other methods of dealing with aboriginal tribes. Perhaps, in later years, Mr. Bradley-Birt's enthusiastic admiration of it may cool. As matters stand, his enthusiasm, and his evident sympathy with the simple peoples he describes, serve to enhance the charm of his work.

To the Anglo-Indian this volume will recall much that is pleasant; to the tourist, and even to the stay-at-home Englishman, it will afford a bright glimpse of native country life which is not to be found on the beaten track.

## NOTES.

AT the meeting of the Royal Society on May 18 the following were elected foreign members:—Prof. L. Hermann, Koenigsberg; Prof. H. A. Lorentz, Leyden; Prof. H. Moissan, Paris; and Prof. Hugo de Vries, Amsterdam.

THE annual visitation of the Royal Observatory, Greenwich, will take place on Saturday next, June 3.

THE international conference having for its object the establishment of an international institute of agriculture was opened in Rome on Sunday, May 28, in the presence of the King of Italy. On Monday the conference held a sitting at the Accademia dei Lincei, and the Foreign Minister, Signor Tittoni, opened the proceedings with an address.

THE English Arboricultural Society has been granted permission by the King to change its name to the "Royal English Arboricultural Society."

PROF. J. N. LANGLEY, F.R.S., will give one of the general lectures at the meeting of the Association of German Naturalists and Physicians, which will open at Meran on September 24. His subject will be "Recent Researches on the Nervous System."

A REUTER telegram from Portici states that Vesuvius has for some days been in active eruption. At 7 p.m. on May 27 the western side of the small terminal cone collapsed, and a large quantity of lava burst forth, which in an hour's time reached the base of the great cone, at Atrio Cavallo, one kilometer distant.

WE learn from the *Board of Trade Journal* that the *Gaceta de Madrid* for May 11 contained the text of a Royal Order providing for the duty-free admission into Spain of instruments and accessories carried by foreign men of science deputed to observe the eclipse of the sun on August 30.

ACCORDING to a Reuter telegram, dated New York, May 27, the Cunard liner *Campania* reports that she was in continuous communication with land, by wireless telegraphy, throughout her entire voyage from Liverpool. In mid-ocean she had simultaneous communication with America and Europe, a feat which had not previously been accomplished.

A CORRESPONDENT of the *Times* states that in the early part of May enormous shoals of dead fish were thrown up for a considerable distance along the sea coast by Karachi The whole beach was strewn with dead fish, lying in some places five or six inches deep. The Port Trust authorities had to make arrangements for the removal and burial of these millions of fish. Captain Belton, of the steamship *City of Dundee*, on arriving at Karachi reported some very curious electrical phenomena about a hundred miles out to sea, repeated flashes of light being observed to pass over the surface of the ocean in a curious way.

AN international congress for the study of radiology and ionisation will be held at Liège on September 12–14 inclusive. The congress will be divided into a physical section and a biological section. The former will be concerned with the physics of electrons, radio-activity and dependent transformations, meteorological and astronomical phenomena and their relation to ionisation and radio-activity. In the biological section the subjects to be considered will include the physiological properties of various radiations and of radio-activity, and their medical value and application. The method of procedure in this section will be determined upon by a special committee presided over by Profs. Bouchard and d'Arsonval. The other members of this committee are Drs. Béclère, Bergonié, Broca, Charpentier, Charrin, Danysz, and Oudin. There will also be a general committee, presided over by M. Henri Becquerel, to examine, classify, and decide upon such reports, papers, and notes as may be offered. The acting president of the congress is to be Prof. H. Kuborn, president of the Royal Medical Society of Belgium, and the general secretary, to whom all communications or contributions should be sent as soon as possible, is Dr. J. Daniel, rue de la Prévoté, 1, Brussels.

MENTION has already been made of the recent visit of British physicians and surgeons to Paris, and the cordial and enthusiastic welcome extended to them by French men of science, as well as by the State and municipal authorities. Further particulars of the visit are given in the *British Medical Journal* of May 20. Among the numerous receptions arranged by the scientific and medical societies and by civil bodies of every kind to do honour and give pleasure to the British visitors, no meeting was more appreciated than that which gave the British men of science the opportunity of paying homage to the memory of Pasteur. On May 11 the visitors attended at the Pasteur Institute to witness the ceremony of placing a wreath upon the tomb of Pasteur in the crypt of the institute by Dr. J. Kingston Fowler, dean of the medical faculty of the University of London. Dr. Roux, the director of the Institute, conducted the visitors and a distinguished party of French medical men to the gates of the crypt, where Dr. Fowler delivered in French the speech referred to in NATURE of May 18 (p. 63), in which he craved permission to place a wreath on the tomb of the master, who accomplished so much for science and for humanity, and to whose labours the institute is a fitting memorial. Dr. A. Waller, dean of the faculty of science of the University of London, followed with an eloquent eulogy, also delivered in French. He laid great stress upon the value to humanity of Pasteur's work in the direction of the infinitely little, and spoke of Pasteur as *le médicin de la médecine*. Dr. Waller maintained that in a thousand years' time historians will not speak much of the nineteenth century as remarkable for the invention of the locomotive and other mechanisms, but rather as the epoch in which Pasteur inaugurated so brilliantly the study of the infinitely small. The earnest speeches, and the impressive scene as the visitors passed before Pasteur's tomb in respectful homage to their master, made the occasion a memorable one. The evidence thus given of the reverence in which Pasteur's memory is held should help to cement the friendly relations existing between France and Britain, and to foster that spirit of mutual confidence—that comity of nations—which already exists in the world of science.

THE May number of *Museum News* (Brooklyn Institute) contains an interesting notice of specimens in the collection illustrating the now obsolete manufacture of tapa cloth in Hawaii and other Polynesian islands.

A PRELIMINARY report, by Dr. H. W. Conn, on the fresh-water protozoans of Connecticut, issued as Bulletin No. 2 of the Connecticut Geological and Natural History Survey, is illustrated by no less than thirty-four beautifully executed plates. Hitherto the American fresh-water representatives of these lowly organisms have been but little studied, and the present research is merely a prelude to a fuller account of their distribution and their relation to the purity of drinking water. Descriptions of species are altogether omitted in this report, and even the generic position of some of the forms mentioned is left more or less undecided.

IN connection with the preceding paragraph may be appropriately noticed Mr. D. J. Scourfield's address (delivered in December last) on fresh-water biological stations, which is published in the April issue of the *Journal of the Quekett Microscopical Club*, since this also deals with the effects of organisms on the purity of water used for domestic purposes. The gradual awakening of interest in the subject of the detailed study of fresh waters and their organisms is sketched, and the history of the establishment of stations for the purpose briefly described, special reference being made to the one founded by Mr. E. Gurney on Sutton Broad, Norfolk, in 1902. The lecturer concludes with remarks about what fresh-water biological stations should be, whenever the requisite financial means are obtainable.

AMONG other monographs on American invertebrates recently received is a revision of the beetles of the family Staphylinidæ included in the section Pæderini. In this article, forming No. 2 of vol. xv. of the *Transactions of the St. Louis Academy*, the author, Mr. T. L. Casey, points out that the taxonomic problem presented by these beetles is one of great interest in reference to the comparative morphology of the tribe. Genera from all parts of the world are included in the revision, but with the exception of the types of new generic forms, the only species catalogued are those inhabiting America to the northward of Mexico.

IN an article on the affinities of Equisetum in the May number of the *American Naturalist* Prof. D. H. Campbell comes to the conclusion that these archaic plants are related to ferns rather than to lycopods, and that both ferns and equisetums are probably divergent branches from a common ancestral stock. In the same issue Mr. D. D. Jackson discusses the movements of diatoms, many of which appear to be due to the evolution of oxygen gas produced by the activity of the chlorophyll in these organisms. Attention may likewise be directed to Mr. A. H. Clark's paper on the habits of the important West Indian food-fish known locally as "whitebait" or "tritri" (*Sicydium plumieri*).

IN the report of the delegates of the University Museum for 1904, published on May 16 as a supplement to the *Oxford University Gazette*, special attention is directed by the Hope professor of zoology (Prof. Poulton) to the increase in the insect collection and the work that has been accomplished, or is in progress, in connection with the insect collection, which is rapidly becoming one of the finest in the world. The most recent addition is the collection of 7000 British Microlepidoptera presented by Mrs. Bazett, of Reading, another splendid acquisition being the collection of Hymenoptera and Lepidoptera bequeathed by Mr. G. A. J. Rothney. The report also alludes to the recent decisive confirmation of the existence of three distinct mimetic types of female in a South African Papilio, and to the remarkable features presented by certain southern butterfly faunas, which are almost wholly of a northern type. The editing of the Burchell manuscript, and the identification of the specimens in the collection of the great traveller referred to therein, are also mentioned.

AMONG the more important articles in the issues of the *Proceedings of the Philadelphia Academy* for the current year, the following may be specially mentioned. To the January issue Mr. C. W. Johnson contributes an annotated list of the type-specimens of Cretaceous invertebrates in the collection of the academy, while Mr. H. W. Fowler gives the second instalment of a paper on new or little-known scombroid fishes. Later on Mr. H. Crawley discusses the movements of gregarines; and in the February issue Mr. H. A. Pilsbry describes a number of new Japanese marine molluscs. Both entomologists and morphologists will find much to interest them in an article by Dr. E. F. Phillips on the structure and development of the compound eye of the bee, while Mr. Crawley's preliminary notice of a new sporozoon (*Coelosporidium blattellae*) found in the croton-bug (*Blattella germanica*), and Mr. T. H. Montgomery's contribution to our knowledge of the spermatogenesis of certain spiders and remarks on chromosome reduction, will appeal to specialists in such matters.

A RECENT issue of the *Jenaische Zeitschrift* contains the report of an address delivered in June last before the Medical and Scientific Society of Jena by Prof. E. Haeckel on the progress of biology in that city during the nineteenth century. Confining himself chiefly to morphology, and dwelling specially on the various theories which have been advanced in regard to that of the vertebrate skull, the professor pointed out that in Jena the "science century" may be divided into three periods. The first of these, during which Schleiden advanced the cell-theory, extended to 1838; then followed an interval of twenty years, after which, in 1859, came Darwin's epoch-making theory of the evolution of species. After referring to the work of Blatt on embryology and development, the lecturer emphasised the morphological importance of the "vertebral theory of the skull" enunciated by Goethe and Oken in the first third of the century, and of Huschke's labours in connection with the development of the skull and the sense organs in the second third. A whole paragraph is devoted to Goethe's discovery of the premaxilla in man. Oscar Schmidt, Johannes Müller, Carl Gegenbaur, and the other great names associated for longer or shorter periods with Jena and its teaching, receive in turn their share of praise in this admirable historical address.

MM. CALMETTE AND BRETON have repeated the experiments of Loos and others on the transference of infection in ankylostomiasis through the skin. They find that the larvæ of both the human and the canine Ankylostoma pass with the greatest facility through the skin of the dog, causing infection of the animal (*Acad. de Méd.*, Paris March 24).

THE *Bulletin of the College of Agriculture of the Imperial University, Tokyo* (vol. vi., No. 4), contains several papers of interest on the value and use of artificial manures for various crops, and others on the flowering of the bamboo, on oxidases, on the determination of fusel oil, on a bacillus observed in flacherie, &c. With regard to flacherie (a destructive disease affecting silkworms), the conclusion is

arrived at that it is not caused by any special bacterium, but by several different species of common occurrence on mulberry leaves.

WE have received part ii. of the reports of the commission appointed for the investigation of Mediterranean fever, part i. of which has already been noticed in NATURE (May 4, p. 17). Dr. R. W. Johnstone deals with the sanitary circumstances and prevalence of the disease in the Maltese Islands, but is unable to give any definite pronouncement on the mode of human infection. The facts do not indicate that dust, personal contact, or excretal pollution play an important part in the spread of the disease. Staff-Surgeon Bassett-Smith, R.N., details experiments on the saprophytic life of the *Micrococcus melitensis*, and Dr. Eyre on the virulence of this organism for the guinea-pig.

THE Bulletins of the Bureau of Government Laboratories, Manila, several of which have from time to time been noticed in these columns, always contain matter of interest. No. 20, in five articles, discusses various diseases occurring in the Philippine Islands, and in No. 21 Dr. Strong deals with certain questions relating to the virulence of micro-organisms and their immunising powers. The conclusion is arrived at that a virulent cholera spirillum possesses a greater number of bacteriolytic and agglutinable haptophore groups, or these groups are endowed with a greater binding power for uniceptors and amboceptors than the avirulent. That is to say, virulent cholera microbes have a greater capacity than avirulent microbes for uniting with living cells and their products.

AN article on roses by Mr. Jekyll in the April number of the *Bulletin of the Department of Agriculture, Jamaica*, warns growers against attempting to grow hybrid perpetuals in the island. First place is assigned to the tea and noisette sections, which produce good results except in so far as the sun is too strong for some, and a good selection of suitable roses may be made from the list which is given.

A FLORA of the islands of Margarita and Coche, lying off the coast of Venezuela, is being prepared by Mr. J. R. Johnston, but meantime he has published a list of new plants from these islands in the *Proceedings of the American Academy of Arts and Sciences* (April). A new genus, Anguriopsis, is formed having affinities with the cucurbitaceous genus Anguria. Among the new species are a Bactris—a palm with handsome foliage—two new orchids, and several trees, including a Capparis, a Cæsalpinia, and a Casearia. The new species are for the most part additions to genera or sections of the genera which are confined to tropical America.

ONE of the most fruitful lines of recent research in botany has been concerned with the investigation of fossil seeds, of which several species of Lagenostoma are the best known. The evidence in favour of referring these seeds to certain vegetative portions of Carboniferous plants, formerly regarded as fern fronds, formed the subject of Dr. Scott's presidential address to the Royal Microscopical Society, which is published in the April number of the Journal. The cycadofilicinean position assigned to *Lyginodendron Oldhamium*, which shows a sphenopteris type of foliage, was confirmed by the evidence which connected the same plant with *Lagenostoma Lomaxi*. Mr. Kidston's discovery of the fructification of *Neuropteris heterophylla* fixed the seed to another typical fern-frond, and recent research points to the production of winged seeds by a species of Adiantites.

IN a sketch of the geology of Upper Assam (*Records Geol. Surv. India*, xxxi., part iv.) Mr. J. Malcolm Maclaren describes the region as a great plain, 320 feet to 500 feet above sea-level, bounded on the north-west by the eastern Himalayas and on the south-east by the Patkai ranges, while the head of the valley is closed in by the crystalline and metamorphic rocks of the Miju ranges. Upper Tertiary sandstones occur at a considerable height (maximum 6900 feet) on the Patkai and Himalaya ranges, but have not been observed anywhere on the heights of Miju. Attention is directed to the general uptilting and reversed faulting of the Tertiary rocks on either side of the great plain, and to the deflection in the trend of the Patkai range where it abuts against that of Miju. These features are attributed to earth stresses during the formation of the mountains. The author concludes that the Patkais and Himalayas, in their later growth at least, are of contemporaneous development, and that both are orographically and geologically distinct from the great meridional mountain system of Upper Burma, Tibet, and western China. In another article Mr. Maclaren deals with the auriferous occurrences of Assam. Gold was there worked in ancient times, and it is distributed in extremely small percentages throughout the alluvial gravels of the Brahmaputra; but the author is of opinion that only two or three localities are worthy of further prospecting, and that these are likely to yield comparatively small results. He believes that in Assam, as in most other parts of India, the climatic conditions that make for concentration of gold have always been absent. There never has been that even flow of waters confined within well-marked banks, that after a lengthened period results in a separation and local concentration according to specific gravity of the river-borne minerals in "leads" and "runs." On the other hand, there have been annual floods, varying so quickly in height, velocity, and direction that the slight local concentration of one year has been effaced by succeeding floods.

WE have received vol. ii. of the year-book of the Austro-Hungarian Meteorological Observatory of Agram for the year 1902, a large folio publication containing fifty pages of tables giving detailed and summarised observations and results at a number of stations in Croatia and Slavonia. The size of the work is somewhat unwieldy, but the tables are very legible, and have been carefully prepared on the plan of the international scheme for meteorological publications. Hourly readings, and hourly and daily means, are given for Agram.

THE recently published annual *Journal of the Scottish Meteorological Society* (third series, Nos. 20 and 21) contains an interesting discussion of the rainfall of the Ben Nevis observatories, by Mr. Andrew Watt. The measurement of precipitation on the summit was attended with great difficulties; the high wind velocities, at an altitude of 4400 feet, made the registration of snow (which mostly falls between October and May) and even of rain somewhat uncertain. The tables show the falls at the upper and lower stations for the nineteen-year period 1885–1903. The average annual rainfall at the summit was 160·8 inches, and that at the foot 78·6 inches; in individual years the amounts varied from 49 per cent. above to 33 per cent. below the mean values on the summit, and from 45 per cent. above to 23 per cent. below at the lower station.

With regard to daily range, the author states that, speaking very generally, rain falls more frequently, but less heavily, by night than by day, at the foot of the mountain; whilst on the summit the variations are less pronounced, but, on the whole, are in sympathy with those at Fort William. On the top of the mountain falls of 4 to 6 inches in a day were occasionally recorded.

A GOOD oil-immersion lens at a moderate price has long need has been met by Mr. Gowlland, of Selsea, who has been wanted by histologists and bacteriologists. This produced an objective of 1/12-inch focal length and 1·30 numerical aperture at a price of 2*l.* 15*s.* It is an admirable piece of apparatus, and is well corrected for spherical and chromatic aberration. We have tested it on a number of objects, and can recommend it as thoroughly efficient. It is claimed by the maker that it has good photographic qualities.

IN a paper published in the *Gazzetta* for April 3, Dr. Italo Bellucci proves that the so-called hydrated platinum oxide, $PtO_2,4H_2O$, is in reality a platinic acid of the structure $H_2Pt(OH)_6$, corresponding with chloroplatinic acid $H_2PtCl_6$, and forming a series of well defined salts of the type $M_2Pt(OH)_6$. In a second paper, written in conjunction with N. Parravano, the metallic stannates and plumbates are shown to be derived from similar acids, $H_2Sn(OH)_6$ and $H_2Pb(OH)_6$, whilst the three salts $K_2Pt(OH)_6$, $K_2Sn(OH)_6$, and $K_2Pb(OH)_6$ are strictly isomorphous. The views brought forward are of considerable importance from the standpoint of the systematisation of inorganic chemistry, and as showing that so-called water of crystallisation may in many instances play an important part in molecular structure.

SINCE Lord Rayleigh published in 1897 his interesting results on the oxidation of atmospheric nitrogen by an electric arc, many attempts have been made to devise a practical method of synthesising nitric acid from the gases of the atmosphere. Owing, however, to the fact that nitric oxide is formed by an endothermic change and to the early production of a condition of equilibrium when little oxidation has occurred, the processes hitherto published have been far from economical. In the *Gazzetta* for April 3 E. Rossi describes how the efficiency of such methods may be greatly increased by working with air under a very great pressure. The heating is effected by means of an incandescent resistance similar to the filament of a Nernst lamp, and the nitric oxide is absorbed by concentrated sulphuric acid within the interaction chamber, as fast as it is produced, so as to obviate an equilibrium.

IN the *Verhandlungen* of the German Physical Society (vol. vii. p. 78) L. Graetz replies to the objections raised by Profs. Precht and Otsuki (compare NATURE, vol. lxxi. p. 468) against his view that hydrogen peroxide gives rise to a special radiation capable of affecting a photographic plate. He considers that a substance so comparatively non-volatile as hydrogen peroxide, which has a vapour tension less than that of water, and can be concentrated by allowing a current of air to pass through it, cannot be conceived as directly permeating sheets of celluloid and gelatin. Again, the extreme readiness with which hydrogen peroxide is decomposed catalytically by metals makes it improbable that it would pass as such through minute holes in thin metallic plates. In a second communication, published in the same periodical (vol. vii. p. 163), Profs. Precht and Otsuki maintain their original contention by emphasising the minuteness of the quantity of hydrogen peroxide necessary to affect a photographic plate. The action of the peroxide on sensitive plates has since been discussed in detail by Prof. Otsuki in a paper read before the Society of Chemical Industry on May 1.

A HERBERT SPENCER lectureship has been founded at Oxford by a Hindoo gentleman who is a Master of Arts of Balliol College. The first lecture was delivered on March 9 by Mr. Frederic Harrison, and has been published by the Clarendon Press. It is appreciative, but not—lecturer or printer has surely blundered in regard to the prefix—"an apodictic eulogy." Mr. Harrison's chief criticisms of the synthetic philosophy are:—(1) that, laying all the emphasis on evolution, it disregards the laws of stability and permanence, such as are manifested chiefly in the inorganic sciences—which it accordingly passes over; (2) that its attempt to reduce all manner of sciences under the same laws only succeeds because it neglects the peculiarities which make any one science or set of sciences incommensurable with others, as, *e.g.*, the human sciences are with the non-human. But the lecturer readily admits that Spencer did not allow himself to be confined by the materialistic dogmas with which he set forth, and that while "Philosophy never opened with aspect more physical, it never insisted more imperatively on the law of Justice from man to man, on the supreme duty of Altruism."

THE thirty-fifth of the privately printed opuscula issued to the members of the Sette of Odd Volumes is entitled "The Early History of the Royal Society." The author of this brochure is Mr. Henry B. Wheatley, sometime clerk to the Royal Society, who has succeeded in writing a very interesting account of the early years of our national association of men of science. Mr. Wheatley shows that Charles II.—"Founder, Patron, and one of the Royal Society of London for improving Natural Knowledge"—took a genuine interest in the advancement of the society. "True he did not give any money, but then money was never very plentiful with His Majesty. He was always ready to assist with his name and influence. His interest doubtless made the Society the fashion." Doubt is cast on the truth of the story of the paradox put forward by Charles II. concerning the weights of respective bowls of water with or without fish in them. A suggestion of Sir William Petty, the inventor of the double-bottomed boat, as to the society's anniversary, is worth repetition. Aubrey writes:—"I remember one St. Andrew's day I sayd methought it was not so well that we should pitch upon the Patron of Scotland's day. We should rather have taken S. George or S. Isidore, a philosopher canonized. No, said Sir William Petty, I would rather have had it been S. Thomas's day." Objections were on one occasion made to Charles II. that a member recommended by him for election was a shopkeeper. By way of reply the King "gave this particular charge to his Society, that if they found any more such tradesmen they would be sure to admit them all, without any more ado." Mr. Wheatley records many more quaint stories and odd incidents associated with the society's earlier years, and his paper will excite lively interest in all scientific readers who are able to obtain a copy of it.

MR. HENRY FROWDE has published in pamphlet form the Robert Boyle lecture delivered by Prof. H. B. Dixon, F.R.S., before the Oxford University Junior Scientific Club in 1903, on the nature of explosions in gases.

NEW editions of "Half Hours with the Microscope," by Dr. Edwin Lankester, and "The Preparation and Mounting of Microscopic Objects," by Mr. Thomas Davies, have

been published by Messrs. C. Arthur Pearson, Ltd. Dr. Lankester has made important additions to his book descriptive of the compound microscope and its accessories, and has incorporated a chapter by Mr. F. Kitton on the polariscope and its uses. Dr. John Matthews has edited the second book, and has made several alterations and additions, among the latter being a prefatory chapter dealing with preliminary histological manipulation.

THE *Bulletin de la Société des Naturalistes de Moscou* (1904, Nos. 2 and 3) contains the following papers:—Four notes on the crystalline forms and optical properties of various salts.—On the theory of endosaprophytism with lichens, by A. Elenkin. A defence of the latter as against the mutualistic theory, with a bibliography of the literature of the subject (in German).—The Jurassic corals of the Sudagh, by A. Missuna (with plates). In a total of 108 species, 46 are new for the Crimea, and 14 new species are described. The Crimean coral-fauna has its nearest relative in the Jurassic fauna of Switzerland (this paper is in German).—Materials for the algology of Lake Baikal, by V. Dorogostaïsky (with a plate). Results of a two years' study of the algæ in Lake Baikal and its affluents. A list of 350 species is given, a few of them being new (this paper is in French).—History of development of the excretory system with the Amphibiæ, D. P. Filatow (in German, with a plate).—The same number contains a fine portrait of Prof. T. A. Bredikhin, and a biographical sketch of the late Moscow astronomer, including a sketch of his theory of comet tails, by P. K. Sternberg.

## *OUR ASTRONOMICAL COLUMN.*

ASTRONOMICAL OCCURRENCES IN JUNE:—

| | | |
|---|---|---|
| June | 2. | Venus at maximum brilliancy. |
| ,, | 11. | 13h. 3m. Minimum of Algol ($\beta$ Persei). |
| ,, | 12. | 8h. 22m. to 9h. 24m. Moon occults $l^2$ Virginis (mag. 4·9). |
| ,, | 13. | Saturn. Outer major axis of outer ring = 40″·87; outer minor axis of outer ring = 6″·03. |
| ,, | ,, | 9h. Mars in conjunction with moon, Mars 6° 14′ S. |
| ,, | 14. | 9h. 52m. Minimum of Algol ($\beta$ Persei). |
| ,, | 15. | Venus. Illuminated portion of disc = 0·365; of Mars = 0·938. |
| ,, | 21. | 15h. Sun enters Cancer, Summer commences. |
| ,, | ,, | 22h. Saturn in conjunction with Moon, Saturn 1° 29′ S. |
| ,, | 23. | 23h. Uranus in opposition to the Sun. |
| ,, | 27. | 14h. 48m. to 16h. 33m. Transit of Jupiter's Satellite III. (Ganymede). |
| ,, | 29. | 14h. 10m. to 15h. 1m. Moon occults $\theta^2$ Tauri (mag. 3·6). |
| ,, | ,, | 14h 15m. to 14h. 56m. Moon occults $\theta^1$ Tauri (mag. 3·9). |

A REMARKABLE VARIABLE STAR.—In a note published in No. 4017 of the *Astronomische Nachrichten* Prof. E. C. Pickering states that the light-changes of the variable star 154428, R Coronæ Borealis, are unlike those of any other known variable. A series of observations, made by Mr. Leon Campbell, showed that during the period March-September, 1903, the magnitude underwent remarkable changes between the limits 6·0 and 9·4. Since then until March of the present year it remained stationary at 6·0 m. The unusual character of the changes during April and May is shown in the following table:—

| 1905 | | Mag. | | 1905 | | Mag. |
|---|---|---|---|---|---|---|
| April 1 | ... | 6·0 | ... | May 1 | ... | 11·4 |
| 11 | ... | 7·3 | ... | 7 | ... | 12·5 |
| 21 | ... | 8·4 | | | | |

Observations with large telescopes are now desirable in order to see whether or not this object disappears entirely. It is easily recognised on the Harvard "Map of the Sky," plate No. 18 (118·75), and is nearly equidistant from $\gamma$, $\delta$, and $\epsilon$ Coronæ.

RADIAL VELOCITIES OF THIRTY-ONE STARS.—For the past ten years line-of-sight observations have been made at the Emerson McMillin Observatory (Columbus, Ohio), but Prof. Lord has now arrived at the conclusion that, as so many better equipped observatories, situated in more favourable atmospheres, are engaged in this work, it seems advisable to discontinue the observations there and direct the available resources into some other channel of research for which they are better equipped. Consequently he has collected all the results obtained during the decennary, and has published them in No. 4, vol. xxi., of the *Astrophysical Journal*. Complete catalogues of the plates taken and of the standard lines employed, and the collected results, are embodied in his communication. Amongst the thirty-one stars dealt with there occur $\alpha_1$ Cassiopeiæ, Aldebaran, $\alpha$ Arietis, $\alpha$ Persei, Capella, Pollux, Dubhe, Arcturus, $\beta$ and $\gamma$ Cygni, and $\delta$ Cephei.

MAGNITUDES OF NOVA PERSEI AND NOVA GEMINORUM.—In No. 4017 of the *Astronomische Nachrichten* Prof. A. A. Nijland publishes the results of a number of magnitude observations of Novæ Persei and Geminorum. The observations of the former covered the period November 15, 1901, to January 13, 1905, and the figures given show frequent increases of brightness, which were, however, very small. A gradual decrease of magnitude underlies these minor fluctuations, and on January 13 the Nova was of magnitude 10·74.

The Nova Geminorum observations extended over the period March 27, 1903, to December 30, 1904, and on the latter date the magnitude recorded was 13·3, more than 2·7 magnitudes fainter than Nova Persei on the same date.

OXFORD UNIVERSITY OBSERVATORY.—Prof. Turner's report of the work done at the Oxford University Observatory during the twelve months ended April 30 informs us that the Oxford work in connection with the International Astrographic Catalogue is at last within measurable distance of publication. The measures and reductions were completed last year, and the whole thing is now ready to print. What is still more satisfactory, the university has set aside 1000*l.* for this purpose, and this is to be supplemented by a similar contribution from H.M. Government.

The stereo-comparator has been used to compare some of the newer with some of the older plates, but, so far, nothing of importance has been discovered; more time will be given to this work when the coming eclipse is past and the Oxford contribution to the International Catalogue is safely in the press. As some of the earlier plates for the catalogue are less satisfactory than the later ones, they are being duplicated, and the new ones are being measured and reduced as opportunity occurs. An expedition from the observatory, comprised of Prof. Turner and Mr. Bellamy, will observe the total solar eclipse of August next in Egypt.

VARIATIONS OF LATITUDE.—The provisional results of the work accomplished by the International Latitude Service during 1904 are given by Prof. T. Albrecht in No. 4017 of the *Astronomische Nachrichten*. The results obtained at the six stations employed in the service are grouped, and the variation of the momentary from the mean pole during the years 1900–4 is graphically shown. From this curve it appears that the year 1904 was marked by a diminution in the amplitude of the variation.

NEW REFRACTION TABLES.—Appendix ii., vol. iv. (second series), of the *Publications of the U.S. Observatory* contains a number of reduction tables for transit-circle observations compiled under the direction of Prof. Eichelberger. All of them, except the refraction tables, are of no use at any other observatory, but these may be found useful by other transit observers. They consist of nine separate tables, in which the logarithms of the various arguments necessary for determining the exact refraction correction for each minute of apparent zenith distance from 0° to 85° are given. An example which precedes the tables clearly illustrates the method of using them. The tables are based upon those of Pulkowa.

## ISLANDS FOR WEATHER FORECASTING PURPOSES.

THE aim of meteorology from a practical point of view is the forecasting of the amount of rainfall and the approach of storms.

The former will tell us whether we may expect high river flows producing floods and much damage, an average amount of water for successful crop production, or a deficiency of rain which might result in a disastrous drought and possibly a famine. In the case of storms, a means will be afforded of saving many lives and ships, and also, probably, much property ashore.

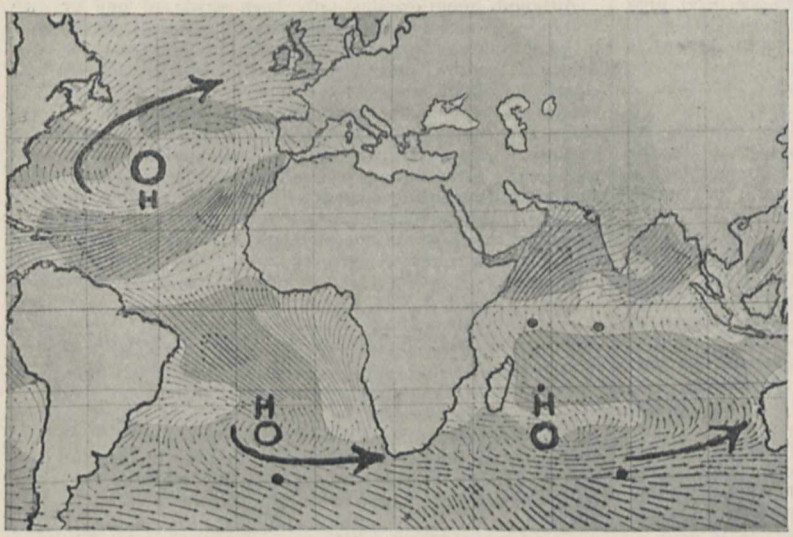



FIG. 1.—The wind system during summer in the northern hemisphere and winter in the southern hemisphere. The black dots represent islands, and the letter H the centres of regions of high pressure or anticyclonic areas.

The study of the weather, therefore, should be fostered to its fullest extent, and every advantage should be taken of means which will bring us nearer the goal of satisfactory forecasting.

Investigations carried out during the last decade have indicated the importance of each weather bureau extending its area of inquiry beyond the region for which it is making its forecasts. Needless to say, many of these institutions have for some years been in telegraphic communication with outlying stations. Thus, for instance, the Indian Meteorological Service receives information from a station so far distant as Mauritius, while the U.S. Weather Bureau utilises valuable observations by telegraph from stations in the West Indies, Azores, Europe, &c.

It is important to bear in mind that rain-bearing winds are those that have passed over large stretches of water, and that the rainfall of a country is deficient or well supplied with this commodity according to its geographical position in relation to the oceans or inland seas, mountain ranges, and the prevailing winds. It is for these reasons that the nearer the coast is approached from the centre of any continent, the greater becomes the rainfall. Thus, for instance, the interior of Australia, the Sahara, the Arabian Desert, Tibet, &c., are all very dry areas.

For forecasting purposes, therefore, attention should be, and in many regions is, paid to the region from which the prevailing winds come, due consideration being given to the particular barometric system of which the wind forms part.

From the above the important functions of islands conveniently situated become obvious. It is not, however, every country bordering on the ocean that is blessed with such an island in the direction of the prevailing wind, and the British Isles, in consequence, suffer very much from this very defect. In Great Britain the main rain-bearing wind is that from the south-west. In summer this forms part of a large anticyclonic system situated in mid-Atlantic towards the south-west (see Fig. 1), while in winter it is a portion of a cyclonic system the centre of which is near Greenland (see Fig. 2). With no islands in the track, the only meteorological information that is at once useful is that which can be gathered from messages sent by the Marconi system of wireless telegraphy from steamers *en voyage*. British weather forecasters are thus undoubtedly heavily handicapped by the lack of some permanent outlying source of information in this region.

Mention has already been made of the use of islands by the United States and India. The latter is particularly fortunate, for Mauritius, Seychelles, Chagos (marked with dots in the figures), and other islands are all conveniently situated to render information if necessary.

Another region which very probably would gain considerably by utilising observations made at island stations is South Africa.

In a previous number of this Journal (vol. lxxi. p. 342, February) Mr. E. Hutchins, Conservator of Forests, Cape Town, gave an excellent account of the general weather conditions in this region. He pointed out that South Africa lies on the border of the south-east trade area. In summer, from Cape Town to the Zambesi, the country comes entirely under the influence of the south-east trade winds. In winter, on the other hand, the southern portion of Cape Colony is subject to "another type of weather, due to the passage of storms from the South Atlantic, the

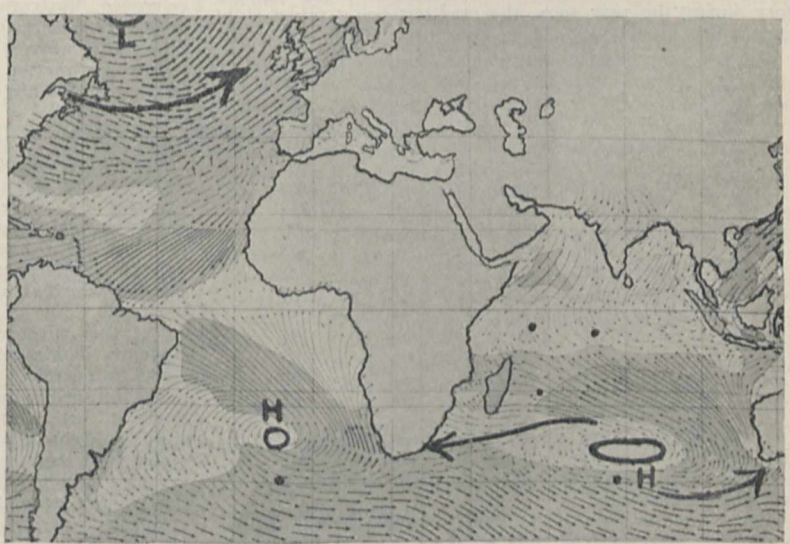



FIG. 2.—The wind system during winter in the northern hemisphere and summer in the southern hemisphere. Notation as in Fig. 1. The letter L indicates the centre of a low pressure or cyclonic area.

'roaring forties' of mariners." He further directs attention to the need of distinguishing between these two weather systems, which play distinct parts in the meteorology of this region. A study of the accompanying two figures will indicate the importance of the islands of Tristan d'Acunha and Gough (indicated by a black dot towards the south-west), and also of Mauritius (the dot east of Madagascar). The two former islands lie in the wind system pertaining to the anticyclonic (high-pressure) area on the west, the centre being indicated by the letter H, while Mauritius, situated to the east of South Africa, is in the south-east trade area in the system formed by the high-pressure (anticyclonic) region, the centre of which is marked also with an H.

By observing the general trend of the air currents indicated by the large arrow, it will be seen that for the winter season in South Africa (Fig. 1) meteorological observations made in either Tristan d'Acunha or Gough Islands would undoubtedly render valuable aid to the weather forecasters.

In the case of the summer months (Fig. 2) there is no conveniently placed island that could furnish equal assistance, but it seems very possible that use could be, and most probably has been, made of the observations at Mauritius for determining the strength of the south-east trade current which impinges on the African coast at this time of year. For forecasting purposes Mauritius, and possibly Rodrigues, would have greater value for regions further up the African coast.

Unfortunately, the Amsterdam and St. Paul islands (marked with one dot) lie too far south and east to serve as useful outlying stations for South Africa. On the other hand, these islands should be undoubtedly utilised by the Australians.

An examination of the accompanying figures indicates the relative positions of the Australian continent and this large southern Indian Ocean wind system. These islands will thus be seen to be right in the track of the current which strikes the south and west coasts of Australia, and should form ideal out-stations for gauging the general condition of this wind system.

That the prevailing winds on the west coast of Australia come from a southerly direction is indicated in the following table, which gives the number of times the wind has blown from each point of the compass at the Perth Observatory during the year 1902, the readings being taken eight times a day:—

| | |
|---|---|
| N. | 98 |
| N.N.W. | 51 |
| N.W. | 73 |
| W.N.W. | 67 |
| W. | 92 |
| W.S.W. | 113 |
| S.W. | 232 |
| S.S.W. | 432 |
| S. | 425 |
| S.S.E. | 245 |
| S.E. | 194 |
| E.S.E. | 121 |
| E. | 157 |
| E.N.E. | 139 |
| N.E. | 159 |
| N.N.E. | 98 |

Another table shows that the resultant direction of the wind, at the same observatory for the same year, was south for the months January to April and October to December inclusive.

There seems every reason, then, to hope that the utilisation of information from one of these islands for several months in the year would in time amply repay the initial cost and maintenance of the station.

It is not without interest to remark that the air current which passes the west coast of Australia in July (that is, in winter in Australia) becomes later the south-east trade wind of the Indian Ocean, and eventually reaches the Indian area in the form of the south-west monsoon in the summer months of the northern hemisphere. In the months about July, Western Australia is thus apparently closely connected, meteorologically speaking, with India, but in the months about January the connection is between Australia and South Africa.

The natural deduction to be made from the above is that the meteorological services of all these countries should be closely in touch with each other. Their combined efforts will certainly considerably increase our knowledge of the meteorology of this vast region, and each will benefit by this mutual interchange of information.

Although mention has only been made of one or two instances in which the employment of islands as meteorological stations would most probably be rewarded with practical results, there are other countries that might equally profit by adopting the same principle.

It is, however, important for the study of world meteorology that many islands should be employed as observing stations. They may not be very ideal places for observers to live in, but a change every few months, and the adoption of self-recording instruments, would possibly simplify matters. Where cables are lacking, and the island in question is of great meteorological importance to some continent, wireless telegraphy might be employed with advantage. WILLIAM J. S. LOCKYER.

## AN OPTICAL CONGRESS AND EXHIBITION.

THE aims of the optical convention, which was opened at the Northampton Institute, Clerkenwell, on Tuesday, May 30, are to increase the interest taken in optical science in this country, to promote an improvement in technical education in optical matters, and to aid the development of the British optical industry. In his address, the chief part of which is subjoined, the president, Dr. R. T. Glazebrook, F.R.S., after explaining the origin of the proposal to hold a convention, and the steps taken to realise it, gives an outline of the history of optical progress during the past two hundred and fifty years with the view of illustrating the close union which has existed between theory and practice at times of marked progress, and of showing how each has reacted on the other in assisting this progress. The programme of the convention includes meetings for papers and discussions, which will be subsequently published in a volume, and an exhibition of optical and scientific instruments of British manufacture, with a catalogue which is intended to serve as a work of reference illustrating the productions of opticians in this country. A description of some of the exhibits follows the president's address abridged below; and an article on the nature and matter of the papers and discussions will appear in these pages after the close of the convention.

### PROGRESS OF OPTICAL SCIENCE AND MANUFACTURES.[1]

The study of optics is a fascinating one, and its history full of interest. I do not propose to-night to attempt to cover the whole ground, but to ask you to look at one or two special periods during which, it seems to me, theory and practice reacted on each other in a marked manner, and to consider what lessons we may draw as to the relation which should in these days of ours subsist between the two.

For this purpose I might go back to very early days. Ptolemy in his attempt to discover the laws of refraction —and wonderfully good the attempt was, as we know now —Archimedes with his burning glass, if, indeed, he ever made it, had both practical aims in view. But we will start to-night nearer our own time. The end of the seventeenth century is such a period. The telescope was invented about 1608, the microscope at rather an earlier date, about 1590, both, probably, in Holland.

Galileo, hearing of this, made his first telescope in 1610. In 1611 Kepler, in his "Dioptrica," described the astronomical telescope with one or more convex lenses as the eye-piece; with this exception, up to Descartes's book on "Dioptrics" in 1637, no other form of telescope but Galileo's was known. The law of refraction was first enunciated by Snell in 1621.

Thus by the year 1660 the importance of the telescope to the astronomer was fully appreciated, and its limitations were being realised. In 1663 Gregory published an account

1 From the inaugural address delivered before the Optical Convention on May 30 by the president, Dr. R. T. Glazebrook, F.R.S.

of the first reflecting telescope designed to meet some of these defects, and about this time two men, whose work has left indelible marks on the science, were led to study it in a great measure from their interest in astronomy—Christian Huyghens, who lived from 1629 to 1695, and Isaac Newton, 1642 to 1727.

Huyghens was the discoverer of the wave theory and of the law of double refraction, but he was also a skilled mechanic, and he worked himself at grinding his lenses and erecting his telescopes. He realised from a consideration of the theory that many of the most marked defects were due to the fact that the rays from a distant star traversing the various parts of the lens were not brought to a focus at the same point on the axis, and that for a lens of given aperture this axial aberration decreased rapidly as the focal length increased. The magnification of the telescope depends on the ratio of the focal length of the object glass to that of the eye-piece. Hence by keeping this ratio constant, and increasing both focal lengths in the same proportion, the magnification could be maintained and the spherical aberration decreased.

Thus he was led to make lenses of 120 feet focal length. Tubes for such instruments could not be produced, and they were mounted on the top of tall poles and moved from below by ropes. With one of these telescopes, which he afterwards presented to the Royal Society, he discovered Saturn's rings and its fourth satellite. In this case the desire to improve an instrument caused an appeal to theory, and theory led the optician to make a real advance. The advance, it is true, was an inconvenient one, and the defects, as we shall see, were not entirely due to spherical aberration, but the fact remains.

In another branch of instrument making Huyghens is famous for applying science to manufacture. His treatise "Horologium Oscillatorium," which discussed most ably many problems of motion, was long the standard work on clocks, and he was the first to bring into practical use, in 1657, the pendulum as a regulator for time measurements, though according to Sir E. Beckett the first pendulum clock actually made was constructed in 1621 by Harris, of London, for St. Paul's Church, Covent Garden.

In 1665 a posthumous work of an Italian Jesuit, Francis Maris Grimaldi, entitled "Physico Mathesis de Lumine, Coloribus et Iride aliisque annexis," was published at Bologna. It contains some notable observations, particularly the discovery of diffraction.

Newton, who in the previous year had taken his B.A. degree at Cambridge, purchased a prism at Stourbridge Fair in 1666 "to try therewith the celebrated phenomena of colours," and to repeat some of Grimaldi's experiments. During that year also he had applied himself to the grinding of "Optic Glasses of other figures than spherical." He was already interested in astronomy, possibly had already made, but not confirmed, his great discovery. Writing to Halley in 1686 about some of the controversies which followed the publication of the "Principia," he says:—"But for the duplicate proportion I gathered it from Kepler's theorem about twenty years ago."

The celebrated apple is supposed to have fallen in his mother's garden at Woolsthorpe, in Lincolnshire, in 1665, where he was driven by the plague, and the story has some authority. It is stated to be the fact by Conduitt, the husband of Newton's favourite niece; it was told by Mrs. Conduitt to Voltaire, and the tree from which it was said to have fallen was seen by Sir David Brewster in 1820.

Various suggestions have been made, for the reason why the discovery that the same cause which produced the apple's fall also maintained the moon in her orbit was not published for many years; the true one is probably due to Dr. Glaisher, who pointed out that it was necessary to know the attraction not merely between two particles of matter, but between two spherical bodies of large size, and that this problem was not solved until much later; but, be this as it may, we are sure that in 1667 Newton was an astronomer, and realised the necessity for accurate astronomical observations, and all that the improvement of the telescope meant to astronomers.

Now his experiments with the prism in 1666 led to the discovery of the spectrum; little was known about colours at that time, and Dr. Barrow's "Treatise on Optics," published with Newton's help in 1669, contains very erroneous views; but some time shortly after that date Newton was able to draw the important conclusion that white light is not homogeneous, but consists of rays some of which are more refrangible than others; the pictures of the spectrum, so familiar to us in numerous text-books, come from Newton's "Optics," published first in 1704, though his discoveries as to the analysis of white light were laid before the Royal Society in various papers in 1671, and were given in lectures on optics as Lucasian professor in Cambridge in 1669, 1670, and 1671.

The bearing of all these physical experiments and researches on the practical manufacture of the telescope was at once obvious; the lenses behave like prisms, and decompose the light into its constituent colours. No alteration of shape will remove this entirely, and Newton was driven, too hastily as we know now, to the conclusion that the refracting telescope could not be greatly improved; its defects were inherent in the refraction of light.

The defect, however, does not exist in images formed by reflection, and he came to the conclusion that optical instruments might be brought to any degree of perfection imaginable provided a reflecting surface could be found which would polish as freely as glass and reflect as much light as glass transmits, and provided a method of communicating to it a parabolic figure could be found. In 1668 he thought of a delicate method of polishing by which he believed "the figure would be corrected to the last," and the Newtonian reflecting telescope was the result. An instrument made with his own hands is now in the possession of the Royal Society, and the many noble instruments which have added so greatly to advance our knowledge of the stars are the direct outcome of Newton's experiments with the prism and the deductions he drew from them.

But these experiments convey another lesson, for Newton, misled by his observations on dispersion, decided, wrongly, as we know now, that achromatic lenses were impossible, and that the colour defects must always exist in reflecting instruments; and as a result attempts to improve these instruments were almost in abeyance for nearly ninety years. Two or three achromatic telescopes were made by Mr. Hall about 1730, but it was not until 1757 that Dollond re-invented this instrument and commenced the regular construction of such lenses.

Thus the discoveries of Huyghens and of Newton reacted powerfully on the instruments of their day. Indeed, in each of these two instances the discoverer and the instrument maker were the same person. Such a combination may be less possible now; still, there are mathematicians skilled in the theory of optics and opticians skilled in the practice of their art.

The Optical Convention aims at coordinating the efforts of the two. But if 200 years ago the progress of the telescope was determined by the advance of optical theory, theory itself was no less indebted to the interest in instruments and observations thus aroused for the progress that took place.

Huyghens was the founder of the wave theory, though the labours of Young and the genius of Fresnel were necessary before Newton's rival theory of emission was displaced.

For nearly 100 years after the date of Newton's "Optics" progress was slow. The world was occupied in assimilating what he had taught. English mathematicians, overawed, perhaps, by his transcendent greatness, employed themselves in expounding his teaching. In England, at any rate, the emission theory was supreme, and few, if any, questioned his dicta as to the impossibility of achromatism.

But a change came with the new century. Thomas Young, 1773–1829, was the first in his various papers between 1801 and 1811 again to direct attention to Huyghens's work, and to place on a firmer basis the ground-work of the wave theory. He it was who established clearly the principle of the superposition of waves, and showed how interference may be explained by it.

Young's work, however, would have been incomplete without Fresnel (1788–1827), who re-discovered for himself the principle of interference and extended it to explain diffraction, besides enunciating his theory of double re-

fraction and deducing the well known expressions for the intensity of the light reflected from or transmitted by a transparent surface.

Young, in his "Lectures on Natural Philosophy," illustrated in an admirable way the applications of optical theory to instruments. Fresnel was an engineer by profession attached to the service of the bridges and roads, and as such was the inventor of the arrangements of lenses employed in the French lighthouses.

The discoveries of these two men changed the whole of the theory on which the construction of optical instruments is based; it is idle to attempt to explain the action of a microscope, the resolution of a double star or of the fine lines of the spectrum, to discuss the conditions for such resolution, or, instead, to attempt the construction of any of the more delicate of the beautiful apparatus about us without clearly understanding the fundamental laws discovered by these two, and verified with marvellous skill by Fresnel in his country home in Normandy, not by the aid of modern apparatus, but by such means as his own hands, aided by the skill of the village blacksmith, could construct; and though it is true that only recently have we appreciated the full importance of the wave theory in its bearing on the construction of optical instruments, it is the fact that without their labours and the work of those who followed in their path few of the modern discoveries of the astronomer, few of the results which the skilled optician of to-day has arrived at, would have been possible. The object glass of a microscope, the lens of a camera or a telescope, have reached their present perfection because men have been found who could apply to the art of lens grinding the highest teaching of Young and of Fresnel.

In the earlier years of the last century Englishmen were well to the fore in this work. In astronomy the labours of the two Herschels are well known, and though, perhaps, the success of the elder Herschel was due rather to his mechanical skill than to a profound knowledge of optical theory, Sir John Herschel advanced in no small measure the application of theory to practice.

At a somewhat earlier date Fraunhofer, of Munich (1787–1826), a contemporary of Young and of Fresnel, had realised the fact that the development of the achromatic lens "depended on the exact determination of refractive indices, and that the chief difficulty in that determination lay in the difficulty of obtaining homogeneous radiations to serve as standards" (Schüster, "Theory of Optics").

For these he used the dark lines of the solar spectrum, originally observed by Wollaston, and in this we have an example of the manner in which practical needs react to assist in the advance of science, for from these observations springs the whole of spectrum analysis and all that is involved in that.

Thus theory and practice progress together; each alone carries us but a short way, but the judicious use of hypothesis and reason, supported by the verdict of experiment, carries us on to new knowledge, and brings us nearer to the truth.

Until after the middle of last century we in Britain took our full share in promoting this advance. We might add to the names already mentioned those of Sir George Airy and of the distinguished men who, in the first half of the century, adorned Trinity College, Dublin, notably Sir William Hamilton.

Sir George Airy gave, about 1802, an account of the aberration of the lens of the camera obscura of the utmost value to the early designers of the photographic lens, while Sir William Hamilton's essay on the "Theory of Systems of Rays" contains the essence of all that is needed to calculate to a high degree of accuracy the aberration of such a lens.

But at that date photographic lenses were not thought of, and when Daguerre announced his invention in 1839 the work of Airy and of Hamilton was forgotten. Thus to quote, as I did lately in the Traill Taylor lecture, from the recent work of Dr. M. von Rohr.

"The important signification of Airy's writings for photographic optics does not seem to have been appreciated until a later date. Although they exercised an influence on English text-books, like that of Coddington, they seem unfortunately never to have become known in wider circles on the Continent. It appears, then, that the theoretical opticians of later years to whom his investigations into the astigmatic deformations of oblique pencils would have been of great interest did not base their work on that of Sir G. B. Airy," while Sir W. Hamilton's paper remained unnoticed by the optician until Finsterwalder directed attention to it, and another distinguished German, Prof. Thiessen, quite lately put his results into an accessible form.

There was a divorce between theory and practice in England. The importance of Daguerre's discovery was at once realised, and English opticians set to work with no small success to develop the lens and to make it perfect, and splendidly in many ways they performed their task; but the work was empirical. A certain amount of progress was possible, and was achieved, but without the guidance of well founded theory the progress could not be for long.

The learned Transactions of the Cambridge Philosophical Society and of the Royal Society of Dublin were perhaps the last places to which the practical optician would apply for help, and so it came about that because the opticians of another nation first recognised that a full knowledge of the action of a lens on the light that traverses it was a condition precedent to further truth, for some years past the great improvements in the products of the optician's skill which have taken place have had their origin mainly in Germany.

This brings me to our last example of the manner in which science and practice may combine to produce effects unattainable by either singly. But before dealing with this I would mention one great advantage which, until a few years ago, the English optician possessed in a special degree, an advantage to which much of the progress of our English lenses is undoubtedly due. The story of Gunand's invention of optical glass is deeply interesting. A poor carpenter, and later a watch-case maker, of Brenetz, in canton Neuchatel, he was born in 1740, and became at an early age interested in telescopes. Prompted by the desire to possess a pair of spectacles, he undertook to make the glass for the lenses. A little later, through M. Droz, a gentleman of the neighbourhood, he was allowed to examine one of Dolland's achromatic lenses, and learnt of the difficulty of obtaining the flint glass required. This he determined to make, and years of penury and unremitting toil followed, until at last he succeeded in casting discs sufficiently homogeneous to be used for optical work.

Fraunhofer persuaded him to migrate to Munich, but the venture was not a success. He returned to Switzerland, and again started glass making. After his death his son told the secret of the art to George Boutemps, a Frenchman, who some years later was brought to England by Messrs. Chance, and helped them to establish the optical glass works which for so long were practically the sole source of the supply of raw material for the optician.

Our catalogue to-day bears witness to the progress in glass manufacture that has taken place since Boutemps's time, and it is right to recognise the influence that progress has had on opticians' work.

But to return to our main subject. An optical convention in 1905 would be incomplete without some reference to the work of that master optician who a few months ago was taken from us, the more so since the work of Ernst Abbe affords perhaps the most striking illustration of the effects of the reasoned combination of theory and practice. A comparison of the statistics of the optical trade of Germany now and twenty years ago will suffice to prove this.

The story of the growth of the Jena industry has been told frequently, still I will repeat it in barest outline. Abbe, then a young man, had settled at Jena as a privat docent in 1863, and soon after Carl Zeiss, who then made microscopes of the ordinary class, applied to him for help in the development of the instrument. Abbe's task was a hard one; the theory of the microscope was at that date only partially understood, the corrections to the lenses were made by a rough trial and error method, and the results were doubtful. The first step was to solve a mathematical problem of no small difficulty, to trace the paths

of the pencil through the object glass. Abbe soon realised the defects of the ordinary theory. He found it necessary to apply the principles of the wave theory, the teaching of Young and Fresnel, to the problem, and was led in 1870 to the theory of microscopic vision which bears his name. His work was the direct outcome of that of Fresnel.

He soon realised that it followed from the mathematical theory that with the glass then at the optician's disposal no great improvement in the microscope object glass could be expected. Certain relations between the dispersion and refraction in the various lenses were requisite to secure achromatism, and no glass having these relations existed. An inspection of the instruments in our loan exhibition at South Kensington in 1876 confirmed this view, and he published it in a report in 1878 on the results of the exhibition:—"The future of the Microscope as regards its future improvement in its dioptric qualities seems to be chiefly in the hands of the glass maker."

The investigations of Petzval and of von Seidel led to a similar result with regard to photographic lenses. Von Seidel's work dates back to 1856–7, but his main paper was not written until 1880, after the date of Abbe's report, and was not published in full until 1898.

It follows from these investigations that with the glass then on the market it was impossible to make the field of a photographic lens at once flat and achromatic.

Thus the theoretical work indicated a bar to future progress which could only be removed by the manufacture of new glasses having certain definite properties. It is fitting to say that at an earlier date this fact had been recognised by our countrymen Mr. Vernon Harcourt and Prof. Stokes, who for some eight years previous to 1870 had endeavoured, but with scant success, to make the glass required.

Abbe was more fortunate; his report fell into the hands of Dr. Otto Schott, a glass maker of Witten, in Westphalia, who realised its importance. In 1881 Schott communicated with Abbe, and the next year he removed to Jena, and the firm of Schott and Partners was born.

In the first catalogue of the Jena Glass Works they write:—"The industrial undertaking here first brought into public notice and which has arisen out of a scientific investigation into the dependence between the optical properties and the chemical composition of solid amorphous fluxes was undertaken by the undersigned (Schott and Abbe) in order to discover the chemicophysical foundations of the behaviour of optical glass." The inquiry was aided by large grants from the Prussian Minister of Education. The practical result is seen in the catalogue of the Jena firm and the enormous export of German optical goods.

Nor is this all, for in virtue of the distribution of profits settled by the scheme of the Carl Zeiss Stifting, drawn up by Abbe some years ago and ratified by the Bavarian Government, the University of Jena alone has received a sum approaching 100,000*l*. Abbe's work at Jena is perhaps the most striking illustration of the way in which progress depends on the cooperation of science and experience. One could give statistics to illustrate the truth of this and the important effect it has had on German trade and prosperity. They are hardly necessary; the facts are patent, and their cause well known to all who care to inquire. We can progress too if we follow the path laid down for us of old by Newton, Young, Herschel, Airy, and the others of whom I have spoken.

## Exhibition of Optical and Scientific Instruments.

The exhibition of optical and scientific instruments which is being held during the present week at the Northampton Institute, Clerkenwell, E.C., in connection with the optical convention, presents many features of interest, and all who have had any experience in the use of an optical instrument, from the wearing of a pair of spectacles to the handling of an accurate spectrometer, will find something to repay the trouble of a visit to Clerkenwell, still the centre of the optical industry. While the number of actual novelties offered is not, perhaps, very large, there are few classes of instruments unrepresented, and though the names of certain important firms are conspicuously absent from the list of exhibitors, the exhibition as a whole may be taken as well representative of the activities of the British manufacturers of optical and other scientific instruments.

In the main of an optical character, the scope of the exhibition has been extended to cover such other scientific instruments as are usually manufactured by optical instrument makers. Meteorological instruments and thermometers, mathematical and drawing instruments and calculating machines, and laboratory apparatus generally, are thus included. Electrical measuring instruments, however, are not shown. It is for many reasons to be regretted that the exhibition has been confined to the work of British makers; a foreign section would have had much interest for the ordinary visitor, and would have been of great educational value both to the British manufacturer and his competitors; we understand, however, that the limitation was dictated by considerations as to space, and the necessity of restricting the magnitude of a somewhat novel undertaking.

In the catalogue which has been prepared in connection with the exhibition, the convention committee is to be congratulated on having produced a volume which should be of considerable value as well to the user of scientific instruments as to the firms whose instruments are there described. The volume is not confined to apparatus actually exhibited; the aim has been to provide a convenient work of reference generally descriptive of the productions of British firms, and in which particulars as to the types offered by different makers of any special instrument may be readily found. To this end the instruments have been arranged in classes, which are in many cases further subdivided, and in addition to a table of contents, an alphabetical list of exhibitors, with general information as to their manufactures, and an index of instruments have been provided. A short introduction to each class furnishes some particulars as to the instruments included thereunder, with notes as to recent advances in the mode of construction.

In class i., tools and materials, the most interesting exhibit is that of Messrs. Chance Bros., which includes some varieties of optical glass only quite recently produced by the firm, and not previously shown. Some special opal glass of low coefficient of expansion for speculum discs is also exhibited. Messrs. Jas. Powell and Sons, of the Whitefriars Glass Works, show specimens of glass for thermometers and other purposes. Tools for lens grinding, and exhibits illustrating processes of manufacture, are shown by Messrs. Geo. Culver and other firms.

Class ii., simple elements and instruments, includes some accurate glass work by Messrs. A. Hilger, while Lord Blythswood shows specimens of his diffraction gratings ruled on speculum metal, 14,400 lines to the inch, up to a length of 6 inches. Replicas of Rowland gratings, with spectroscopes of various forms in which they are employed, are shown by Mr. T. Thorp, of Manchester.

Class iii., astronomical instruments, and class iv., nautical instruments, are by no means representative of the best English work, and it is to be regretted that the catalogue is here so meagre.

In class v., surveying instruments, on the other hand, few firms of importance are omitted, and some excellent work is shown. In particular may be mentioned the Wells theodolite of Messrs. Elliott Bros., which embodies several novel features; Messrs. Joseph Casartelli and Son, of Manchester, also show instruments of somewhat special pattern. Messrs. W. F. Stanley, J. J. Hicks, and E. R. Watts and Son are well represented. The chief characteristics of the more modern instruments are the use of larger and more powerful telescopes, and the increased accuracy of graduation.

Class vi. is devoted to range finders and heliographs, and the exhibits of most interest are the naval and field range finders of Messrs. Barr and Stroud, and the stereoscopic range finder of Prof. Geo. Forbes. Messrs. Ross, Ltd., show specimens of their new variable power gun sighting telescopes, in which by a simple device the power can be altered while the image remains always in focus on the cross wires.

Class vii. includes meteorological instruments and thermometers, and most of the well known makers have sent exhibits. In class viii., spectacles and eyeglasses, the exhibits are also sufficiently representative of the best English

work. An historical collection of no little interest is shown by Mr. M. W. Dunscombe, of Bristol.

In class ix., small telescopes and binoculars, are exhibited various patterns of prism binoculars by Messrs. Aitchison, Dallmeyer, Ross, Ltd., &c. Messrs. Aitchison show also a field glass of novel type with a body machined from a solid casting, focusing being effected by moving each object glass in its own tube.

In class x., microscopes and accessories, the catalogue furnishes a very complete account of the English microscope as produced by the best makers, including binocular microscopes and various forms of instrument for special purposes. Photomicrographic cameras are shown by Messrs. Beck, and Ross, Ltd. Information of interest with regard to different types of photographic lenses is given in class xi., though too much space is perhaps devoted in the catalogue to illustrations of camera bodies.

In the careful classification and selection of instruments to illustrate the various types, class xii., optical projection apparatus, appears to us to be the most successful in the catalogue. The class includes an exhibit by Messrs. Chance Bros. of a complete lighthouse optical apparatus of the fourth order. Other exhibits of interest are Mr. R. W. Paul's projector lamps, the triple rotating lantern of Messrs. Newton, and animatographs by Messrs. Paul, the Prestwich Manufacturing Co., and J. Wrench and Son.

In class xiii., apparatus for optical measurement, some new optical benches are shown by Messrs. Aitchison and Beck, and there are interesting exhibits from the Cambridge Scientific Instrument Co. and Messrs. Hilger. A half-shadow polarimeter is shown by Prof. Poynting, the half-shadow field being produced by the tilting of two glass plates forming a V between the polariser and analyser.

Under photometric apparatus the Ediswan Co. show specimens of Prof. Fleming's large bulb standard lamps, and various forms of photometer are exhibited by Messrs. Alex. Wright. Class xv. is devoted to ophthalmic apparatus, and includes a novel form of ophthalmoscope of British design and construction. The Cambridge Scientific Instrument Co. and Messrs. Griffin show laboratory apparatus under class xvi. Under class xvii., mathematical and drawing instruments, some new forms of slide rule are shown, including one with additional slides by Messrs. Davis, of Derby, and an optical slide rule with reciprocal division for determination of conjugate foci, &c., by Mr. A. Salomon, of Huddersfield. An arithmometer of English make is exhibited by Mr. S. Tate, and an adding machine by the Burroughs Adding Machine Co.

## *UNIVERSITY AND EDUCATIONAL INTELLIGENCE.*

CAMBRIDGE.—Among the twelve distinguished men who will receive honorary degrees on June 14 only two are connected with scientific work. These are Commander R. F. Scott, R.N., of the *Discovery*, and Colonel Sir Francis E. Younghusband, K.C.I.E. The latter has been appointed Rede lecturer, and has chosen as his subject "Our True Relationship with India." The lecture will be delivered in the Senate at 11.30 a.m. on Saturday, June 10.

Mr. L. A. Borradaile, of Selwyn College, who is well known for his researches on the crustacea, has been appointed assistant secretary for lectures to the local examinations and lecture syndicate.

A university lectureship in mathematics will shortly be vacant owing to the resignation of Mr. G. B. Mathews, F.R.S., of St. John's College.

The special board for biology and geology has nominated Mr. J. J. Lister, Fellow of St. John's College, to occupy the university table at the laboratory of the Marine Biological Association at Plymouth for one month during the present year.

In spite of the efforts of the master of Pembroke, Prof. Ridgway and others to bring the work of the studies and examination syndicate to an end, the Senate decided by 112 votes to 99 that its deliberations should be continued. It seems evident that a majority of residents is in favour of some change.

The syndicate entrusted with the building of the new medical schools has exceeded the sum granted by Grace of the Senate by 2571*l.* 15*s.* 6*d.* It is now asking for authority to pay this amount, and for 920*l.* for the completion and fitting of the Humphry Museum, and 380*l.* for extra fittings and furniture in the departments of surgery, midwifery, medicine, pharmacology, and pathology.

THE *Pioneer Mail* states that a grant of 10,000 rupees has been made to the Victoria Diamond Jubilee Technical Institute of Lahore for buildings and appliances. A permanent grant of 100 rupees a month has also been made, and the assistance thus given will enable the governors to complete the equipment for the teaching of practical and applied chemistry.

AT a meeting of the School Nature-Study Union held at the College of Preceptors on Friday, a paper was read on the training of teachers for nature-study by Miss R. Lulham. In it the necessity for a proper ground work was brought out, and during the discussion which followed a resolution was passed urging upon the London County Council the need of providing classes for those who have to teach nature-study, and suggesting that a wild garden for their benefit should be established in at least one of the London parks, in which the botanic gardens arranged for the students of systematic botany have already proved so useful.

WE have received the first number of the *University Review*, which is published by Messrs. Sherratt and Hughes at 6*d.* net. Dr. Bryce contributes an introductory note on the university movement, and among other articles dealing with many aspects of higher education may be mentioned one by Prof. Arthur Schuster, F.R.S., on "Universities and Examinations," and another by Sir Oliver Lodge, F.R.S., on "Questions for Discussion." Prof. Schuster formulates briefly what the aims of an ideal university should be, and proceeds to divide its work into two parts. These are the acquisition of knowledge and the power of applying it. The second part of the work of the university is the higher, and is what is required for success in life. Prof. Schuster says that it can be taught, and therefore should be taught, in the university, but that this power of applying knowledge cannot be tested satisfactorily by examination. He then considers exhaustively the function of examinations, and shows what they are capable of doing and the qualities they are incompetent to gauge. He concludes by remarking that when a student "has shown that he deserves a degree, it is right and proper that an opportunity shall be given him to develop his special powers and to distinguish himself." Prof. Schuster makes a proposal to secure this by giving a year which is absolutely at the student's disposal to be used under the guidance of his teachers as he thinks fit. Sir Oliver Lodge discusses the possibility of introducing a change in the "time of year when examinations should be held:—whether candidates should be examined directly lectures cease, and before Session ends; or whether they should be given time for revision and digestion, and perhaps oblivion, and be examined just before a new Session commences." The review also supplies full information of current events in British and foreign universities.

## *SOCIETIES AND ACADEMIES.*

LONDON.

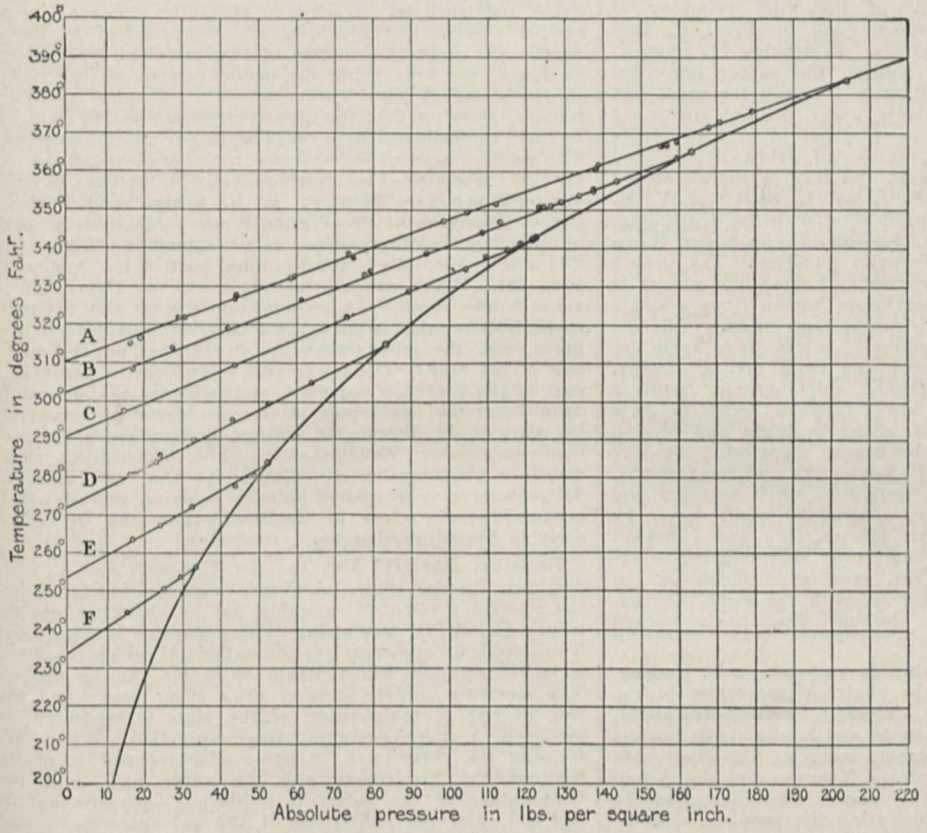
**Royal Society**, March 30.—"The Determination of the Specific Heat of Superheated Steam by Throttling and other Experiments." By A. H. **Peake.** Communicated by Prof. Ewing, F.R.S.

This paper is an account of original investigations undertaken to determine the specific heat of superheated steam. Two methods have been followed:—(1) the throttling or wire-drawing of steam to obtain the law connecting the variation of temperature with pressure, for constant total heat; (2) the direct heating of a current of steam by electrical means.

An account of an investigation on the same lines as method (1), by Mr. J. H. Grindley, was published in the *Philosophical Transactions of the Royal Society*, A, vol.

cxciv. pp. 1 to 36. The results here given differ from those obtained by Mr. Grindley in one important particular. Mr. Grindley came to the conclusion that steam taken from a separator contained a definite proportion of suspended moisture, because when he caused such steam to expand through an orifice to a slightly reduced pressure the steam did not become superheated, but its temperature fell to that corresponding to saturated steam at the new pressure. In the research here described, however, it was found that steam taken from a separator and reduced in pressure in the slightest degree by wire-drawing became superheated. This result was only obtained after a considerable amount of experimental work had been done, and a number of improvements made in the apparatus as first constructed.

The experimental results obtained in the throttling experiments are represented in the accompanying figure. The curves A, B, C, D, E, and F show the connection between the temperature and pressure of superheated steam for constant total heat. The method of obtaining




each of these curves was as follows:—The pressure of steam in the separator was maintained constant at the point where the constant total heat curve meets the curve which connects the pressure with temperature for saturated steam; the pressure on the low-pressure side of the orifice could be regulated by means of a wheel valve, which allowed the steam to escape at any desired rate. This lower pressure was adjusted to various values, and the temperatures corresponding were observed when the conditions had become steady. By plotting these results points were obtained which enabled the curve to be drawn.

The total heat corresponding to each of the curves was obtained from Regnault's tables for saturated steam, and the specific heat at constant pressure calculated for various pressures. The specific heat as thus calculated was found to increase rapidly with increase of temperature from 0·43 at 230° F. to 1·0 at 350° F. This apparent increase in the specific heat led the author to suspect the accuracy of Regnault's tables, and caused him to turn to the direct heating method, with the result that he is now convinced that Regnault's tables are not sufficiently accurate for the purposes of these calculations, and that a great degree of accuracy would be necessary before such was the case.

In method (2) the rise in temperature was observed in steam flowing at a measured rate, due to the heat imparted by an electric current, and the specific heat calculated from the formula

$$K_p = \frac{\text{electrical input in watts} \times 0{\cdot}236}{\text{grams of steam passing per sec.} \times \text{temp. rise } ^\circ \text{C.}}$$

The connection between grams of steam passing per minute and the input of electrical energy in watts for a definite rise in temperature was obtained for rates of flow differing over a considerable range; the points thus obtained were plotted on squared paper, and were found to lie on a straight line which did not pass through the origin, but cut the watts ordinate at a height corresponding to the radiation loss expressed in watts.

The difficulty experienced in keeping all the conditions constant during the long time necessary for a complete set of points was always considerable. Numerous experiments were carried out, but the results varied too much amongst themselves to enable conclusions to be drawn as to the manner in which the specific heat may vary with pressure or temperature, except that any such variation must be small, and by no means of the order indicated by the results of the throttling experiments based on Regnault's tables.

The mean value of the specific heat of superheated steam at constant pressure obtained from the most satisfactory experiments was 0·46.

May 11.—"A Study of the Process of Nitrification with Reference to the Purification of Sewage." By Dr. Harriette **Chick.** Communicated by Prof. Marshall Ward, F.R.S.

The process of nitrification during sewage purification was studied by means of small experimental filters erected in the institutes of hygiene in Vienna and Munich.

The oxidation of sewage passing through the filters was investigated during the maturing period, and also when the filters were mature, a special study being made, chemically, of the oxidation of the nitrogen from the ammoniacal form to that of nitrites and nitrates, and of the distribution of these processes both in time and space.

Nitrification was traced to the activity of two sets of organisms, the first of which oxidised ammonia to nitrous acid, and the second completed the oxidation to nitric acid. These bacteria were found to differ only very slightly from those isolated from the soil by Winogradsky, thus confirming the recent results of Schultz-Schultzenstein. The activity in sewage filters of these organisms, which are very sensitive to the presence of organic matter, requires explanation, and various explanations are considered, based upon experimental foundation.

The theory of previous physical absorption of ammonia upon the surface of the filtering material and subsequent nitrification was found to be unsupported by experiment; nitrification is rather to be considered as a very rapid biological process, requiring only the time taken by the sewage to trickle through the filter.

**Linnean Society**, May 4.—Prof. W. A. Herdman, F.R.S., president, in the chair.—The botany of Gough Island, part i., phanerogams and ferns: R. N. **Rudmose-Brown.** Gough Island, or Diego Alvarez, lies in the mid South Atlantic, lat. 40° 20′ S., long. 9° 56′ 30″ W., and may be regarded as the most outlying member of the Tristan da Cunha group, a small island between seven and eight miles long, and half as wide, rising to a height of 4000 feet. It has been occasionally visited, but never permanently inhabited. The chief features of the vegetation are the tree *Phylica nitida* and the tree-fern *Lomaria Boryana*. Four of the seventeen species of phanerogams are almost certainly introduced, while two are new to science, a species of Cotula and an Asplenium. The Scottish Antarctic Expedition lay off the island for three days in April, 1904, but owing to high sea landing was only practicable on one day, when the materials for the present paper were collected.—The study of vegetation: its present condition and probable development: Prof. A. G. **Tansley.** The word œcology, introduced by Prof. Haeckel, means the study of the vital relations of organisms to their environment, and by Prof. E. Ray Lankester was termed bionomics. Restricting his remarks to a special branch of the subject, the author proceeded to consider the plant-association as the unit, the great fact being the association of plants under definite conditions of environment. Instances were given of sets of plants found in meadows, woods, cultivated fields, moors, and dunes.—Schizopoda captured in the Bay of Biscay during a cruise of H.M.S. *Research*: E. W. L. **Holt** and W. M. **Tattersall,** with an appendix dealing with the distribution statistically by Dr. G. H. **Fowler.** The paper forms part v. of the series on Biscayan plankton. Ten genera and eleven species were described; of these one species is new to science, and one, previously known from a single example, is represented by eight specimens. All the commoner forms are epiplanktonic, but of these some are represented by scattered specimens from greater depths. *Euphausia pellucida,* essentially epiplanktonic, with a centre of distribution about 50–75 fathoms, seems to show a marked vertical oscillation, rising by night and sinking by day; it was plentiful in bright moonlight; by day scattered specimens occurred between 250 and 100 fathoms. *Meganyctiphanes norvegica,* caught in small numbers and on few occasions, was only captured by night, never by day at any depth whatsoever. Messrs. Holt and Tattersall suggest that this species is sufficiently sharp-sighted to see and avoid a net by daylight, even at a depth of 100 fathoms. *Nematoscelis megalops,* with the same distribution as *Euphausia pellucida,* showed a less clearly marked oscillation.

**Anthropological Institute**, May 9.—Dr. A. C. Haddon, F.R.S., vice-president, in the chair.—Some tribes of the Uganda Protectorate: Lieut.-Colonel C. **Delmé-Radcliffe.** The author described the customs and habits of the natives with whom he came in contact, including the Kavirondo and other tribes on the Victoria Nyanza, and the Acholi in the Nile Province. The paper was illustrated by numerous lantern slides, illustrating the peoples, animals, and scenery, and by a large and interesting collection of ethnographical specimens from the Protectorate.

**Challenger Society**, May 10.—Prof. d'A. W. Thompson, C.B., in the chair.—A new species of Tuscarusa from the North Atlantic: Dr. **Wolfenden.**—Observations on the temperature and salinity of the water of the North Atlantic, made during two cruises of Dr. Wolfenden's yacht *Silver Belle* during the summers of 1903 and 1904: Dr. H. N. **Dickson.** In 1900–2 much valuable work had been done by Dr. Wolfenden in the Færöe Channel, but as this area lay within the field of the International Council for the Study of the Sea, he worked in 1903 farther out in the Atlantic, to the west of Ireland, and at the entrance to the Færöe Channel south of the Wyville-Thomson Ridge, the observations connecting directly with those of the International Council in the Channel itself and in the Norwegian Sea during the August cruises. The work in 1904 was more directly concerned with the general oceanic movements of Atlantic waters; a line of soundings was run from the south-west of Ireland to the Azores, thence into the Mediterranean through the Straits of Gibraltar, and thence to the English Channel. Dr. Dickson illustrated the observations by diagrams of temperature and salinity along the sections, and discussed the considerable light thrown on the behaviour of the easterly drift on reaching the shores of Europe, the exchange of waters between the Atlantic and the Mediterranean, the volume of current in the straits, and the extension in the Atlantic of Mediterranean water of high temperature and salinity.

**Geological Society**, May 10.—Mr. R. S. Herries, vice-president, in the chair.—The geology of Dunedin (New Zealand): Dr. P. **Marshall.** A detailed account of the petrography of the district was given. The age of the oldest rocks seen, mica-schists, is not definitely known. They are followed by Tertiary sandstones and limestones. Fine, plant-bearing shales succeed unconformably, and upon these, again, rests a light scoria-bed. The igneous rocks next described cover them. These rocks include an ill-exposed, gold-bearing syenite, a diorite, lavas, rhomb-porphyry, tinguaite, hypabyssal trachydolerite, a teschenite-dyke, and trachyte. Trachytoid phonolites occur as interbedded sheets. The andesites are characterised by hornblende and augite. Dolerites of two principal types occur in dykes, one type being the commonest of all the rocks in the area. A considerable series of chemical analyses follows, showing that the silica-percentage varies from 66 in the Portobello trachyte to 44·84 in one of the dolerites. The relative ages of the volcanic rocks are worked out so far as possible.—The Carboniferous limestone of the Weston-super-Mare district: T. F. **Sibly.** The Carboniferous limestone of the Weston-Worle ridge includes part of the Syringothyris-zone (C), extending from the "laminosa-dolomites" upwards, and part of the Seminula-zone (S). While the dip of the rocks of the ridge is towards the south, a reversed fault throws the Syringothyris-beds on the south against the Seminula-beds to the north, and the latter rocks are over-folded on the north side of the fault. The lower part resembles the equivalent part of the Clevedon sequence, and indicates shallow-water conditions; the upper part of C resembles the corresponding part of the Burrington section, and indicates the predominance of a Mendip-facies. The Woodspring ridge shows a sequence exactly similar to that of Clevedon. There were two periods of volcanic activity, one of which occurred at the close of Zaphrentis-time and the other early in Syringothyris-time.

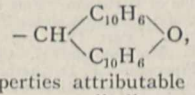
**Physical Society**, May 12.—Dr. C. Chree, F.R.S., vice-president, in the chair.—A simple method of determining the radiation constant, suitable for a laboratory experiment: Dr. A. D. **Denning.** The apparatus consists of a hemispherical copper cap to the outside of which is affixed a jacket through which steam or water can be passed. The receiving surface consists of a silver plate, and the rate of rise of temperature of the plate is measured by means of a silver-constantan thermo-junction. When performing the experiment, a non-conducting pad is placed between the hemisphere and the silver disc until the temperature of the jacket is uniform. Then the pad is slid out, and the deflections of the galvanometer in the thermo-junction circuit are noted every few seconds. By plotting these deflections on a curve the initial slope of the curve, *i.e.* the initial rate of rise of temperature of the silver disc, is obtained; and from this, knowing the constants of the disc, &c., the radiation constant can be calculated.—A bolometer for the absolute measurement of radiation: Prof. H. L. **Callendar.** It is now generally agreed that the electric compensation method, in which the heat received by radiation on a metallic strip is determined by measuring the electric current required to produce the same rise of temperature in the strip, is the most satisfactory and accurate method for absolute measurement. In the practical application of the bolometric method for the absolute measurements of solar radiation, the author has introduced certain modifications suggested by experience in platinum thermometry, with the object of securing (1) temperature compensation, so that the zero remains constant in spite of changes in the surrounding temperature; (2) conduction compensation, so that loss of heat by conduction at the ends of the strips may not affect the readings; (3) accurate measurement of the area of radiation absorbed. Comparisons have been made between

the bolometer, in which the platinum strips are directly exposed to radiation, and one of the author's ordinary sunshine receivers enclosed in a glass bulb, in order to determine the effect, if any, of the glass bulb in selective absorption. The values of the reduction constant obtained for the glass receiver showed no certain variation over a wide range of quality of radiation, from sunshine or arc-light down to a dull red heat. This result is probably to be attributed to a self-compensating action of the glass bulb, which radiates to the enclosed coils precisely those rays which it absorbs.—Results of experiments carried out at Crompton's works at Chelmsford, by Mr. C. H. Wright, on the possibility of using the resistance of a conductor heated by an alternating electric current as a measure of the current: W. H. **Price.**

**Zoological Society**, May 16.—Mr. G. A. Boulenger, F.R.S., vice-president, in the chair.—Examples of a new golden mole obtained in connection with Mr. C. D. Rudd's exploration of South Africa: O. **Thomas.** It is proposed to call the mole *Amblysomus corriae*, sp. n.—Microscopic slides of *Lankesterella tritonis*, a hæmogregarine parasitic in the blood-corpuscles of a newt, *Triton cristatus*: H. B. **Fantham.** This parasite was recently found by Mr. A. S. Hirst and the exhibitor, and their observations had since been independently confirmed by Dr. A. C. Stevenson.—A contribution to the knowledge of the encephalic arterial system in Sauropsida: F. E. **Beddard.**—Criticisms of the Hon. Walter Rothschild's proposed classification of the anthropoid apes: Sir H. H. **Johnston.** The author was disposed to agree with Mr. Rothschild's classification of the African apes, but suggested that the proper transcription of the native name for the bald chimpanzee should be *nkulunkamba* instead of (as Du Chaillu wrote it) *kooloo-kamba*. He, however, could not agree with Mr. Rothschild's proposed change of the generic name of the orang from Simia to Pongo, and although considering him right in applying the former name, at present used for the orang, to the chimpanzees, he was of opinion that either Satyrus or Pithecus was a far preferable name to Pongo for the orang. He concluded the paper with a list of words used in several African languages for the name of the chimpanzee, and with a *précis* of the history of European knowledge of the anthropoid apes down to the eighteenth century.—Some species of bats of the genus Rhinolophus: K. **Andersen.** The author showed the progressive evolution from the Austro-Malayan *R. simplex* (allied to *megaphyllus*), through a long series of Oriental forms, to the W. Palæarctic *R. ferrum-equinum*, and a similar chain from the Oriental *R. lepidus* (allied to *minor*) to the W. Palæarctic *R. blasii* and *R. euryale*. *R. hipposiderus* was traced back to the Oriental *R. minor*. A slight difference between the British colony of *R. hipposiderus* and the central European form of the same species was pointed out. All the Ethiopian species of Rhinolophus were shown to be of Oriental origin.—Results of observations on the stridulating-organs and descriptions of five new species (two of which were referred to new genera) of the hemipterous family Halyinæ: Dr. E. **Bergroth.**—On the anatomy of limicoline birds, with special reference to the correlation of modifications: Dr. P. C. **Mitchell.** The paper dealt with the anatomy, chiefly muscular, of Charadriidæ, Chionididæ, Glareolidæ, Thinocoridæ, Œdicnemidæ, and Parridæ.—Results of observations made upon a female specimen of the Hainan gibbon (*Hylobates hainanus*), now living in the society's gardens: R. I. **Pocock.**

PARIS.

**Academy of Sciences**, May 22.—M. Troost in the chair.—New experiments in experimental parthenogenesis in Asterias: Yves **Delage.** Additional proof is given of the fact that it is not an increase in the osmotic pressure alone which determines parthenogenesis, several of the reagents employed, manganese chloride, sodium phosphate, &c., acting as well, if not better, when the total concentration of the mixture is lower than that of sea water. Attention is directed to the marked action of solutions of manganese chloride, a salt which is not present in sea water.—Magnetic hysteresis produced by an oscillating field superposed on a constant field. Comparison between theory and experiment: P. **Duhem.** The author compares the results obtained by him in a theoretical study recently published with some experimental results of M. Maurain, and shows that his theoretical conclusions are completely confirmed.—On the voyage of the *Princesse Alice*: the **Prince of Monaco.** A sketch is given of the work attempted in oceanography, bacteriology, chemical biology, zoology, and the meteorological exploration of the upper atmosphere by means of kites.—On a condition of convergence of Fourier's series: Henri **Lebesgue.**—On minimal curves: E. **Vessiot.**—On the compressibility of different gases below atmospheric pressure and the determination of their molecular weights: Adrien **Jaquerod** and Otto **Scheuer.** The compressibility of several gases has been measured at 0° C. for pressures between 400 mm. and 800 mm. of mercury, and for ammonia and sulphur dioxide for pressures between 200 mm. and 400 mm. From the measurements the coefficient of deviation from Boyle's law has been determined, and this has been applied to the formula of D. Berthelot for the limiting density of gases and the estimation of their molecular weight. The molecular weights calculated agree with those obtained by the best analytical methods with the exception of nitrogen compounds, for which an atomic weight of 14·01 must be assumed.—The atomic weight of nitrogen deduced from the ratio of the densities of nitrogen and oxygen: Philippe A. **Guye.** From a consideration of the whole of the experimental data available, the mean value N = 14·009 must be regarded as the most probable value for the atomic weight.—On the fusibility of the mixtures of antimony sulphide formed with cuprous sulphide and mercuric sulphide: H. **Pélabon.**—The equilibrium between acetone and hydroxylamine hydrochloride: Philippe **Landrieu.** This equilibrium has been previously studied by means of the acid set free during the reaction, but owing to the rapidity with which the equilibrium is displaced this method is not trustworthy. In the present paper the reaction is followed by calorimetric studies.—Physicochemical researches on hæmolysis: Mlle. P. **Cernovodeanu** and Victor **Henri.**—The action of the metal ammoniums on the polyatomic alcohols: E. **Chablay.** The alcohol is dissolved in liquid ammonia and is then acted on by the solution of the alkali metal, sodium or potassium, also dissolved in ammonia, and the result of the reaction washed several times with liquid ammonia at −40° C. In this way one of the hydroxylic hydrogen atoms of the alcohol is replaced by potassium (or sodium), the alcohols studied being mannite, erythrite, and glycerol.—On benzhydroxamic and dibenzhydroxamic acids: R. **Marquis.**—A new method of preparing mesoxalic esters: their condensation with cyanacetic esters: Ch. **Schmitt.** The corresponding malonic esters are treated with nitrous fumes, descriptions being given of the preparation of the methyl and ethyl esters. These condense with cyanacetic esters in the presence of piperidine, one or two molecules of the cyanacetate entering into the reaction according to the experimental conditions.—The basicity of pyranic oxygen. Double halogen salts of some metals and dinaphthopyryl: R. **Fosse** and L. **Lesage.** The group dinaphthopyryl,



possesses basic properties attributable to tetrabasic oxygen strikingly analogous to an alkaline metal, and the present communication gives details of the preparation of several double salts of this radical.—On some circumstances influencing the physical state of starch: J. **Wolff** and A. **Fernbach.**—Researches on animal lactase: Ch. **Porcher.** It is shown that ether saturated with water is capable of extracting from the intestines of certain animals considerable quantities of lactase.—Contribution to the study of histological staining substances: G. **Halphen** and André **Riche.** The albuminoid substances in animal tissues preserved in formol solutions are profoundly altered, and the methods of staining to be employed require considerable modifications.—On some minerals of Djebel-Ressas (Tunis): L. **Jecker.**—Variation in the histological characters of leaves in the galls of *Juniperus Oxycedrus* from the Midi and Algeria: C. **Houard.**—On the biology of *Melampyrum pratense*: L. **Gautier.**—On the transformations of the nitrogenous materials in seeds in the course of maturation: G. **André.**—Observations on the fibrous intersections of

the polygastric muscles: J. **Chaine.**—The respiratory curve in the newly-born: L. **Vallois** and C. **Fleig.**—On the food value of different kinds of bread: Pierre **Fauvel.**

CALCUTTA.

**Asiatic Society of Bengal,** May 3.—Contributions to Oriental herpetology, iii., notes on the Oriental lizards in the Indian Museum (part ii.), Lacertidæ, Scincidæ, and Dibamidæ: Dr. N. **Annandale.** Three new Indian skinks are described, and four imperfectly diagnosed species re-described, while one, *Lygosoma pulchellum*, is added to the fauna of Burma. Notes on other examples of the family and of the Lacertidæ are given, based on the late Dr. J. Anderson's collection from N.W. Asia and the late Prof. J. Wood-Mason's from Sinkip Island and Malaya, as well as the extensive Indian, Burmese, and Persian collections in the museum. A revised list of the species recorded from India, Burma, and Ceylon is appended, with their distribution within these limits.—Materials for a flora of the Malayan Peninsula, No. 16: Sir G. **King** and J. S. **Gamble.** The present contribution to these materials contains the account of the genus Psychotria required to conclude the joint account by the authors of the natural order Rubiaceæ commenced in part xiv. and continued in part xv. of this series. This account of Psychotria comprises descriptions of 26 completely represented and 3 imperfectly known species; of these, 11 species are new to science. In addition, this fasciculus contains accounts, for which the authors are jointly responsible, of several natural orders.

## DIARY OF SOCIETIES.

*THURSDAY*, JUNE 1.

ROYAL INSTITUTION, at 5.—Electro-magnetic Waves: Prof. J. A. Fleming, F.R.S.

INSTITUTION OF MINING ENGINEERS (in the Rooms of the Geological Society), at 11 A.M.—The Firing of Babcock Boilers with Coke-oven Gases: T. Y. Greener.—Compound Winding-engine at Lumpsey Mine: M. R. Kirby.—Note Supplementary to a Paper on the Electric Driving of Winding-gears: F. Hird.—Electric Winding engines at the Exhibition of the North of France, Arras, Pas-de-Calais: Ed. Lozé.—The Education of Mining Engineers in the United States: Prof. Howard Eckfeldt.—An Outline of Mining Education in New Zealand: Prof. James Park.—Goaf-blasts in Mines in the Giridih Coal-field, Bengal, India: Thomas Adamson.

LINNEAN SOCIETY, at 8.

CHEMICAL SOCIETY, at 8.—(1) The Constituents of the Seeds of *Hydnocarpus Wightiana* and *Hydnocarpus Anthelmintica*. Isolation of a Homologue of Chaulmoogric Acid.—(2) The Constituents of the Seeds of *Gynocardia Odorata*: F. B. Power and M. Barrowcliff.—The Relation of Ammonium to the Alkali Metals. A Study of Ammonium Magnesium and Ammonium Zinc Sulphates and Selenates: A. E. H. Tutton.—Camphorylazoimide: M. O. Forster and H. E. Fierz.—Influence of Substitution on the Formation of Diazoamines and Aminoazo-compounds. Part III. Azo-derivatives of the Symmetrically Disubstituted Primary Metadiamines: G. T. Morgan and W. O. Wootton.—Diazo-derivatives of Mono-acylated Aromatic Para-diamines: G. T. Morgan and Miss F. M. G. Micklethwait.—The Significance of Optical Properties as Connoting Structure; Camphorquinone-hydrazones-oximes; a Contribution to the Chemistry of Nitrogen: H. E. Armstrong and W. Robertson.—Solubility as a Measure of the Change undergone by Isodynamic Hydrazones. (1) Camphorquinonephenylhydrazone. (2) Acetaldehydephenylhydrazone: W. Robertson.—The Design of Gas-regulators for Thermostats: T. M. Lowry.—The Constitution of Barbaloin. Part I.: H. A. D. Jowett and C. E. Potter.—Influence of Substitution on the Formation of Diazoamines and Aminoazo-compounds. Part IV. 5-Bromo-*as*(4)-dimethyl-2: 4-diamine-toluene: G. T. Morgan and A. Clayton.—The Action of Hypobromous Acid on Piperazine: F. D. Chattaway and W. H. Lewis.—The Action of Magnesium Methyl Iodide on Pinene Nitrosochloride: W. A. Tilden and J. A. Stokes.—Racemisation Phenomena during the Hydrolysis of Optically Active Menthyl and Bromyl Esters by Alkali: A. McKenzie, and H. B. Thompson.

RÖNTGEN SOCIETY, at 8.15.—The Röntgen Congress in Berlin: Dr. W. Deane Butcher.

*FRIDAY*, JUNE 2.

INSTITUTION OF MINING ENGINEERS (in the Rooms of the Geological Society), at 10.30 A.M.—The Conveyor-system for filling at the Coal-face, as practised in Great Britain and America: W. C. Blackett and R. G. Ware.—Underground Fires at the Greta Colliery, New South Wales: J. Jeffries.—The Geology of Chunies Poort, Transvaal: A. R. Sawyer.—Underground Horses at an Indian Colliery: T. Adamson.—Description of the Eimbeck Duplex Base-line Bar: W. Eimbeck.

GEOLOGISTS' ASSOCIATION, at 8.—Note on a Piece of Mosasaurian Jaw obtained by G. E. Dibley from the Chalk of Cuxton, Kent: Dr. A. Smith Woodward.—The Chalk Area of North-east Surrey: G. W. Young.

*SATURDAY*, JUNE 3.

ROYAL INSTITUTION, at 3.—Exploration in the Philippines: A. H. Savage Landor.

*MONDAY*, JUNE 5.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Exploring Journeys in Asia Minor: Colonel P. H. H. Massy.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Manufacture and Use of Art Papers: R. W. Sindall.—The Influence of Gelatine Sizing on the Strength of Paper: C. Beadle and H. P. Stevens.

INSTITUTE OF ACTUARIES, at 5.—Annual General Meeting.

*TUESDAY*, JUNE 6.

ZOOLOGICAL SOCIETY, at 8.30.—Notes on the Natural History of Western Uganda: Colonel C. Delmé-Radcliffe.—Descriptions of New Species of Œdionychis and Allied Genera: M. Jacoby.—On the Intestinal Tract of Mammals: Dr. P. C. Mitchell.

*WEDNESDAY*, JUNE 7.

ENTOMOLOGICAL SOCIETY, at 8.—New African Lasiocampidæ: Prof. C. Aurivillius.—Rhynchota collected by Dr. A. H. Willey at Birara and Lifu: G. W. Kirkaldy, with an introduction by Dr. David Sharp.

GEOLOGICAL SOCIETY, at 8.—The Microscopic Structure of Minerals forming Serpentine, and their Relation to its History: Prof. T. G. Bonney and Miss C. A. Raisin.—The Tarus of the Canton Ticino: Prof. E. J. Garwood.

VICTORIA INSTITUTE, at 4.—Annual Meeting. The Earl of Halsbury will take the chair.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Separation of Strychnine and Brucine: D. L. Howard.—Ammonium Oxalate, its Formula and Stability: P. V. Dupré.—(1) Notes on some Abnormal Milks from Cleveland and South-east Durham; (2) A Simple and Convenient Camera for Photomicrographic Work: A. C. Wilson.—The Composition and Analysis of Milk: H. D. Richmond.

*THURSDAY*, JUNE 8.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: (1) On the Thermoelectric Junction as a Means of Determining the Lowest Temperatures; (2) Studies with the Liquid Hydrogen and Air Calorimeters: Sir James Dewar, F.R.S.—Colours in Metal Glasses, and in Metallic Films and Metallic Solutions: J. C. M. Garnett.—Correction to Dr. H. A. Wilson's Memoir "On the Electric Effect of Rotating a Dielectric in a Magnetic Field": S. J. Barnett.—On the Application of Statistical Mechanics to the General Dynamics of Matter and Ether. The General Method of Statistical Mechanics: J. H. Jeans.—On the Magnetic Qualities of some Alloys not containing Iron: Prof. J. A. Fleming, F.R.S., and R. A. Hadfield.—On the Phosphorescent Spectrum of Sδ and Europium: Sir William Crookes, F.R.S.—On the Perturbations of the Bielid Meteors: Dr. A. M. W. Downing, F.R.S.—The Pharmacology of Indaconitine and Bikhaconitine: Prof. J. T. Cash, F.R.S., and Prof. W. R. Dunstan, F.R.S.—And other papers.

ROYAL INSTITUTION, at 5.—Electromagnetic Waves: Prof. J. A. Fleming, F.R.S.

MATHEMATICAL SOCIETY, at 5.30.—On a Class of Many-valued Functions Defined by a Definite Integral: G. H. Hardy.

*FRIDAY*, JUNE 9.

ROYAL INSTITUTION, at 9.—Submarine Navigation: Sir William White, K.C.B., F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 5.

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