THURSDAY, MARCH 30, 1905.

THE CLASSIFICATION OF THE SCIENCES.

Philosophy as Scientia Scientiarum and a History of Classifications of the Sciences. By Robert Flint, D.D., LL.D., F.R.S.E. Pp. x+340. (Edinburgh and London: William Blackwood and Sons, 1904.) Price 10*s*. 6*d*. net.

THE relation of science to philosophy is, in theory, filial. It is, perhaps, no contradiction of the filial relationship that in practice it has an unfortunate tendency to run to mutual recrimination. The man of science too often ignores the philosopher, or despises him as an obscurantist who habitually confounds abstraction with generalisation. To the metaphysical philosopher, on the other hand, the typical specialist in science is a variety of day-labourer, dulled by the drudgery of occupational routine. Amidst such conjugal plain-speaking on both sides, it is no wonder that we hear much of what is called the divorce of philosophy and science; and yet there are many problems which for their adequate treatment surely require the combined resources of both science and philosophy. Is not the problem of the classification of the sciences one of these? Yet the comparative isolation of the scientific and philosophic approaches to this subject is a conspicuous fact, well attested by some recent instances. One of the most eminent of European men of science quite recently brought forward, as an original contribution, a scheme of classification which the philosophical critics at once detected as almost identical with that of Auguste Comte. Another very eminent man of science not long ago published a critical survey of some of the best known schemes of classification. His criticsm of Comte's scheme was apparently based upon an allusion in the practical treatise (the "Positive Polity"), the critic himself being presumably in ignorance that Comte's treatment of the subject can only be adequately studied in the "Positive Philosophy," where indeed the general theory of science is so elaborately worked out as to extend over several volumes.

Then again, there is that stupendous work, the "International Catalogue of Scientific Literature," itself a classification of the (natural) sciences in being. For the taxonomic preparations antecedent to this, the Royal Society was mainly responsible. It would be interesting to know if the Royal Society, in preparing its scheme, consulted either the Aristotelian Society (as the leading corporate representative of philosophy in England), or any individual philosopher, known, like Herbert Spencer, to have made a special study of the classification of the sciences. Had a precedent been wanting for the explicit and formal cooperation of science and philosophy, a not unworthy one might have been cited in the collaboration of Whewell, sought and obtained by Lyell, for the classification and nomenclature of Tertiary geological strata.

Prof. Flint's new book should serve as a mediating influence between philosophical and scientific interests. It brings together into one convenient source the leading attempts made, from Plato to Karl Pearson, towards a classification of the sciences. This, it seems, is the first time in the history of the subject that an exhaustive endeavour has been made to collect these data. How invaluable a service Prof. Flint has thus rendered to future investigators, can be appreciated only by those who have tediously toiled at the scattered literature of this subject. Its bibliography appears hitherto to have been left unorganised —having escaped even the ubiquitous zeal of German scholarship. As a special study, the classification of the sciences has been singularly little cultivated in Germany, though Wundt went too far when, first taking up the subject himself, about a generation ago, he declared that German sources were nil.

In point of purely taxonomic requirement, the first questions evoked by the problem of classification of the sciences are:—(1) What order of phenomena is it that falls to be classified? (2) Which (if any) amongst existing sciences deal with this particular order of phenomena? Can we, without leaving the assured ground of scientific method, adequately determine the first of these two questions? Does science itself yield criteria for determining its own order of phenomena? Science, to be sure, when self-contemplative, is more often in a postprandial mood than in a critical one. But when the man of science, in a metaphysical moment, does critically turn his eye inwards, and surveys the whole scientific domain, does he not see a manifold complexity of very partially analysed phenomena? Truth to tell, the evolution of science itself—*i.e.* its rationalised history and its methodology—considered as a department of scientific research, is one that has scarcely begun to be cultivated. It would be interesting, incidentally, to inquire whether the establishment of a chair of the "History of Science" in the Collège de France (due to positivist advocacy) has been followed by any similar initiative elsewhere; while as to methodology, what chance would even the most eminent amongst men of science have as a candidate for a chair of logic?

The few great men of science who have contributed to these departments of study have done so as philosophers rather than as men of science. Personal and individual views on the history and the methods of science—views of the first value and significance —have time and again been emitted, but there has scarcely yet been initiated in this field, that system of cooperative, impersonal, detached research which ensures continuity and consensus—the essential criteria of science. Not far short of a hundred systems of classification come within Prof. Flint's survey. The great majority of these have been put forward explicitly in the name of philosophy. Perhaps less than a dozen may be counted as having issued from professed men of science; and of these, each is, like the philosophical schemes, a personal and individual production, generated in comparative isolation from other similar endeavours. Hence it is, that while there is no generally recognised system of arranging the sciences in any rational order, there is a whole series of competing pseudo-classifications, each characterised by the particular qualities and defects of its individual originator. One of the unfortunate results, is that the problem itself has fallen into some disrepute. Prof. Flint's book will help substantially to rescue the problem both from neglect and obloquy.

With existing resources, what tentative lines of orderly development may be discerned in the evolution of science which may help towards this preliminary problem of classification? Looking at the sciences collectively, and their field of investigation as a whole, we may without transcending scientific limits take several standpoints in turn. These may be held to include the following:—

(1) Science, collectively considered as a body of knowledge, differentiated from other bodies of knowledge (*e.g.* common knowledge on the one side and philosophy on the other) by its more systematic character, its greater quantitative precision, its more fully and explicitly known sources of origin and methods of growth, the more certain verifiability of its generalisations, the greater exactitude of its forecasts. Here, from this standpoint, science appears as a system of symbolism, a methodised scheme of notation, an organisation of interdependent formulæ—in short, a well-made language, as Condillac said.

(2) Science considered as a psychological process—*i.e.* as a power or faculty which, under certain definable conditions of heredity, training, and environment, the individual mind may acquire and utilise in the course of its normal growth. Here, from this standpoint, science appears as an artificial Psychic Organ, a portable illuminant like the miner's lamp, a racial eye adjustable to the individual brain—an eye that discerns the obscurities of the present, penetrates the past, and reveals the future. In short, science is here a rational development of instinct, by means of which the individual may be educated to possess himself more fully of the accumulated social heritage; and, in turn, more fully contribute to it, from his personal experience—the individual being here postulated as unique.

(3) Science considered as a social process, *i.e.* as a growth of racial experience, accumulated by an infinitude of contributions from cooperating individuals and generations in endless succession. It is a social process differing in its development from parallel growths of racial experience, chiefly in being more capable of consciously directed control and guidance, and therefore able to yield more verifiable ideals. Here, from this third point of view, science appears as a Social Institution, aiming at the organisation of communitary experience by a collective process in which the intervention of any given individual is a negligible quantity. The personality of the individual man of science is here to be observed as a social fact of a definitive order, and interpreted as itself the product of past and contemporary social evolution. The individual is here postulated, not as unique, but as a type. The existing body of men of science make up, at any given moment, the temporary and evanescent personnel of one amongst abiding social institutions. They constitute one of a number of competing and cooperating social groups, composed of types of personality which are material for observation and study, like any other commensurable objects of natural history. And in this observational study of types of scientific personality would, of course, be included the corresponding study of their mental products—*i.e.* their contributions to science.

Here, then, are three aspects of science, under which it may approach the problem of its own structures and functions, its own history and ideals. The first approach is that of the nascent science of methodology (inheriting the philosophical traditions of logic and epistemology); the second is that of the well-established science of psychology; and the third, that of the nascent science of sociology (inheriting the traditions of philosophy of history and social philosophy). As each of these three sciences develops, it must, in pursuit of the first of scientific ideals—that of an over-evolving order—work out an increasingly natural classification of the phenomena with which it deals. The whole field of science would be surveyed from each of these points of view, and it would follow that in course of time there must emerge several classificatory schemes, each with a scientific status and validity of its own. But, given these several taxonomic systems—logical, psychological, sociological, and perhaps also æsthetic and ethical—there would, of course, remain the problem of their unification. Here surely would be scope for the activities of the philosopher; and yet the man of science would presumably decline to delegate that supreme taxonomic survey of his own domain. As sociologist, he may even propose a scientific survey of the philosophical field! For are not systems of philosophy themselves to be observed and classified as sociological facts, and interpreted as products and factors in social evolution?

What, then, is the right division of labour between science and philosophy? Is it not expressed in the simple and homely ideal—every man of science his own philosopher? Does not the existing fashion of exclusive devotion, either to speculation or to observation, tend to a multiplication of individuals who are neither philosophers nor men of science, but degenerate variants known to American psychologists as respectively "lumpers" and "splitters"? Is it not an alternation of speculation and observation, of the philosophical and the scientific mood, that most prolongs and intensifies each of these two complementary phases of mental activity? That surely is the lesson to be learned from the lives of the great initiators in science—of Faraday and Darwin, of Virchow and Helmholtz, of Bichat and Claude Bernard. The ordinary working man of science is ready enough, like Claude Bernard, to put off his imagination with his coat when he enters the laboratory. Only let him remember, like Claude Bernard, to put it on again when he leaves, for without it he cannot cultivate philosophy.

ELEMENTARY MATHEMATICS.

(1) *Elementary Pure Geometry, with Mensuration.* By E. Buddon, M.A., B.Sc. Pp. viii+284. (London and Edinburgh: W. and R. Chambers, Ltd., 1904.) Price 3*s*.

(2) *Lessons in Experimental and Practical Geometry.* By H. S. Hall, M.A., and F. H. Stevens, M.A. Pp. viii+94+iii. (London: Macmillan and Co., Ltd., 1905.) Price 1*s*. 6*d*.

(3) *The Elements of Geometry, Theoretical and Practical.* By B. Arnett, M.A. Books i., ii., and iii. Pp. viii+195, viii+238, and viii+242. (London: Simpkin, Marshall, Hamilton, Kent and Co., Ltd., 1904.) Price 2*s*. each volume.

(4) *The Elements of Trigonometry.* By S. L. Loney, M.A. Pp. xii+339+xiv. (Cambridge: The University Press, 1904; London: Macmillan and Co., Ltd., 1904.) Price 3*s*. 6*d*.

(5) *Elementary Algebra, Part II.* By W. M. Baker, M.A., and A. A. Bourne, M.A. Pp. viii+277 to 468+lxxvi. (London: George Bell and Sons, 1904.)

(6) *Clive's Shilling Arithmetic.* Edited by W. Briggs, LL.D., M.A., &c. Pp. viii+154. (London: W. B. Clive, 1905.) Price 1*s*.

(7) *Graphic Statics.* By T. Alexander, C.E., and A. W. Thompson, D.Sc. Pp. viii+50. (London: Macmillan and Co., Ltd., 1904.) Price 2*s*.

(1) THE geometry of Mr. Buddon is a notable addition to the elementary text-books which owe their appearance to the freedom of the last few years. The subject is introduced by experimental work, very suggestive in character, and leading by induction to fundamental definitions and theorems. Thus from the sliding and folding of flat cards and the like the author arrives at his definition of a plane as "a surface, infinite in extent, which can be folded about any two points of the surface so that one part lies entirely on the other." The definition of a straight line naturally follows as the infinitely extended fold of a plane. A plane angle is clearly and rationally defined. Parallel lines are those having the same direction in a plane, direction being measured by the angle made with any reference line. It is pointed out that a plane, a plane angle, and a straight line can in each case be reversed on itself, and thus symmetrical properties are satisfactorily established in which the two halves are alike but of opposite aspect. Then follow general cases of congruence. In dealing with ratio and proportion the idea of a continually subdivided decimal scale is introduced; this enables all numbers which can be expressed as continuous decimal fractions, *e.g.* 1·4142. . . ., to be included, and to any degree of approximation. In later chapters the subject-matter comprises a very full treatment of the properties of circles; elementary trigonometry; an introduction to projective geometry; conic sections treated by modern methods; and solid geometry with the mensuration of the simple geometrical solids. The book contains in profusion sets of graphical and deductive exercises. The figures are drawn with thick, thin, and dotted lines on a systematic plan to distinguish more readily between the data, the construction lines, and the result. The use of variable type serves to differentiate parts of greater or less importance. In fact, the book on every page bears witness to the great care and thought bestowed on its production. There is a stimulating freshness in the matter and its method of presentation. Some will doubt the wisdom of carrying on at school the study of pure geometry to the extent covered in the book; others may wish that the geometry of vectors had been included; but all will agree that the author has produced one of the most important of the new elementary text-books, and one that should be known to every teacher interested in the subject.

(2) The "Lessons in Experimental and Practical Geometry" by Messrs. Hall and Stevens might very fittingly be incorporated in the authors' "School Geometry," to which it forms an excellent introduction as well as supplement. The subject is treated in the masterly way that is found in the mathematical text-books of these writers. Young pupils are fortunate who obtain their first notions of geometry from a course such as the one outlined in its pages. They will become accustomed to the use of compasses, squares, scales, and the protractor by interesting quantitative and experimental work, fundamental propositions being at the same time inductively established. They will have practice in the application of geometrical problems; will learn how to measure areas; and will be introduced to the simpler geometrical solids. The authors make good use of tracing paper. The list of instruments and apparatus which they give might with advantage have included the drawing and compass pencils, with a caution added against the employment of soft blunt leads.

(3) In the preface of his elementary geometry Mr. Arnett states that the work "has been written for the use of candidates who are being prepared by a master for the different examinations conducted by the universities and the Civil Service Commission." The subject-matter is confined to plane geometry, and is almost wholly deductive. The first book gives definitions and axioms, and investigates some of the properties of lines, angles, parallels, triangles, and quadrilaterals. The second book deals mainly with the circle and with ratio and proportion, and the last book treats of areas and of similar figures. The principal feature of the work is the very large number of exercises provided, a few of which are numerical or graphical, the great bulk, however, being of the nature of geometrical riders. The text-book is not at all suitable for beginners, for general school work, or for private study except under the direction of a tutor who could direct the student as to which parts should be read and which omitted, and who would probably re-arrange the order in which the theorems and problems should be taken.

(4) Mr. Loney's "Elements of Trigonometry" is mainly taken from part i. of the author's "Plane Trigonometry," and is designed as an easier text-book. The subject is treated in the usual way, and there is nothing to call for special mention. The first chapters relate to acute angles and right-angled

triangles. The definitions are then extended to angles of any magnitude, and formulæ are established for the sum and difference of angles, and for multiple and submultiple angles, &c. There is a chapter on logarithms, and a number of four-figure tables are given. This work leads up to the properties and solution of triangles with applications. Inverse functions are introduced, and general expressions established for angles having given trigonometrical ratios. There are a large number of examples, any necessary answers to which are given at the end of the book.

(5) Part ii. of Messrs. Baker and Bourne's excellent algebra begins by formally establishing the laws of operation of algebraical symbols. It contains chapters on surds and indices, proportion, logarithms, progressions, series, scales of notation, permutations and combinations, the binomial theorem, interest and annuities, exponential and logarithmic series and partial fractions. There are numerous groups of examples, and special sets of revision papers at intervals, the answers being all given in an appendix. A special feature of the book is the frequent use of graphs and of geometrical illustrations. This text-book must give satisfaction wherever used.

(6) Clive's shilling arithmetic is intended for the use of teachers who adopt almost entirely the oral method of instruction, and who only require a class-book containing concise statements of rules, with graduated sets of exercises, and with the formal proofs of theorems omitted. Thus a small volume is sufficient to cover the range of subjects usually taught in schools, and which this manual contains. The book can be obtained with answers included at an extra cost of threepence.

(7) In the graphical statics of Messrs. Alexander and Thompson the authors first give a set of sixteen graduated problems on coplanar forces, solved by means of force and link polygons; these include couples, centres of area and moments of inertia of beam sections. Then follows a set of seventeen examples showing applications to roof trusses, girders, walls, and masonry arches. The treatment is somewhat fragmentary and arbitrary, but, if supplemented by the teacher, the course would prepare a student for a systematic study of graphic statics, and the book is intended more particularly as an introduction to the author's "Elementary Applied Mechanics."

SALT-BEDS AND OCEANS.

Zur Bildung der ozeanischen Salzablagerungen. By J. H. van 't Hoff. Pp. vi+85. (Brunswick: Vieweg and Son.) Price 4 marks.

THIS work will be welcomed alike by chemists, geologists, and oceanographers. It forms the first instalment of the collection into one publication of the results of some forty memoirs of the author and his collaborators on the formation of double salts.

The principal object of the work was the study of the problem of the natural salt beds. As these beds have in all probability been formed by the evaporation of a body of water comparable with the existing oceans, which certainly contain some of everything, it was necessary to set limits to the investigation. This was effected by confining attention to the principal constituents of the salt-beds. These are chloride of sodium, in great preponderance, and the chlorides and sulphates of magnesium and potassium with their water of crystallisation. The latter form a series of more complex bodies which appear and disappear with the changing equilibrium of the solution. After these come the calcium salts, such as anhydrite and polyhalite; but they are held over for treatment in the next fascicule.

The work is a gigantic exercise in physical chemistry, which the author carries through on strictly scientific lines, while at the same time touch is kept with the important applications of his results in the economy of nature, and chemistry is thus vindicated as a branch of natural history.

The experimental part of the work is of especial interest to physical chemists, and the publication of it in a connected and condensed form will be welcomed by them. It is proposed here to notice only the application of it to the occurrence of salts in nature in beds and in solution.

The experimental basis of the work is the determination of the solubility, at certain temperatures, of the common salts of the sea, in water and in solutions of each other. With the information so obtained, it is possible to follow exactly the crystallisation of a solution containing all these salts, as it gradually loses water by evaporation at the temperature of the experiment. The temperature most used is 25° C., which is fairly representative of the temperature of sea water evaporating in salt gardens, such as those of Hyères or Cadiz in summer.

When average sea-water has been evaporated down to the point at which chloride of sodium begins to crystallise, the liquor contains (in molecular proportions) 100 NaCl, 2·2 KCl, 7·8 $MgCl_2$, 3·8 $MgSO_4$; and this mixture of salts is associated with, roughly, 1000 mol. H_2O (exactly 1064). On allowing this liquor to evaporate at 25° C., the crystallisation follows a definite route, which can be traced exactly, and without difficulty, on one of those marvellous charts representing the march of physical and chemical phenomena with which the resourceful inventiveness of van 't Hoff has familiarised us.

The crystallisation takes place in four acts corresponding to the regions in the chart.

(1) Rock-salt: separation of chloride of sodium in great abundance. Of the 100 NaCl present when crystallisation began, only 4·6 NaCl remains dissolved; the remainder, 95 NaCl, has been deposited.

(2) Kieserite region: separation of chloride of sodium, sulphate of magnesium, and kainite

$$(MgSO_4KCl3H_2O).$$

The salt separated in this act consists of 4·42 NaCl, 2·02 KCl, and 3·07 $MgSO_4$; or, 4·42 NaCl, 1·05 $MgSO_4$, and 2·02 kainite.

(3) Carnallite region: separation of chloride of sodium, carnallite ($KMgCl_3,6H_2O$), and kieserite ($MgSO_4.H_2O$), and the amounts separated are 0·03 NaCl, 0·1 carnallite, and 0·35 kieserite.

(4) Final liquor: what remains solidifies to 0·15

NaCl, 7·62 $MgCl_2$ (bischofite), 0·08 carnallite, and 0·38 kieserite.

	Rock salt	Kieserite	Kainite	Carnallite	Bischofite
(1)	95·4	—	—	—	—
(2)	4·42	1·05	2·02	—	—
(3)	0·03	0·35	—	0·1	—
(4)	0·15	0·38	—	0·08	7·62
	100·00	1·78	2·02	0·18	7·62
	NaCl	3·8 $MgSO_4$	2·2 KCl	7·8 $MgCl_2$	

Within the limits of a notice of this kind it is impossible to give an adequate account of so important a work. It is hoped, however, that the above extract will show that it has an interest for others as well as for chemists. J. Y. B.

EVOLUTION FOR BEGINNERS.

An Outline of the Theory of Organic Evolution; with a Description of some of the Phenomena which it Explains. By Dr. Maynard M. Metcalf, Professor of Biology in the Woman's College of Baltimore. Pp. xxii+204. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1904.) Price 10*s*. 6*d*. net.

THIS is one of the best popular accounts of the theory of evolution that have come under our notice. The author makes little or no claim to originality, but he has on the whole succeeded in his aim of providing a clear and intelligible statement of evolutionary doctrine in most of its recent developments. Technicalities have been largely avoided; but, as the author truly says, "the subject is somewhat intricate, and cannot be presented in so simple a manner as to require no thought on the reader's part." With regard to controverted points, the position taken is generally sound; Dr. Metcalf has no difficulty in recognising the supreme importance of natural selection, or in rating at their true value the speculations of the Lamarckian school, whether new or old. He rightly lays stress on the great fact of adaptation as affording the most conclusive evidence of the controlling power of selection; "adaptation," as he remarks, "is the key-note of organic nature." To some readers his faith in the beneficial character of certain modifications will seem a trifle too robust; but for the most part he treats this branch of the subject with sound judgment and the force born of reasoned conviction.

An excellent feature of the book is its wealth of pictorial illustration. Many of the figures are already well known, but it is of great advantage to the ordinary reader to have them grouped together in such a way as to throw fresh light on each other, and thus materially to assist his comprehension of the subject. Many of the reproductions of original photographs are particularly good; to "find the woodcock" in plate l. makes an interesting puzzle. The representation of the snow grouse in plate lvii., and of the sargassum fish in plate lxv. are also admirable, while the copies in colour of Tegetmeier's figures of fancy poultry, though a little rough in execution, are amply sufficient for their purpose.

A few points call for criticism. The author is occasionally betrayed into a slipshod or unmeaning expression, as when he speaks of the sun "moving along its appointed daily course under the control of gravitation." A sentence on p. 31 is entirely misleading, unless the word "artificial" be substituted for "natural." The factors to which special attention has been directed by Osborn, Baldwin and Lloyd Morgan, though not ignored, are rather inadequately treated; the author, moreover, falls into some confusion between individual and specific plasticity. On p. 134 Fritz Müller's interpretation of "synaposematic" resemblances is erroneously attributed to Bates. Indeed, the whole subject of common warning colours, which is one of the most interesting and complicated in the entire range of evolution, deserves more extended and more accurate treatment than it receives at Dr. Metcalf's hands. On plate lxxvi. *Papilio merope* (*caeneae*) is somewhat uncritically assumed to be edible, and on plate lxxvii. we meet with the astonishing statement that the male of *Perrhybris* (*Mylothris*) *pyrrha* is edible, and "imitates the inedible Heliconidæ," while the female of the same species "is not a mimic"; the fact being that it is one of the best mimics known, probably of the Müllerian kind. The lettering of many of the plates stands in need of revision. F. A. D.

OUR BOOK SHELF.

Précis de Chimie physiologique. By Prof. Allyre Chassevant. Pp. iv + 424; illustrated. (Paris: Félix Alcan, 1905.) Price 10 francs.

THIS is a very excellent text-book of physiological chemistry, and it presents the subject in an attractive way. It treats first of the chemical substances found in the body, then of the various liquids and tissues of the organism, and finally of function.

The work contains all the essential facts of this branch of science, without going exhaustively into details; references are given throughout to the names of investigators, but not, as a rule, to their writings. The subjects treated most fully are the urine, the milk, and diet, for the work aims at being not only academic, but also of practical use to the clinical investigator.

The author is well known for his original work in chemical physiology, and he will be personally known also to many in London, as he was one of those who joined in the recent visit of French medical men to London. He possesses what is rarely absent in French writers, a power of clear and lucid exposition. He is fully conversant with recent progress in science, as evidenced by the way he deals with questions in which physical chemistry is involved.

The line between physiology and pathology is never a well defined one, and thus we find in the book subjects like immunity, serum diagnosis, and serum therapy to the fore. It is inevitable that this should be so, for a proper understanding of ferments and anti-ferments, the prime factors in animal chemistry, cannot be attained except through the knowledge and new ideas which were in the first instance the outcome of study in pathological fields.

M. Chassevant is to be congratulated on his interesting work. He has furnished the student, the investigator, and the teacher with what will be useful to all of them. W. D. H.

Unsere Pflanzen. By F. Söhns. Dritte Auflage. Pp. iv+178. (Leipzig: Teubner, 1904.) Price 2·60 marks.

Children's Wild Flowers. By Mrs. J. M. Maxwell. Pp. viii+171. (Edinburgh: David Douglas, 1904.) Price 7*s.* 6*d.* net.

THE derivation of many botanical names being very uncertain, it is probable that the subject appeals more to the philologist than the botanist. Who shall say, for instance, whether the speedwell takes its name from a saint Veronica, or should be derived from "vera icon" or "vera unica"? Vernacular names are perhaps more easily explained, but vary greatly in different districts. Similar difficulties occur with German popular names, so that Mr. Söhns has a number of problems of an indeterminate nature to solve in his book, which deals with the nomenclature of plants and their place in mythology and folklore. Generally the author's arguments are carefully deduced and convincing, and, as might be expected, the correct derivation is not always obvious. Tausendgueldenkraut, the popular name of *Erythraea centaurea*, suggests a connection with "centum aurum," but the specific name is undoubtedly given in honour of the Centaur Chiron, who was skilled in medicine, and the German name, which was at first hundert guelden Kraut, has apparently given place to Tausendgueldenkraut, where thousand is used in a hyperbolic sense, and thus the Centaur's plant has become associated with a fanciful expression. In addition to etymology, the book contains many references to popular superstitions. On account of the dissimilarity between German and English popular names it cannot be expected that the book will appeal strongly to English readers, but a third edition points to its success in Germany.

The book by Mrs. Maxwell is intended to interest children in wild flowers by narrating the legends and stories connected with them. Scientific description is practically limited to habitat and comparative characters for distinguishing between the species of a genus, and coloured illustrations are provided as a means of identification of the plants. Obviously the purpose of the writer is not to train the powers of observation or inculcate accuracy, but rather to stimulate the faculties of imagination.

Superstitions about Animals. By Frank Gibson. Pp. 208. (London and Newcastle-on-Tyne: Walter Scott Publishing Co., 1904.) Price 3*s.* 6*d.*

THIS is an unpretentious little book which will interest many people. It brings together some of the most common superstitions about animals, "dealing with them in a light and popular way," with copious quotations from the poets. One of its aims is to sweep away those superstitions that are foolish and degrading, to clear the air for a free appreciation of the real wonders of nature. For "there is no subject under heaven which will give more pleasure or lasting and real profit than that of Natural History." Mr. Gibson deals first with omens, such as the ticking of the death-watch and the baying of a dog; he goes on to distortions of facts of natural history, such as "salamanders in the fire," "crocodile's tears," "the hibernation of swallows"; he ends up with creatures of the imagination, like the "basilisk," the "phœnix," and the "griffin." The author is a devout admirer of the real things of nature with an unusual knowledge of the poets both great and small. He has not seriously tackled the difficult side of his subject—the attempt to account historically and psychologically for the origin and persistence of the more important superstitions. He has forgotten the salt.

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.*]

A Great Oxford Discovery.

IN a recent study of some eighteenth century naturalists' writings I was a good deal struck by the amount of attention devoted to the problem of whether the white man was a sport from negroid stock or the negro a sport from a white race. The matter was discussed from every standpoint, physiological, geographical, and theological, but the consensus of opinion, based chiefly on the existence of albinotic and pied negroes, and on the misunderstood effects of leucoderma, was that the white might be a negro sport, but that there was no evidence of a black sport in the case of the white races. If such an opinion were correct, and the white man only a negro sport, we should certainly expect to find the negroid cranial type common among the white races. Two distinguished Oxford men of science have just thrown remarkable light on this problem. They have given a very simple series of conditions by which crania can be classed into skulls of negroid, non-negroid, and intermediate types. These conditions depend entirely on a classification of nasal and facial indices, and by their processes our authors are able to distinguish between the negroid, non-negroid, and intermediate types among prehistoric Egyptian crania. Not being an anatomist, I am quite unable to judge of the processes by which they have reached their criteria, and the photographs which accompany their volume are of so obscure a character—indeed, in the present state of cranial photography somewhat unworthy of a university press—that they hardly allow the uninitiated even with a lens to appreciate the justification which the authors find for their classification in the outward appearances of their cranial groups. I think, however, we may safely give the greatest weight possible to a judgment formed by the Oxford professor of human anatomy and the Oxford reader in Egyptology in a folio volume just issued by the syndics of the University Press.

Taking their classification as beyond discussion, I have applied it:—

First, to a fairly long series of admittedly negro crania, all males. I find 7·3 per cent. are non-negroid, 39·0 per cent. are truly negroid, and 53·7 per cent. are intermediate. It is clear that we only need to let the negroes change their skins, and a sensible percentage will be non-negroid.

Secondly, to a fairly long series of English skulls, male and female. I find of Englishmen 20 per cent. are negroid, 46 per cent. non-negroid, and 34 per cent. are intermediate in type. Among Englishwomen 11 per cent. are negroid, 48 per cent. non-negroid, and 41 per cent. are of intermediate type. Thus of the whole English population slightly more than 50 per cent. are either pure negroid or partially negroid; while in an outwardly pure negroid group, upwards of 60 per cent. are non-negroid or mixed with non-negroid elements.

I have not yet had time to apply Prof. Thomson and Mr. Randall-Maciver's test to Asiatic races, but I have not the least doubt that I shall find there also pure negroid and intermediate negroid elements. But that the Englishman should have as large a negroid element in his constitution as the prehistoric Egyptian, and only half as little pure negroid element as admitted negroes, is to my mind an epoch-making discovery, which will at once attract attention to Oxford as a centre for a novel school of craniometry and anthropology. KARL PEARSON.

University College, London.

Inversions of Temperature and Humidity in Anticyclones.

IN NATURE of February 16 Mr. W. H. Dines cited an example of a large temperature inversion, observed with kites during the prevalence of very high barometric pressure in England, and remarked on the possible connection between the two phenomena.

Observations with kites at Blue Hill during the past ten years, and with balloons elsewhere, show that inversions of temperature occur at some height in the free air under almost all weather conditions. In a discussion of the kite observations at Blue Hill, published in 1897 in part i., vol. xlii., *Annals of the Astronomical Observatory of Harvard College*, Mr. H. H. Clayton probably first pointed out that marked inversions of temperature at heights of from a quarter to half a mile in the free air occur in the rear of anti-cyclones. He gives one example of a rise of 26° F. between 2180 feet and 2530 feet, accompanied by a corresponding fall of 50 per cent. in the relative humidity, this rise of temperature being more than twice that mentioned by Mr. Dines.

Prof. Hergesell's soundings with kites on board the Prince of Monaco's yacht last July, in the permanent high barometric pressure south of the Azores, showed a decrease of temperature of 6° F. up to about 1800 feet, when the temperature suddenly rose 14° F., and so remained throughout a stratum 3000 feet thick, above which it fell at the adiabatic rate, the relative humidity decreasing 50 per cent. with the rise in temperature. It would appear, therefore, that such inversions of temperature and relative humidity at a moderate height are characteristic of areas of high barometric pressure, both over the land and water.

A. LAWRENCE ROTCH.

Blue Hill Meteorological Observatory, Hyde Park, Mass, U.S.A., March 13.

The Planet Fortuna.

ONE point of interest to Airy's brother men of science has not been noticed—that he either misunderstood or wilfully misapplied the lines of Juvenal. The "Purists" urged that planets had always been named after deities, and that Fortuna was not a deity. Airy said that she was, and quoted "nos te, nos facimus, Fortuna, deam." What did Juvenal really say? He said, "the wise see *no* divinity in Fortune; it is only human folly that calls her goddess, and assumes for her a place in heaven." As Gifford renders it:—

"We should see
If wise, O Fortune, nought divine in thee;
But we have deified a name alone,
And fixed in heaven thy visionary throne."

"Nullum numen *abest*" belongs to a numerous class of misquotations, and spoils the whole tenor of the passage. The supreme authority on Juvenal, J. E. B. Mayor, does not even condescend to cite it.

W. T.

CITY DEVELOPMENT.[1]

THE elegant volume under notice was written by Prof. Patrick Geddes in response to an invitation by the Carnegie Dunfermline Trust. The report is copiously illustrated, and embodies a very great amount of valuable and important information, plans, and suggestions as to the laying out of the public park, and as to the buildings, in or around it, needed or desirable for carrying on the work of the trust.

The author set to work by having a complete photographic survey made of the park and its environments. All those photographs, however, could not be incorporated in the report, but they will be preserved as a permanent record of the appearance of the park and its surroundings before any changes were inaugurated by the trust. Not content with mere photographs and maps, the author strongly recommends the construction of a relief model of the park, bearing on its surface pasteboard models of the new buildings proposed, in order that the general effect of these buildings on their surroundings may be clearly anticipated, and thus the erection of structures out of harmony with their surroundings may be avoided.

[1] "City Development, a Study of Parks, Gardens, and Culture Institutes." A Report to the Carnegie Dunfermline Trust. By P. Geddes. Pp. 232. (Westminster: Geddes and Co., 5, Old Queen Street.) Price 21s. net.

At the beginning of the report a general plan of the park is given, showing the proposed improvements. At first sight the plan appears very elaborate and overcrowded with detail, but this is due

FIG. 1.—View down House Dene, showing back of old Mansion-house to left (south), and on opposite bank, a little nearer than the large tree, Wallace's Well, fallen in. Old paths effaced. From "City Development"

to the fact that its designer has endeavoured to show all the essential details in the plan, in order to reduce the number of blocks in the text, and a little study is all that is required to show that the proposed improvements are not of such a radical nature as a first impression might convey. The proposed treatment is essentially a conservative one, and the suggested changes and improvements have been designed to interfere as little as possible with the existing features, views, and even details of the park and glen.

About one-half of the report is devoted to a detailed consideration of the park, its environs, gardens, and nature museums. The possible approaches and entrances are carefully considered and selected. These must render easy access to, and be in keeping with, the important centre to which they lead. The park must not end abruptly where the town begins, but its environs or setting should be such that a harmonious blending—one with the other—is secured, and in this connection the author seems to have made the most of the material at his disposal.

FIG. 2.—The same view, with Wallace's Well simply re-built, and roughly rustic foot-bridge, uniting old paths now renewed. The Mansion-house shows also one of the proposed new turrets. From "City Development."

As regards the laying out of the park, the proposed lakes, gardens, tennis courts, cricket pitches, bowling greens, and other recreation grounds, its pavilions, band-stands, museums, walks, and groves, are too numerous to be noticed individually here. Shortly stated, the author has given the benefit of his extensive knowledge and wide experience in the planning, equipment, and arrangement of parks and all their accessories. Every practical expedient that ingenuity can suggest to encourage that open-air life and physical exercise so necessary and beneficial for young and old has been adopted in the schemes and plans submitted by the author of the report.

A word or two about the nature palace may not be out of place. This very important building has been designed to serve several different purposes, such as a winter garden adapted to receptions and conversaziones, and it also could be used as a promenade and popular assembly room, and as a centre for bazaars, periodic industrial exhibitions, flower shows, &c. The author further proposes to give this building the additional and educational interest of a great museum—a museum which, however, should not aim at having a large general collection of geological, botanical, zoological, and anthropological material, such as those which already exist in larger cities. Indeed, the author points out that it would be cheaper for the trust to send whole schools to the museums of Edinburgh than to attempt to possess an independent institution containing, say, the sixth best collection of skeletons in Scotland or the like. This museum in the nature palace is to be something apart from any existing type of museum; in the words of the author, "A museum not primarily of geology, botany, natural history, anthropology, and so on, yet the whole of these within the living unity of nature, scene by scene—in short, a museum of geography." So far as the special requirements of the various natural sciences are concerned, the author recommends as a model the Perth Museum, with its well chosen collection of types.

The latter half of the report, forming book ii., deals with the culture uses of museums and institutes. In this part of the volume, art, music, history, and science are all provided for and suitably housed, with a view not merely to their immediate wants, but ample allowance and provision are made for the future development and expansion of each and every phase of human activity bearing on culture and industry.

In this handsome volume, the author has included a vast amount of detailed information and convincing arguments to show the value of parks, gardens, museums, and culture institutes in the social advancement, education, and well-being of communities.

NATURE'S WAYS.[1]

UNLIKE the great majority of works of the same class, this little volume takes no notice of birds, but, as its title implies, is entirely devoted to the lower forms of life which may be met with during rambles in different parts of the country, including both animals and plants. As in the case of his earlier book, all the articles have previously been published in various periodicals and journals; and the opportunity for revision given by their re-publication ought to have enabled the author to correct certain deficiencies in style and expression by which the present issue is disfigured.

For example, on p. 29, Mr. Ward manages to introduce the word "which" three times in the course of a single sentence without the use of any higher stop than a comma. On p. 2 we find an obtrusive instance of the *ego et rex meus* class; and on p. 172 we are told that *occasionally* examples of a certain organism are not *uncommonly* met with. Again, on p. 204 the reader, owing to the misuse of the pronoun "they," is informed that the jaws of a snail possess neither jaws nor teeth; while in the

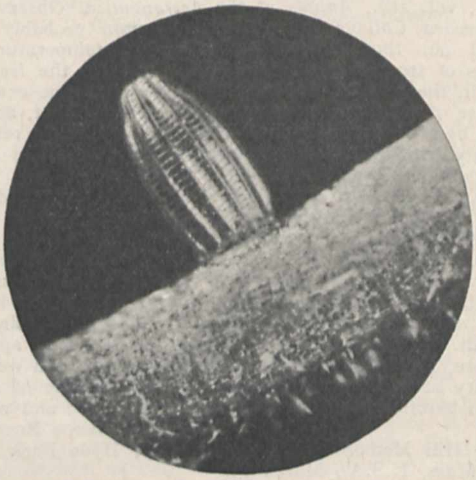

FIG. 1.—Magnified egg of the orange-tip butterfly, on a flower-stalk. From "Peeps into Nature's Ways."

second paragraph on p. 91 we observe a plural pronoun used in connection with a substantive in the singular. The misprint in the first sentence on p. 181 is perhaps excusable; but the statement (p. 186) that

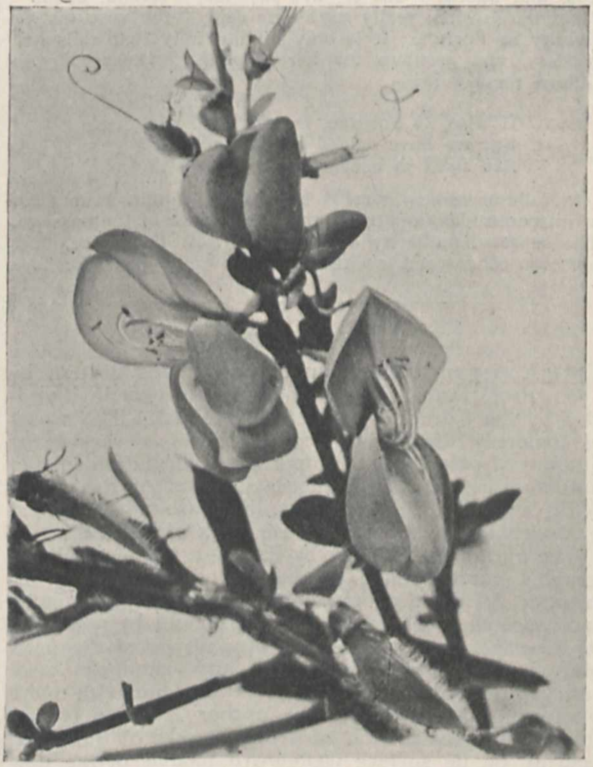

FIG. 2.—A sprig of broom, showing fertilised and unfertilised flowers. From "Peeps into Nature's Ways."

carbon chemically combines with the water sucked up by plants is scarcely an exact definition of what takes place.

Apart from blemishes like the above, the author may

[1] "Peeps into Nature's Ways; being Chapters on Insect, Plant, and Minute Life." By J. J. Ward. Pp. xviii + 302; illustrated. (London: Isbister and Co., 1905.)

be heartily congratulated on his work, which is interesting and readable from start to finish; while the illustrations, reproduced from his own photographs, are in most cases exquisite, as our readers may see for themselves from the two examples furnished herewith. Although he appears to have little or nothing new to record, Mr. Ward is evidently a careful and accurate observer, with the faculty of recording his facts in language that "can be understanded of the people."

With the exception of one chapter on the hydra and a second on the "tongues" of molluscs, Mr. Ward's work is restricted to insects and plants. In his opening chapter he details the fascinating life-history of the orange-tip butterfly, showing how its coloration harmonises with the plants it frequents, and how the beautiful green mottling on the hind wings is produced by the blending of dots of black and yellow. As an example of the author's skill in microscopic photography, we reproduce from this chapter his enlarged figure of the egg of the butterfly in question.

Another chapter we have read with special interest is the one on the gorse, in which the author points out how this plant retains evidence of its relationship to the clovers in the form of its seed-leaves; while he also suggests that the broom may be regarded as in some degree representing a plant in course of evolution to the gorse type, but that its career to this goal has been checked by the fact of its having a bitter taste, which renders its leaves, unlike those of the gorse, uneatable by cattle, so that a protective panoply of spines is superfluous. As a specimen of the author's exquisite photographs of plants, we reproduce the one showing the broom in blossom. Of the other chapters dealing with plants, one is devoted to their hairs and scales, in the course of which the author expresses his belief that he has brought to notice a hitherto undescribed type (in the Auricula); a second chapter is accorded to the sensitive plant, a third to the flowers of woodland trees, a fourth to plant-battles, and a fifth to plants that catch flies.

Reverting to the zoological series, it may be mentioned that the devotion of two chapters to the biographies of a couple of nearly allied species of hawk-moth is perhaps an ill-judged arrangement, as giving too much importance to one group. Be this as it may, the chapter entitled "Living Files and Rasps," in which are described and figured the lingual ribbons of a number of species of gastropods, can scarcely fail to be generally interesting, although it would have been better had the author in every case particularised the genus and species to which his specimens pertain, instead of merely labelling them "snails." In the chapter on mosquitoes and gnats the author does his best to clear up the popular misconception with regard to these insects, and shows how the female, so far as mankind is concerned, is the source of all harm and evil.

While, as already stated, it is somewhat marred by errors and inelegances of style, the book as a whole may be pronounced decidedly interesting and attractive, and free from all cant and faddism.

R. L.

GERMAN EDUCATIONAL EXHIBITS AT ST. LOUIS.

THE German educational exhibit at St. Louis was, as is usual with German exhibits, remarkably complete, and to enhance its value a series of descriptive catalogues was issued. Among the science catalogues were three on scientific instruments, chemistry, and medicine respectively which have special interest for readers of NATURE. They are all on the same plan, and include a general introduction explanatory of the scope of the work, and a detailed account of the apparatus, &c., exhibited. They served a twofold purpose, that of informing visitors to the exhibition as to what there was to see, and also that of bringing together an account of the best products of German workmanship in the respective subjects of the catalogue.

In the catalogue of scientific instruments the introductory description is very full and of real use; special reference is made to novel instruments. Dr. Lindeck, of the Reichsanstalt, who edited the catalogue of the German exhibit in Paris in 1900, is responsible for this, while Dr. Krüss had charge of the section.

The description of the instruments which follows is arranged alphabetically according to the names of the exhibitors. The system of classification with cross references is somewhat less complete than that adopted in the 1900 catalogue, but by aid of the introduction it is easily possible to find any given kind of apparatus. A glance through the catalogue is sufficient to show its utility, and it is to be hoped that the support given to the proposed optical convention and exhibition in May next will be sufficient to justify the committee in issuing a catalogue of English optical goods which will serve the same purpose.

The chemical section at the exhibition contained a reading-room and library, and in this an interesting collection of alchemistic work was shown. Besides these most of the important modern German works on chemistry were to be found on the shelves. Two very interesting exhibits were the alchemistic laboratory, containing partly original apparatus, partly copies of old examples from the museum in Nuremberg, and the Liebig laboratory, a faithful copy of the well-known laboratory at Giessen. The rest of the exhibition illustrated modern chemical apparatus, methods and preparations.

The object of the medical exhibit is said to have been "to show how the German universities deal with the subject of medical instruction," and this was attained by judiciously grouping the articles shown, and by carefully selecting the apparatus. Naturally, various methods are adopted in the different branches; thus, in the department of internal medicine a complete clinical lecture on the diagnosis and therapeutics of tuberculosis is included, the objects required for demonstrating it being exhibited.

Among the apparatus, the microscopes and projection apparatus of Karl Zeiss occupy a prominent place.

It is noteworthy that among the infectious diseases and disease germs tuberculosis comes first.

The catalogue contains a full list of the exhibits with some account of the principal among them, and it is clear that great pains have been taken to secure that the primary object of the exhibition should be carried out.

The three catalogues, in their completeness and orderly arrangement, are examples of the German plan of carrying the teaching and method of science into everyday life.

NOTES.

THE council of the Linnean Society has appointed a committee to consider the question of zoological nomenclature.

PROF. LANCEREAUX has been elected president for 1905 of the Société internationale de la Tuberculose.

THE Canadian Government has decided to place a Marconi wireless telegraph station on Sable Island. The station will come into operation by August 1 next.

M. PAUL LABBÉ has been appointed general secretary of the Paris Society of Commercial Geography in succession to the late Ch. Gauthiot.

MR. ALFRED BEIT has informed the honorary treasurers of the Institute of Medical Sciences Fund, University of London, that he has decided to increase the amount of his donation to the institute from 5000*l*. to 25,000*l*.

SENOR DON IGNACIO BOLIVAR, of Madrid, has been elected an honorary fellow of the Entomological Society. Profs. W. G. Farlow, H. S. Jennings, E. B. Wilson, and R. B. Wood have been elected honorary fellows of the Royal Microscopical Society.

THE King's Institute of Preventive Medicine was opened at Madras on March 11. The institute supplies animal vaccine to the whole of the Presidency, besides preparing curative and prophylactic sera. On the opening day there was an exhibition of bacteriological and sanitary engineering appliances.

A MOUNTED specimen of the great auk, formerly in the Hawkstone collection, has been sold by Rowland Ward, Ltd., of Piccadilly, to one of the American museums for 450*l*. This is the "record" price, the next highest being 350*l*. obtained some years ago by the same firm for a specimen now in a private museum.

DR. A. R. WALLACE recently presented to the British Museum a number of pencil drawings of fishes from the Rio Negro which were saved some fifty years ago at the time the veteran explorer's collections were burnt at sea on his return from the Amazonian journey. These drawings, some fifty in number, were exhibited at one of the meetings of the Zoological Society, when it was stated that while some of the species depicted had been identified, others appeared to be still unknown to science. This should stimulate investigation of the fish fauna of the Amazonian system.

M. JULES VERNE, whose works are better known in this country than those of any other French writer, died on March 24 at seventy-seven years of age. Jules Verne was one of the first novelists to recognise and utilise the store of scientific knowledge as a source of material from which attractive romances could be constructed. The charm of his style and the realism of his pictures have done much to encourage the study of science among boys and girls. Few writers, indeed, have produced healthier and more stimulating stories, or weaved fancy and fact together so successfully.

ON Saturday next, April 1, Lord Rayleigh will deliver the first of a course of three lectures at the Royal Institution on some controverted questions of optics. On Tuesday, April 4, Mr. Perceval Landon will give the first of two lectures on Tibet, and on Thursday, April 6, Prof. Meldola will commence his course of two lectures on synthetic chemistry, experimental. The Friday evening discourse on April 7 will be delivered by Mr. Alfred Mosely on American industry, and on April 14 by Lord Rayleigh on the law of pressure of gases.

THE Estimates for Civil Services for the year ending March 31, 1906, provide for education, science, and art, the total sum of 16,328,947*l*., being an increase of 533,409*l*. over the grants for 1904–5. There is an increase of 46,100*l*. for university colleges, the grant being raised from 54,000*l*. to 100,000*l*. Of the increase 416,790*l*. under Board of Education, the greater proportion must be described as automatic in character, due to the anticipated growth in the number of scholars in average attendance, and to the larger number of teachers for whose training provision is made by the State. The principal increase, 262,704*l*., is in respect of the elementary education grants. With a view to the further development of the National Physical Laboratory, Parliament is being asked to sanction an increase of 1500*l*. on the grant in aid of salaries and other expenses of the laboratory, and also an additional grant of 5000*l*. in aid of new buildings and equipment for the same institution. Further provision is also included for investigations in connection with the North Sea fisheries.

THE fourth International Ornithological Congress will be held in London in Whitsun week, June 12–17. The organising committee has been able to obtain from the University of London accommodation for the meeting at the Imperial Institute, and from the trustees of the British Museum the use of the Natural History Museum for the purpose of a conversazione on one evening of the week of the congress. The Prince of Wales has consented to become the patron; and the two honorary presidents are Prince Ferdinand of Bulgaria and Dr. A. R. Wallace, F.R.S. The president-elect of the congress is Dr. Bowdler Sharpe. The congress will be divided into general meetings and meetings of sections, of which there will be five, as follows:—(1) systematic ornithology; general distribution, anatomy and palæontology; (2) migration; (3) biology, nidification, oology; (4) economic ornithology and bird protection; and (5) aviculture. It is proposed to devote one day to an excursion to Tring to inspect the collection of birds belonging to Mr. Walter Rothschild. On June 16 the congress will be received by the Lord Mayor of London at the Mansion House. At the close of the proceedings in London, on the invitation of the Duke of Bedford, an excursion will be made to Woburn to view the collection of live animals in Woburn Park, and the following day will be spent at Cambridge, where Prof. Newton will welcome the members at Magdalene College. Finally, a journey has been planned to Flamborough Head, in Yorkshire, of special interest to ornithologists.

THE programme of arrangements for the Optical Convention shortly to be held in London is now beginning to assume a definite shape. The convention will be formally opened with an address from the president, Dr. R. T. Glazebrook, F.R.S., on the evening of Tuesday, May 30, and the gathering will extend over the four following days up to and including Saturday, June 3. The mornings will be devoted to papers and discussions, and in view of the interesting series of papers already announced, there is no doubt that this most important section of the proceedings will result in valuable contributions to optical science, and will fulfil the aims which those who have been active in promoting the convention have set before them. In addition to the papers, demonstrations of apparatus of special interest will be given in the afternoons in the laboratories of the department of technical optics of the Northampton Institute. An exhibition of optical and scientific instruments will be held at the Northampton Institute, and will be open from May 31 to June 3, both dates inclusive. The catalogue is now in active preparation. The arrangement made by the "exhibition and catalogue" subcommittee that each section should be dealt with by an expert in the construction of the instruments represented in the section, together with an independent scientific member of the committee, will ensure that all classes of instruments shall be adequately dealt with and described. In addition to the presidential address to be given on the evening of May 30, there will be an evening lecture by Prof. S. P. Thompson, F.R.S., on the polarisation of light by Nicol prisms and their modern varieties. On a third evening it is proposed to hold a conversazione, and for Saturday afternoon, June 3, a visit to the National Physical Laboratory is proposed. Further particulars will be announced later, when the programme is more definitely settled. The hon. secretary, Mr. F. J. Selby, Elm Lodge, Teddington, Middlesex, will be glad to hear from those wishing to join the convention.

IN an account of a journey to Lake San Martin, Patagonia, published in the *Geographical Journal* for March, Captain H. L. Crosthwait directs attention to the magnetic and meteorological observatory established by the Argentine Government on New Year Island—a small island situated in lat. 54° $59'$ S., and about five miles off the north coast of Staten Island. The observatory, which is complete in every respect, is superintended by four Argentine naval officers, and is here illustrated from Captain Crosthwait's paper. The observatory was opened in February, 1902, and during the time which has since elapsed, the temperature conditions recorded there by the officers are:—highest temperature recorded, $55^\circ\cdot 4$ F.;

FIG. 1.—Magnetic and Meteorological Observatory, New Year Island.

lowest temperature, $16^\circ\cdot 4$ F.; annual mean temperature, 41° F. The magnetic observatory is kept at an almost constant temperature of 64° F. Many interesting facts about Tierra del Fuego are given by Captain Crosthwait in his paper. He directs attention to the astonishing number and variety of the glaciers, and to the fact that most of the larger ones show signs of shrinkage. Of San Martin Lake he says it undoubtedly occupies what was once a strait joining the Atlantic and Pacific Oceans. The level of the water of the lake rises and falls in a peculiar manner. Exact measurements of these "seiches" show that the movements are irregular, but on an average they amount to about five inches, having a period of about four minutes between two successive high waters. The surface of the water to the eye is perfectly smooth.

THE "Fauna of New England," in course of publication by the Boston Society of Natural History, has reached its fourth part, which is devoted to the echinoderms, the author being Mr. H. L. Clark.

BEAVER-DAMS on the Slate River, Colorado, form the subject of a paper by Mr. E. R. Warren in the *Proceedings* of the Washington Academy (vol. vi. p. 429), in the course of which the author shows how largely these rodents have altered the features of the valley.

IN the *Biologisches Centralblatt* of March 1, Mr. S. J. Wasmann continues the account of his theory of the origin of slavery among ants, Mr. H. Prandt discusses reduction processes and "karyogamy" among infusorians, while Prof. von Hansemann reviews the so-called heterotype cell-formation in malignant tumours, more especially in connection with the recent cancer investigations of Messrs. Farmer, Moore, and Walker.

To the *Proceedings* of the Boston Society of Natural History (vol. xxxii., No. 3) Miss Emerson contributes an account of the anatomy of *Typhlomolge rathbuni*, the blind salamander first made known by specimens thrown up by an artesian well in Texas in 1894. Despite its external resemblance to the olm (Proteus) of the Carniola caves, the author is of opinion that the creature is a member of the family Salamandridæ, and most nearly related to the American Spelerpes.

THREE American publications on fishes have reached us this week. In the first Messrs. Jordan and Starks (*Proceedings* U.S. Nat. Mus., No. 1391) describe a collection from Corea, containing several new generic and specific types, while in the second (*loc. cit.*, No. 1394) Mr. T. Gill discusses the generic characters of Synanceia and its allies. Of more general interest is the much larger memoir by Dr. S. E. Meek on the fresh-water fishes of Mexico north of the Isthmus of Tehuantepec, issued in the zoological series of the publications of the Field Columbian Museum (vol. v.). In this memoir, which is very fully illustrated, the author discusses the physiography of Mexico in connection with its fish fauna in considerable detail.

IN July, 1902, Dr. Merkel, of Wiesloch, was fortunate enough to discover in an overflow of the Leimbach a large number of the generally rare phyllopod crustacean *Limnadia lenticularis*. The specimens then collected form the basis of a paper on the anatomy of this species by Mr. M. Nowikoff, which appears, with numerous illustrations, in vol. lxxviii., part iv., of the *Zeitschrift für wissenschaftliche Zoologie*. In the same issue Mr. L. Cohn describes the subocular tentacle of the remarkable frog *Dactylethra calcarata*, the function of which, in the absence of living specimens, cannot yet be definitely determined. The third article in this part forms the completion of the account by Mr. F. Voss of the anatomy of the thorax of the house-cricket, with special reference to the comparative anatomy and mechanism of the organs of flight in insects generally.

IN the second part of an essay on the structure and relationships of the opisthocœlian, or sauropod, dinosaurs, issued in the geological series of the Field Columbian Museum publications (vol. ii., No. 6), Mr. E. S. Riggs dissents from the view that these gigantic creatures were semi-aquatic, or at least marsh-haunting in their habits. Although the massiveness of their vertebræ recalls cetaceans, yet there is no trace in the latter group of the lightening of this part of the skeleton by means of hollowing and fluting which is so characteristic of these reptiles. More important evidence is afforded by the structure of the limbs, which appears to conform strictly to the terrestrial type. The species described in this paper, *Brachiosaurus altithorax*, is regarded as the type of a family characterised by the great relative length of the fore-limb, the humerus in this genus being as long as the femur.

FROM Dr. Florentino Ameghino we have received a copy of a paper published at Buenos Aires entitled "Nuevas Especies de Mamíferos, Cretáceos y Terçiarios, de la República Argentina," and purporting to be a reprint from vols. lvi.–lviii. of the *Anales* of the Scientific Society of Argentina. It contains a large number of new generic and specific names, which in the absence of illustrations can scarcely be regarded as of much scientific value; and it may be suggested that, despite their admitted richness, the Argentine extinct faunas can scarcely include such a number of forms as the author would have us believe. Moreover, we feel sure that naturalists will display great reluctance in admitting the occurrence of ancestral forms of Tragulus and Galeopithecus in the Argentine Tertiaries, while they will most certainly refuse to follow the author in regarding the latter genus as a member of the Typotherium group of ungulates.

WE have been favoured with a copy of the *Schriften* of the Philosophical Society of Danzig for 1904 (new series, vol. xi., parts i. and ii.). To the naturalist the most interesting of its contents is perhaps the long article by Dr. W. Wolterstoff, director of the Magdeburg Museum, assisted by several specialists, on the fauna of the districts of Tuchel and Schwetz, in west Prussia ("Beiträge zur Fauna der Tucheler Heide"). A systematic zoological survey of this well-wooded area appears to have been undertaken in 1900, and the general results of this are summarised in the introductory chapter. Specialists are responsible for the determination of the specimens collected, Captain Barrett-Hamilton having undertaken this duty in the case of the mammals, represented only by three mice and one vole. The amphibians receive special attention, a coloured plate indicating the distinctive features of *Rana esculenta* and *R. arvalis*.

THE nuclear divisions in the embryo sac of *Fritillaria imperialis* have been studied by Dr. B. Sijpkens, who has published his results in the *Recueil des Travaux botaniques neerlandaises*, No. 2.

THE scope of plant morphology, and the nature of the fundamental problems in this subject which await investigation at the present day, could have no better exponent than Prof. Goebel, who has expressed his views in the *Biologisches Centralblatt* (February). Distinction is drawn between structural morphology, originally based upon systematic study, but later concerned with comparison and phylogeny, and causal morphology, which, inquiring into circumstances and conditions, can only be determined by experiment. The question whether a sporophyll is a modified leaf, or a vegetative leaf a sterilised sporophyte, is not without interest to botanists, but whether it is possible to control development and produce at will a vegetative life or a sporophyll is a problem of much greater significance.

AMONGST American horticulturists engaged in plant breeding with the object of improving certain definite characters of flowers and fruit, Mr. L. Burbank, of California, holds a high position. The improvement of plums by hybridisation and selection is a subject which has received much attention, and by crossing the Japan plum with American species he has produced such fine varieties as the Golden, Climax, and the Wickson. More remarkable are the raspberry-blackberry hybrids, of which the Primus, a cross between the western dewberry and the Siberian raspberry, ripens its fruit several weeks before either of its parents, and is superior in productiveness and size of fruit. The first part of an appreciative article by Mr. W. S. Harwood appears in the *Century Magazine* for March.

WE have received a copy of the observations made at the Hong Kong Observatory in the year 1903. In addition to the usual tables for the year in question, the report contains a valuable summary of hourly and monthly results of the various elements for the ten-yearly period 1894–1903. During this period the maximum shade temperature recorded was 77°, in August, and the minimum 37°·5, in January, and the highest solar radiation was 160°·1, in September. The greatest daily rainfall was 10·19 inches, and the maximum hourly fall was 2·86 inches. A comparison of the daily weather forecasts with the weather subsequently experienced gave a total and partial success of 92 per cent. The extraction of observations from the logs of ships for the construction of trustworthy pilot charts has been continued; the number of days' observations collected during the year was 9428. This useful work is undertaken by Miss Doberck.

THE rainfall of the six months September, 1904, to February, 1905, is summarised in *Symons's Meteorological Magazine* for March, and forms an interesting supplement to the account we published last week from the official reports of the Meteorological Office. The results obtained from fifty-five representative stations are tabulated, and referred to the average rainfall of the thirty years 1870–1899, and although, as Dr. Mill points out, the circumstance is not unprecedented, it very rarely happens that the general rainfall of the country remains below the average for each of six consecutive months. The great advantage of graphical representation in dealing with such data is clearly shown by the map which accompanies the discussion; from that it is seen at a glance that while the rainfall for the six months reached, and even slightly exceeded, the average over a narrow strip in the west of Scotland, and amounted to 75 per cent. in the north of that country, in the north-west of Ireland, in the English Lake district, and a small part of the Welsh coast, all the rest of the British Isles had less than three-quarters of the usual fall. In two large areas it fell short of 50 per cent. of the average, viz. in the south-east of Scotland and in the midland counties of England. Taking each country separately, the rainfall of the six months was:—for England and Wales 60 per cent., Scotland 78 per cent., and Ireland 75 per cent. of the average for the thirty years referred to. The necessity of economising the water supply had already made itself felt in several large towns within the dry area before the end of February.

PROF. G. TORELLI, of Palermo, contributes to the Naples *Rendiconto* (physical and mathematical section), x., 12, some new formulæ for calculating the totality of prime numbers below a given limit. The formulæ are non-asymptotical, and they are applicable to an arithmetical progression as well as to natural numbers.

IN the *Annals of Mathematics* for January, recently received, Prof. G. A. Bliss discusses the proofs of the existence of solutions of the differential equation of the first order in terms of initial values, and Prof. L. Wayland Dowling discusses the conformal representation of triangles, with special reference to cases in which the solution can be represented by hyperelliptic integrals of given deficiency.

IN a contribution to the Berlin *Sitzungsberichte* (1904, lii.), read December 8, Prof. Leo Koenigsberger discusses the extension of the principle of energy to a system having a kinetic potential of any order, and any number of variables dependent and independent. The paper forms a continuation of Prof. Koenigsberger's researches on the dynamics of systems in which *time*, instead of being one dimensional, may be of two or more dimensions.

PROF. GARBASSO has published a short note (Genoa, Angelo Ciminago, 1904) in which he proposes a new theory to account for the duplication of lines in the spectra of variable stars. According to this theory, it is assumed that the phenomena are due to the presence of an element the atoms of which are formed of two separate conductors, and that these atoms are mostly in a state of dissociation. The paper consists of a mathematical investigation of the periods of a system of electric oscillators forming a model of the supposed atoms.

IN 1890 a paper was presented to the Lincei Academy by Prof. Filippo Keller entitled "An itinerary guide to the principal magnetic rocks of Latium," of which only an abstract was printed. Since Prof. Keller's death in 1903 the complete paper has been brought out by Dr. G. Folgheraiter as No. 11 of his series of *Frammenti* dealing with the geophysics of the environs of Rome. It is accompanied by a map of the district and a portrait and biographical notice of Keller, the latter by Prof. S. Günther. It is printed by Panetto and Petrelli, of Spoleto.

THE *Revue générale des Sciences* for February 28 contains a reprint of the paper read at Breslau by Dr. A. Kohler (Jena) on photomicrography by ultra-violet-light. It is illustrated by figures showing the arrangement of the microscope and camera, and the illuminating apparatus. It is pointed out that, independently of the increase of resolving power, ultra-violet light often affords a method of differentiating between organic tissues in virtue of their different degrees of transparency to the rays, and, further, it in some cases can be used to excite interesting phenomena of fluorescence in microscopic objects.

THE *Atti dei Lincei*, xiv. (1) 3, contains a short account of some experiments by Mr. Alessandro Artom on wireless telegraphy with the use of circular or elliptically polarised waves. The experiments were divided into four groups, and in every case established the predicted property that it would be possible to send methods in definite directions by the use of these waves. Thus, in the last series of experiments, signals were sent from Monte Mario (Rome) to the island of Maddalena without any effects being noticed at the island of Ponza, which is situated some way off the line joining the first two stations. Further, it appears that with the use of circular waves the height of the aërial conductors can be reduced.

THE ninth supplement to the present series of *Communications* from the Physical Laboratory of the University of Leyden contains an address delivered in commemoration of the 329th anniversary of the University of Leyden by Dr. H. Kamerlingh Onnes, Rector Magnificus of the university. It deals with the importance of accurate measurements at very low temperatures, a need which, it is pointed out, was first appreciated by Boyle. An important application of such observations has arisen in connection with van der Waals's theory of corresponding states, and Dr. Onnes points out that further researches at low temperatures are required for the problems of the mechanism of the atom that have been forced upon us by recent discoveries. Dr. Onnes emphasises the very important work done by Dewar in rendering such low temperature observations possible.

"MATHEMATICAL Progress in America" forms the subject of Prof. Thomas B. Fiske's address to the American Mathematical Society published in the *Bulletin* of the society for February. Prof. Fiske divides the history of pure mathematics in America into three periods, the first extending up to the foundation of the Johns Hopkins University in 1876, the second extending from 1876 to 1891, when the New York Mathematical Society was converted into the present American Mathematical Society and began to issue the *Bulletin*, and the third covering recent times. The *Bulletin* contains, further, the continuation of the report on last summer's congress at Heidelberg by Dr. E. B. Wilson, and a report of the meeting of the Deutsche Mathematiker Vereinigung by Mr. R. E. Wilson. The *Bulletin* thus furnishes a summary of mathematical progress of a cosmopolitan character such as does not exist in this country.

OF the increasing attention which is being devoted on the Continent to the history of the sciences, and in particular to that of mathematics, abundant proof is afforded by vol. xii. of the *Atti* of the International Congress of Historical Sciences, which met in Rome in April, 1903. This volume is devoted entirely to the proceedings of the section which dealt with the history of mathematical, physical, natural, and medical sciences, and it occupies 330 pages. It includes general discussions by Prof. Elia Millosevich on the iconography of solar eclipses, by M. Paul Tannery dealing with proposals for advancing the history of science, some remarks by Messrs. D. Barduzzi, P. Giacosa, and Gino Loria on the introduction of university courses on history of sciences, and proposals by Prof. Gino Loria for the publication of Torricelli's works, and by Prof. Pietro Giacosa for a catalogue of the scientific manuscripts in Italian libraries and archives. Among the papers read, the two mathematicians associated with the solution of the cubic, Tartaglia and Cardan, receive mention at the hands of Mr. Tonni-Bazza and Prof. Moritz Cantor; Prof. M. Darvai deals with the life of Bolyai; Prof. A. von Braunmühl contributes an interesting paper on the history of the integral calculus; Prof. R. Amalgià writes on early theories of the tides; Prof. Icilio Guareschi on the alleged plagiarisms of Lavoisier. Altogether the volume contains no less than thirty-four papers.

ATTENTION has already been directed to the important series of papers on applied mathematics now being issued by Prof. Karl Pearson, F.R.S., under the title "Drapers' Company Research Memoirs." Two further numbers have now reached us. One of them is the fourteenth of Prof. Pearson's mathematical contributions to the theory of evolution, and deals with skew correlation and non-linear regression. The highly specialised character of the work may be inferred by quoting one of four conclusions on p. 53:—"The correlation between auricular height of head and age in girls is cubical, of nomic heteroscedasticity and of anomic heteroclisy. It is probably really a case of isocurtosis." The other paper is by Mr. L. W. Atcherley and Prof. Pearson, and deals with the graphics of metal arches. In it the authors point out the impossibility of applying purely graphical constructions with any degree of accuracy to the very flat metal arches used in modern bridges, and they propose a kind of "semi-graphical" method, depending partly on analysis and partly on graphics. Some interesting conclusions are drawn as to the relative merits of doubly pivoted, three pivoted, and doubly built in arches. These memoirs are rendered more accessible by being issued with their pages cut. They show what a lot of good work may be done by the expenditure by a public body of a very moderate sum on the endowment of mathematical research. We have another example of the same fact in the Cambridge Smith's prizes and the large number of former winners of these prizes who are now Fellows of the Royal Society.

THE widely extended use of the freezing point and boiling point methods of molecular weight determination has been to a large extent rendered possible by the manufacture of sensitive thermometers of the now familiar Beckmann type. In the current number of the *Zeitschrift für physikalische Chemie* is a very interesting paper by Mr. Ernst Beckmann giving a complete history of the differential mercury thermometer, with especial reference to the modifications it has undergone since its first use in freezing point work. He mentions the fact that the original Beckmann thermometer was due to an accident. A costly instrument, divided into 1/100ths of a degree, was being carried in the hand down a corridor when it was broken in half by the sudden opening of a door. In order still to be able to use the thermometer, a small bulb was blown on above the capillary, and from this the present type was evolved through a series of instruments illustrated in the present paper. Some of the thermometers figured are masterpieces of glass-blowing, notably one combining a Beckmann and ordinary thermometer on one instrument.

MESSRS. JOHN WHELDON AND CO. have sent us their latest catalogue of scientific books they have for sale. The catalogue includes many scarce sets of *Journals* and *Transactions*, as well as selections from the libraries of the late Prof. Everett, Dr. C. W. Siemens, and others.

THE most recent addition to the report being issued by the Engineering Standards Committee is the "British Standard Specification and Sections of Flat-bottomed Railway Rails." Copies of the publication may be obtained from Messrs. Crosby Lockwood and Son. The price is 10*s*. 6*d*. net.

WE have received from Mr. Nasarvanji J. Readymoney, of Bombay, a copy of a publication he has prepared entitled "An Outline of Descriptive, Defining Nature-History Tables, Illustrated; or Nature-History Research Thinking Tables; or Work of Genesis Minutely Tabulated." The object of the tables is to enable the student to summarise and classify "all events in nature or creation" in a philosophical manner.

THE February number of the *Journal* of the Straits Branch of the Royal Asiatic Society has reached us from Singapore. Among other important papers we notice contributions by Dr. Charles Hose on various methods of computing the time for planting among the races of Borneo, by Mr. P. Cameron on descriptions of new species of Iphiaulax and Chaolta (Braconidæ) from Sarawak, Borneo, and by Mr. H. W. Firmstone on Chinese names of streets and places in Singapore and the Malay Peninsula.

A NEW and revised edition of the volume of Prof. W. Schlich's "Manual of Forestry" dealing with forest management has been published by Messrs. Bradbury, Agnew and Co., Ltd. The mathematical problems have been simplified, and some of the calculations have been shortened. The appendices have been considerably altered. In the preface to the new edition Prof. Schlich directs attention to the fact that the most urgent need of British forestry is the collection of statistics, which will enable the proprietor and his forester to gauge the economic value of forest operations. He insists that the fully equipped forester must have a good knowledge of mathematics if he is to secure the best results.

A NEW encyclopædia, prepared and printed by Messrs. T. Nelson and Sons, is to be published in forty fortnightly parts under the title of the "Harmsworth Encyclopædia." Three of these parts, each of 160 pages, have been received, and judging from these we do not hesitate to say that the complete work should be a useful aid to students and a responsive friend to general readers. So far as we have tested the parts received, we have found the information accurate and confined to essential points. Of course, it must be understood that within the limited space allotted to any subject only bare outlines can be described; but as references are in many cases given to authoritative works, inquiring readers may be led to pursue their search for information, inspired by what they find in this encyclopædia. The work is liberally illustrated, and as a convenient guide to information which men and women often seek to know it will be of service.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN APRIL:—

April 4. 2h. Mercury at greatest elongation (19° 11′ E.).
5. 23h. Mercury in conjunction with the Moon. (Mercury 7° 28′ N.).
6. 6h. Jupiter in conjunction with Moon. (Jupiter 3° 35′ N.).
9. 11h. 4m. Minimum of Algol (β Persei).
12. 7h. 53m. Minimum of Algol (β Persei)
15. Venus. Illuminated portion of disc = 0·049; of Mars = 0·975.
17. 8h. 18m. to 9h. 12m. Moon occults η Virginis (mag. 4·c).
20–22. Epoch of Lyrid meteors (Radiant 271° + 33°).

DISCOVERY OF A NEW COMET, 1905 *a*.—A telegram from the Kiel Centralstelle announces the discovery of another new comet by M. Giacobini at Nice on March 26.

The position of the comet at 8h. 11·8m. (M.T. Nice) was R.A. = 5h. 44m. 14s., dec. = +10° 56′ 56″, and its daily movement in R.A. = +3m., in dec. −1° 15′.

This shows the object to be in the constellation Orion, about 6m. W. and 3° 34′ N. of Betelgeuse, or a little more than one-fourth the distance from Betelgeuse to ζ Geminorum, along a straight line joining the two. Apparently the comet passed very near to Betelgeuse on March 29.

COMET 1904 *e* (BORRELLY).—A continuation of the daily ephemeris for comet 1904 *e* is given by Dr. E. Strömgren in No. 4004 of the *Astronomische Nachrichten*.

The ephemeris extends from March 29 to May 4, and from it we see that on the first named date the comet will apparently be situated very near to ζ Aurigæ, and will have a brightness of 0·24. Travelling thence in an E.N.E. direction it will enter the constellation Lynx, its computed position on May 4 being R.A. = 7h. 0m., dec. = +45° 17′, whilst its brightness on that date will be 0·12. The brightness at time of discovery (about mag. 10) is taken as unity.

OBSERVATIONS OF THE RECENT ECLIPSE OF THE MOON.—In No. 9 (1905) of the *Comptes rendus* is published a paper by M. Puiseux wherein he discusses a series of twelve photographs taken between 7h. 32m. and 8h. 12m. on the occasion of the partial lunar eclipse which occurred on February 19.

Amongst other conclusions he states that the apparent changes in the aspects of the circles Messier and Messier A are simply due to differences of illumination and not to actual variations, and that, whilst the recent observations of these two circles and of Linné are not in accordance with the records obtained prior to 1866, there is no substantial evidence for recent changes in these features such as have been announced by several selenographers. M. Puiseux believes that many of the circles are undoubtedly of later origin than certain systems of divergent streaks seen on the lunar surface.

NEW VARIABLE STARS IN THE REGION ABOUT δ AQUILÆ.—In No. 4005 of the *Astronomische Nachrichten* Prof. Wolf publishes a list of thirty-six newly discovered variable stars in the region about δ Aquilæ. Their variability was detected by the comparison of two plates taken with the Bruce telescope on July 12, 1902, and July 6, 1904, respectively. The positions (1875·0) of the new variables are given in the catalogue, and, together with the positions of four others which are also probably variable, are shown on thirty-two circular charts accompanying the paper, each chart including a field twenty-one minutes of arc in diameter. In a second table the magnitudes of the stars on the two plates mentioned above are compared with the magnitudes as shown on a third plate taken on August 11, 1898.

ORBIT OF THE BINARY STAR CETI 82.—The orbit of the binary star Ceti 82 (designated 395 in Prof. Burnham's catalogue) is discussed by Prof. Aitken in *Bulletin* No. 71 of the Lick Observatory.

The Lick observations confirmed the rapid orbital motion, but have also indicated a very different orbit from that previously published by Prof. See (*Astronomische Nachrichten*, vol. cxliv., p. 359, 1897).

The elements obtained by Prof. Aitken show a period of 24·0 years, and give the G.M.T. of periastron passage (T) as 1899·7. The elliptical orbit is graphically presented, and shows the differences between the observed and computed places. The eccentricity of the ellipse is 0·15, and the apparent length of its semi-major axis 0″·66 of arc. Prof. Aitken also gives an ephemeris extending from 1905·7 to 1910·7.

RADIAL VELOCITIES OF CERTAIN STARS.—In No. 70 of the Lick Observatory *Bulletins* Prof. Campbell and Dr. H. D. Curtis discuss the radial velocities of Polaris, η Piscium, ε Aurigæ, and Rigel from the spectrograms obtained at Lick during the last eight years.

In the case of Polaris, the measurement of groups of plates taken during the last four years indicated that the velocity of the centre of mass of the rapid pair in this triple system is changing very regularly with a period of at least eleven or twelve years, but the period may be found to be much longer when further observations are completed.

The radial velocity of η Piscium was suspected by Prof. Lord to be variable with a long period, but as no spectrograms of this star were secured at Lick during the period covered by him, the Lick observations do not settle the question, although the values obtained only range from +16·6 to 13·3 km. per second, whilst Prof. Lord's range was from +9·5 to 25·4 km.

The spectrograms obtained of ε Aurigæ fully confirm Prof. Vogel's conclusion that this star is a spectroscopic binary with a period of several years.

Prof. Vogel's view that Rigel has a variable radial velocity is not confirmed by the Lick observers, who rather favour the conclusion arrived at by Profs. Frost and Adams that the apparent variation is only a function of the difficulty experienced in measuring the wide lines.

STAR PLACES IN THE VULPECULA CLUSTER.—In No. 4004 of the *Astronomische Nachrichten* Dr. H. Meyer gives a catalogue of the positions of thirty-five stars in the Vulpecula cluster. The catalogue contains the B.D. number, the magnitude, and the positions, the latter referred to the equinox of 1900·0 for the epoch of observation 1901·6. The precession and the secular variation in each coordinate are also given for each star, and in the case of fourteen of the brighter ones the proper motion, as determined from the discussion of previous catalogues, is likewise given.

THE U.S. COAST AND GEODETIC SURVEY.

THE report of the Coast and Geodetic Survey for 1904 is a record of manifold labours and results which have for their theatre of action an area practically coterminous with that of the United States and all its island possessions. The main body of the report contains a detailed account of the wide range of duties devolving upon this bureau, and in the appendices we have a presentation of discussions and results which must prove of great economic value and interest to surveyors, engineers, navigators, and physicists.

The re-surveys and developments imperatively required to show the changes in harbours and approaches due to works of improvement or the ceaseless action of natural causes along the Atlantic, Pacific, and Gulf coasts of the United States, and to meet the ever-increasing demands of commerce and the Navy for up-to-date charts, particularly of the waters of Alaska, Porto Rico, Hawaii, and the Philippines, gave constant employment to the eleven vessels available for these duties.

In Alaska the work included the continuation of the survey of Prince William Sound, the survey of Controller Bay, and a deep-sea examination from the Strait of Juan de Fuca to Prince William Sound, preliminary to the laying of a deep-sea cable from Seattle to Valdez. The Porto Rico work was continued in certain bays and harbours as well as in the development of the conditions in the off-shore waters. In the Philippine Archipelago the Survey has secured the cooperation of the Insular Government, and a detailed *résumé* shows a most satisfactory progress of the triangulation, hydrographic, topographic, magnetic, and astronomical operations.

The reconnaissance for the primary triangulation along the 98th meridian was completed to the Canadian border, and a scheme was extended eastward connecting this work with the triangulation of the Mississippi River Commission. The execution of the primary triangulation in the Dakotas and Texas was prosecuted at a rate which surpassed even the notable record which had already secured an enviable reputation for the geodetic operations along the 98th meridian, the total extension amounting to 300 miles (500 kilometres). An equal distinction must be accredited to similar work in California and Oregon, whereon remarkable progress has been made in connecting the Transcontinental Arc work with Puget Sound.

The progress of the magnetic work is shown in detail in Appendix No. 3, which includes a table of results of the magnetic declinations, dip and intensity of force observed on land and sea during the year, this being supplemented with full descriptions of the magnetic stations occupied and meridian lines observed. (This report has been noticed separately, NATURE, March 9, p. 449.)

The determination of the longitude of Manila from San Francisco, thus completing the first longitude circuit of the earth, was one of the astronomical events of the year, and in Appendix No. 4 is a comprehensive illustrated report on the various instruments and operations used in the undertaking, with a comparative *résumé* of the various links and results from which the longitude of Manila had been determined from the westward. The generous cooperation of the Commercial Cable Company, through the patriotic enterprise of which the work was made feasible, is gratefully acknowledged. The results of the determinations from the eastward and westward differ only by 0·006s., or about 8·8 feet. The other results of this expedition are the determinations by the telegraph method of the longitudes of Honolulu and Midway and Guam Islands.

The third attempt at representing the tide for the world at large, the first having been made by Whewell and Airy and the second by Berghaus, is described in Appendix No. 5. The advancement in recent years of the general use of the harmonic analysis, and the greatly improved tidal data that are now obtainable for such a great part of the globe, coordinate to make a new presentation of this subject very opportune. The theoretical discussion of the problems involved, the wide range of data and authorities consulted and referred to, the graphic presentation of the cotidal lines, the results presented, and the conclusions deduced, make a most suggestive paper, and one which will be highly interesting to all students of the subject.

The results of the precise levelling operations for the year are published in Appendices Nos. 6 and 7, which submit them in a detail that makes them immediately available for the requirements of surveyors and engineers. These extend the precise level net, as previously published, six hundred miles to the westward, from Red Desert, Wyoming, to Owyhee, in eastern Idaho, and from Holland, Texas, two hundred miles south-west, to Seguin, Texas. An interesting feature is an account of the change in the manner of support for the levelling rods, with the comparative discussion of the old and the new methods, and the consequent confirmation of the importance of the new system.

The account of operations submitted by the assistant in charge gives the story of the work of the various computing, drawing, engraving, and chart divisions of the office in which the results of the field work are discussed or prepared for the publications and charts wherein they are placed at the service of the public.

A full account of the first recording transit micrometer devised for use in the telegraphic longitude determinations of the Coast and Geodetic Survey is submitted in Appendix No. 8, with an account of the exhaustive tests it was subjected to, and a recapitulation of the results of experience with this form of instrument, mainly in Europe, during the last thirteen years. The results of these experiments indicate that with the transit micrometer the accuracy of telegraphic longitudes may be considerably increased if desirable, or the present standard of accuracy may be maintained at much less cost than formerly.

The results of all triangulation in California south of the latitude of Menterey Bay are printed in the concluding appendix in full, including descriptions of stations as well as their latitudes and longitudes and the lengths and azimuths of the lines joining them. In compact and convenient form there is given all the information in regard to this triangulation that is needed by an engineer or surveyor who wishes to utilise the results in controlling and checking surveys or in constructing maps or charts. The locations of more than 1300 points are accurately fixed by this triangulation.

The report, in addition to the details of the foregoing operations and results, contains a record of a wide range of important work for which the aid of the Survey was sought because of the special training of its officers.

PROTECTIVE RESEMBLANCE.

AN interesting paper on "Protective Resemblance in the Insecta," by Mr. Mark L. Sykes, is published in the *Proceedings* of the Manchester Field Club (vol. i., part ii). After briefly describing the law of natural selection, as propounded by Darwin, the evolution of new species through variations, and the elimination of the least fit during long periods of time, reference is made to the colours of insects, to the advantage of conspicuous adornment, and the consequent easy identification of those of them which possess some feature repellent to the insect-eating animals. The absence in young animals of an intuitive faculty of discrimination between edible and inedible material in the selection of food is emphasised, and reference is made to authors who have experimented on the subject.

Müller's theory of mutual protection, through similarity of colours and patterns, amongst inedible Lepidoptera, and Bates's explanation of the "mimicry" or simulation of distasteful species by edible species, are described, and the superficial resemblances between entirely different species and genera are attributed to the influence of natural selection and elimination, and the transmission and accumulation of variations. The method by which many of these likenesses are produced is shown by a number of camera lucida drawings of the wing scales of many of the butterflies and moths referred to and illustrated in the article; and the scale variations, in colour, size, pattern and arrangement, which produce a common resemblance in the insects, are described. Another branch of the subject, treated in some detail, is protective resemblance of environment, as seen in the striking similarity of many insects, especially amongst the Lepidoptera and Orthoptera, to leaves, twigs, moss, &c.; and a number of illustrations are given of resemblance to natural surroundings, three of which we select as examples.

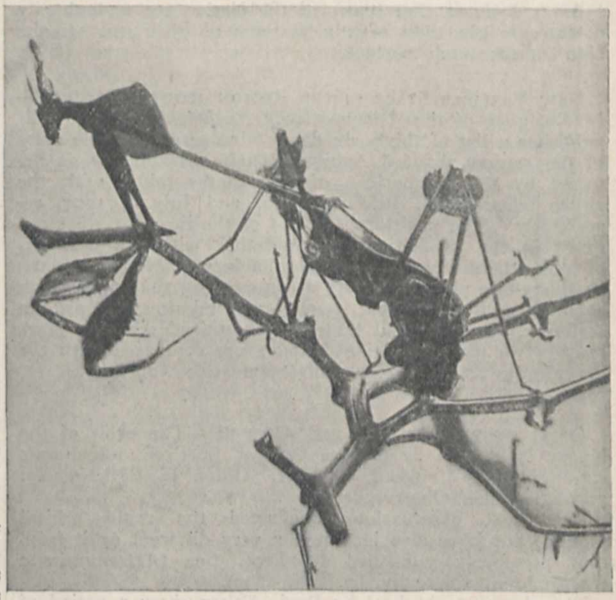

FIG. 1.—*Empusa gongylodes* (Ceylon) at rest on twi

Among the many curious and interesting insects which are found in Ceylon, *Empusa gongylodes* is one of the most singular. It is a brown insect. The thorax is like a long

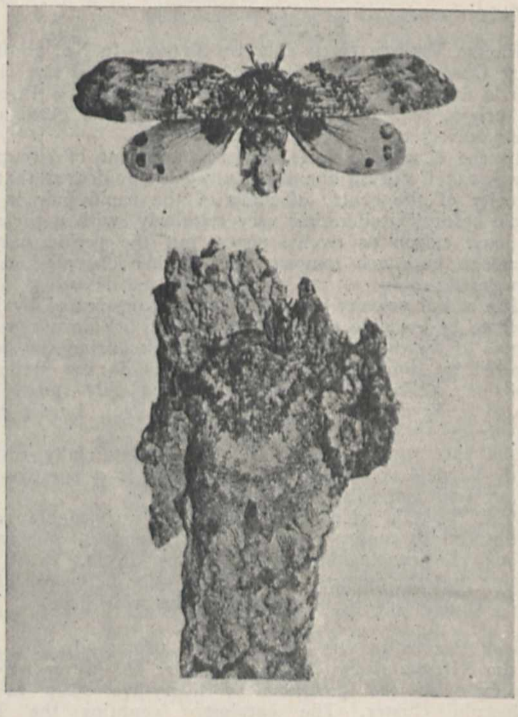

FIG. 2.—*Eurybrachis Westwoodii* (Ceylon) with the wings expanded, and at rest upon a piece of bark.

thin twig, with a wide leaf-like expansion immediately behind the head. The wings are broad, veined and crumpled, like dried leaves, and the long legs, which are spread out in any direction as the animal is at rest, harmonise so closely with the twigs to which they cling that it is difficult to see where one begins and the other ends. Fig. 1 illustrates this insect in the attitude in which it was resting before being captured.

Another interesting insect from Ceylon is one of the moths, *Eurybrachis westwoodii*. The fore wings of this insect are marked in a mottled pattern of green, grey and brown, the hind wings being white, with deep claret-coloured marks near their base, and when it is on the wing the moth is an attractive-looking creature. But its appearance alters when it is at rest, with the mottled wings folded over the back. In Fig. 2 it is shown with the wings expanded as it appears when flying, and below is a piece of bark with the same insect resting upon it, where it was discovered by the keen sight of the collector—a clever capture, as will be admitted when it is noticed how excellently the wings and bark harmonise, and how they seem almost to merge one into the other.

There is found in Madagascar a small beetle which, looked at apart from its natural surroundings, has nothing specially interesting about it except that it is a conspicuous, rugged-looking, pure white and black insect, about three-quarters of an inch long. It feeds upon a species of fungus, which grows upon the bark of trees in mixed cream and black coloured patches. The beetle is shown at the

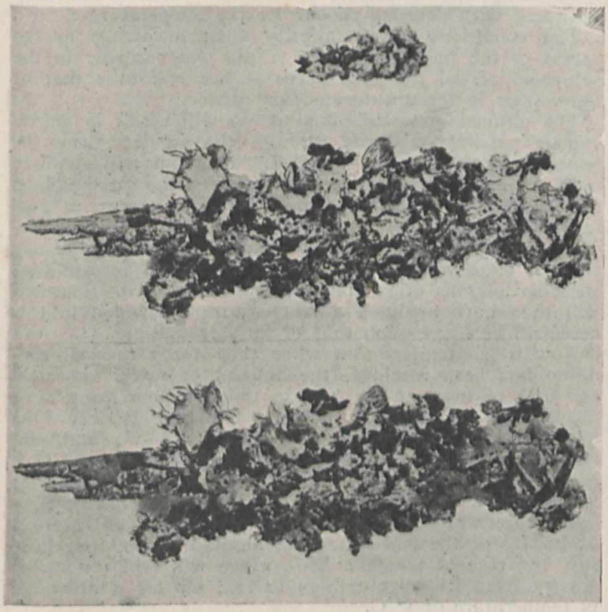

FIG. 3.—*Lithinus nigrocristatus* (Madagascar). The upper figures show beetle and bark separately, and in the lower figure *the beetle is on the bark*.

top of Fig. 3, and beneath it a piece of twig with the fungus growing upon it. At the bottom of the same illustration the same piece of fungus-covered twig is shown, but here the beetle is resting right in the middle of the fungus, effectually concealed amongst the vegetation upon which it feeds.

The paper is very fully illustrated by more than two hundred figures of the insects described, with the localities in which they were taken, covering the whole subject treated by Mr. Sykes.

Exception is taken to the use of the words "imago" and "imagine," introduced by Linnæus, as representing the final stage of insect metamorphosis, and "matura" (maturo = to ripen) is suggested and employed as a substitute, conforming conveniently with the accepted terms for the earlier stages—larva and pupa. The word "mimicry" is also adversely criticised, as implying conscious resemblance, which is not known to exist, and "simulism," "simulation," "simulating," are substituted "as being at once expressive, explanatory and euphonious, and free from the inference of designed and cognitive resemblance."

REPORT OF THE CARNEGIE INSTITUTION, 1904.[1]

IN NATURE for January 7, 1904, a list was given of the awards made by the Carnegie trustees for the prosecution of inquiries in various scientific directions. The third year book, just published by the board of trustees, contains reports upon most of these researches, but the time is far too short to gather in the full harvest, which may hereafter be expected, from so lavish and, presumably, judicious expenditure. There is abundant evidence that many well-known men, engaged in every department of science, have been enabled to attack problems which must otherwise have been neglected, or pursued with inadequate material and less energy. Beyond this general fact, the present volume does not, in most instances, enable us to estimate the results. The balance sheet attached shows that the trust is in a very flourishing condition, and that 267,000 dollars have been provided for inquiries, which the management discuss under the three heads of large, special, and minor grants.

Under the division of large grants, we have a description of the station erected, or adapted, for the study of experimental evolution at Cold Spring Harbour, some twelve miles from New York. Plans of the building are given, and a full account of the opening ceremony, at which Dr. Hugo de Vries gave a scientific address. The objects sought to be gained by such an institution are typical of the uses of the trust, and legitimately appeal to a liberal consideration. The investigations must be long continued, the results may be doubtful or negative, and it is a research which no individual or institution is likely to undertake on a scale sufficiently broad to produce decisive results.

Another far-reaching scheme, the Marine Biological Laboratory at Dry Tortugas, Florida, under the care of Dr. H. G. Mayer, is quite in its first stages of development, but one whose usefulness may be confidently predicted in due time. The buildings that have been erected consist of a main laboratory, 100 feet long, one story high, and with special arrangements for keeping the building cool in the hot weather of those latitudes. A feature in the construction of the laboratory and of the smaller buildings connected with it, is that all are made portable, so that they can easily be removed from their present site and erected elsewhere if thought desirable. Attached to the station is a sea-going vessel of light draft, fifty-seven feet over all, and sixteen feet beam, with a 20 h.p. naphtha engine. There is sufficient accommodation for seven men on board, and the vessel is specially designed to dredge in depths of 500 fathoms or less. Among other projects for which large grants have been made is the subject of economics, whose many subdivisions include, among others, population and immigration, mining and manufactures, banking and finance, social legislation and the labour movement, &c. Reports on all these subjects have been added, showing the scope of the respective inquiries and the progress that has been made. Historical research and terrestrial magnetism are the remaining two subjects which come under the division now being considered. On the latter subject we have some of the results of the discussion of the magnetic disturbance observed during the eruption of Mont Pelée, which are of special interest, since the inquiry discloses the fact that in certain respects the disturbance resembled those storms which are believed to be of cosmic origin.

The Transcaspian archæological expedition and geophysical research are the subjects of special grants. The former is under the charge of Prof. Pumpelly, who left America in December, 1903, and began excavations in the following March, first attacking Anau, in Turkestan. By means of excavations in tumuli and by shafts sunk in the city of Anau, the exploring party has traversed some 170 feet of the accumulations of successive generations of peoples, extending from recent times, through the iron and bronze civilisations, and some 45 feet deep into the stone age. Among the objects of this investigation is the hope of throwing some light on the source of our domestic animals.

The reports on the subjects of the so-called smaller grants cannot be particularly referred to here. The inquiries cover

[1] Carnegie Institution of Washington. Year Book, No. 3, 1904. (Washington: Published by the Institution, 1905.)

the whole ground of physical science, and are in many instances of the greatest importance, but generally have reference to definite researches undertaken by individuals not calling for wide cooperation. A list of papers, prepared possibly to pave the way for future applications, is added, in which are discussed the conditions of solar research at Mount Wilson, by Prof. Hale; the southern observatory project, by Prof. Boss; fundamental problems of geology, by T. C. Chamberlin; plans for obtaining subterranean temperatures, by G. K. Gilbert; magnetic survey of the Pacific Ocean, by L. A. Bauer; and geological research in Eastern Asia, by B. Willis.

THE RECEPTION AND UTILISATION OF ENERGY BY A GREEN LEAF.[1]

THE subject of my lecture is derived from the series of papers laid before the society to-day by my colleagues and myself, dealing with some of the physiological processes of green leaves. In giving an account of some of these investigations I shall dwell mainly on their relation to the *energetics* of the leaf, and shall endeavour to show how the leaf behaves under various conditions when regarded from the point of view of the exchange of energy between itself and its surroundings.

One of the problems which we attempted to solve was to draw up a "revenue and expenditure account" of energy for a green leaf, showing the proportion of the incident energy absorbed, the amount of this absorbed energy which is used up for the internal work of the leaf, and the proportion which is dissipated by re-radiation and the losses due to the convective and conductive properties of the surrounding air under varying wind-velocities.

Of these various factors, the one I have last mentioned, which presupposes a knowledge of the *thermal emissivity* of the leaf-surface, presented by far the greatest difficulty; but during the past year Dr. W. E. Wilson and I have been able to devise a suitable method for determining the thermal emissivity of a leaf-surface in absolute units, so that our story is now fairly complete.

The discussion of the thermal relations of a leaf to its surroundings will be simplified if we first consider the case of a leaf when it is shielded from solar radiation. We will assume that a detached leaf, freely supplied with water, is placed in an enclosure the walls of which are non-reflective and are maintained, along with the enclosed air, at a perfectly uniform temperature t. We will further assume that the air is saturated with water-vapour.

Under these conditions the system would remain in thermal equilibrium if it were not for the respiratory processes going on within the leaf-cells. These are exothermic in their final result, so that the state of complete thermal equilibrium can only be attained when the temperature of the leaf has risen to a point t', somewhat higher than t. The magnitude of the difference $t'-t$, representing the maximal thermometric disturbance between the leaf and its surroundings, will depend on three main factors:—

(1) On the rate of evolution of the heat of respiration.

(2) On the rate at which this heat is dissipated by the thermal emissivity of the leaf-surface, and,

(3) On the magnitude of the slight rise of partial pressure of the water-vapour in the interspaces of the leaf, which gives rise to a certain amount of diffusion of water-vapour through the stomata.

The rate of evolution of the heat of respiration can be deduced with sufficient exactness from the amount of carbon dioxide liberated per unit area of the leaf-lamina in unit of time, since there is evidence that the carbon dioxide proceeds from the oxidation of a carbohydrate with a heat of combustion which cannot be far removed from 3760 calories per gram. Taking the concrete example of a leaf of the sunflower respiring at the rate of 0·70 c.c. of carbon dioxide per square decimetre per hour, it can be shown that the heat of respiration in this case amounts to about 0·00582 calorie per square centimetre of leaf-lamina per minute. From the known weight of a square centimetre of the leaf-lamina, and its specific heat, this spontaneous liberation of energy within the leaf might conceivably raise its temperature through 0°·033 C. per minute, provided there were no simultaneous losses due to radiation, conduction and convection of the surrounding air, and internal vaporisation of water. All these sources of loss, of course, become operative immediately the temperature of the leaf exceeds that of its surroundings. We shall see presently that the thermal emissivity of this leaf in still air is 0·015 calorie per square centimetre of leaf-surface per minute, for a difference of temperature of 1° C. between the leaf and its surroundings, so that the temperature of the leaf, under the conditions postulated, cannot exceed that of its surroundings by more than

$$0{\cdot}00582/2\times0{\cdot}015=0°{\cdot}019 \text{ C.}$$

But this is assuming that transpiration has been in abeyance, which is certainly not the case, so that this small temperature difference of 0°·019 C. will be still further reduced.

The main point which I wish to bring out here is that the thermometric disturbances due to the processes of respiration are very small, so small, in fact, that they may be neglected in considering the large disturbances induced by other causes.

Let us now suppose our leaf to be placed under the same conditions as before, but in air which is not fully saturated with aqueous vapour for the temperature t.

The conditions are manifestly unstable owing to the excess of the partial pressure of the water-vapour in the saturated air of the interspaces of the leaf over that of the vapour in the unsaturated air outside.

The diffusion-potential thus set up will result in water-vapour passing outwards through the stomata, and the temperature of the leaf will fall. This fall will continue until the gradient of temperature between the surroundings and the leaf is sufficiently steep to allow energy to flow into the leaf from without at a rate just sufficient to produce the work of vaporisation, at which point a steady thermal state will be established which will remain constant so long as other conditions are unaltered. The leaf will then have assumed a temperature t', which in this case will be *lower* than that of its surroundings.

Now it is manifest that when this steady thermal condition has been attained, the amount of water vaporised per unit of area of the leaf in unit of time must be a measure of the energy flowing into the leaf for the gradient of temperature represented by $t-t'$, and provided we determine the amount of water lost by the leaf, and the temperature difference between the leaf and its surroundings under the steady conditions, we have all the data necessary for finding the *coefficient of thermal emissivity* of the leaf-surface in absolute units, that is to say, the rate at which a leaf-surface will emit or absorb energy from its surroundings in still air for a difference of temperature of 1° C.

Following out this idea, Dr. Wilson and I have successfully determined the constants of thermal emissivity for leaves of different kinds, both under "still-air" conditions and in air-currents of determinate velocity. The results are interesting from several points of view, since amongst other things they enable us to estimate the rate at which the excess of solar radiant energy falling on a leaf is dissipated by mere contact with the air moving at any ordinary wind-velocity, and they also give us, under certain conditions, a means of deducing the actual rate of transpiration from mere observations of temperature-differences.

Before proceeding to show more in detail the manner in which the thermal emissivity of a leaf is determined, we will turn for a moment to the magnitude of the difference of temperature between a leaf and its surroundings which may be expected from a given rate of transpiration. We will assume that the leaf of a sunflower, transpiring into the unsaturated air of the enclosure, when the steady thermal condition is attained, is losing water at the rate of 0·5 gram per square decimetre per hour, or 0·0000833 gram per square centimetre per minute.

The heat required to vaporise this amount of water at 20° C. is $0{\cdot}0000833\times592{\cdot}6=0{\cdot}04938$ calorie, which, on the theory of exchanges, must represent the amount of energy entering and leaving a square centimetre of the leaf-lamina per minute. The thermal emissivity of this leaf

[1] The Bakerian lecture, delivered at the Royal Society, March 23, by Dr. Horace T. Brown, F.R.S.

is 0·015 calorie per square centimetre of leaf-*surface* per minute, for a temperature gradient of 1° C., so that the temperature difference $t-t'$ will be represented by

$$0{\cdot}04938/2\times0{\cdot}015=1^{\circ}{\cdot}64\ \text{C.}$$

For the simultaneous determination of the temperature difference $t-t'$ and the amount of water transpired, we employed two differential platinum-resistance thermometers each consisting of about 2·4 metres of fine wire arranged in a mica and ebonite plate so as to form a flat grid, against the two sides of which two similar leaves were lightly pressed and held in position by ebonite frames furnished with cross-threads of silk. The two leaf-laminæ were thus in close apposition to the resistance-coils, which were favourably placed for rapidly acquiring the mean temperature of the leaves, which were supplied with water from two small tubes attached to the frames. A definite area of leaf-surface was exposed, amounting in each case to 139·4 square centimetres. The loss of the water of transpiration was determined by weighing the apparatus at suitable intervals.

The difference in temperature between the two coils was determined by means of a Callendar's recorder. Instead of determining the difference of temperature between the leaf and the surrounding air, it was found more convenient to clothe both coils with leaves, but to arrange them in such a manner as to produce differential transpiration between the two pairs, a result which can in most cases be brought about by arranging one pair of leaves with their dorsal sides turned to the platinum coils, and the other pair with their dorsal sides facing outwards. Owing to the comparatively rapid thermal adjustment which takes place, the results are not affected by the gradual closing of the leaf stomata during an experiment, provided the record is correctly integrated so as to give the mean difference of temperature. From this mean difference of temperature between the two pairs of leaves, and the differential transpiration corresponding to this, the thermal emissivity of the leaves is readily calculable.

As an example, we may take an experiment with the leaves of *Liriodendron tulipifera,* in which the experiment lasted 129 minutes. The difference in the amount of water transpired by the two pairs of leaves was 0·510 gram, and the mean temperature difference was 1°·41 C. Taking the latent heat of water at 593·6 calories, it follows that $0{\cdot}510\times593{\cdot}6=302{\cdot}7$ represents in calories the excess of energy which must have entered the cooler pair of leaves from their surroundings, an excess which is conditioned solely by the temperature gradient of 1°·41 representing the difference of temperature between the two sets of leaves. The surface area of the leaves exposed was 139·4 square centimetres, so that the *thermal emissivity* of a square centimetre of leaf-surface per minute for a 1° C. temperature gradient will be

$$302{\cdot}7/129\times139{\cdot}4\times1{\cdot}41=0{\cdot}01194\ \text{calorie.}$$

As examples of the extent to which the thermal emissivities of leaves of various plants differ, the following may be given. They represent the emissivity under conditions of still air:—

Thermal Emissivity of Leaves of Various Species of Plants, under Still-air Conditions.

Species of Plant	Therma emissivity in calories per sq. cm. of leaf-surface for a 1° C. excess of temperature	
	Per minute	Per second
Liriodendron tulipifera (*a*)	0·0119	0·000199
,, ,, (*b*)	0·0127	0·000212
Helianthus multiflorus	0·0150	0·000249
Tropoeolum majus	0·0142	0·000237
Tilia europoea	0·0159	0·000266

Under ordinary outdoor conditions we never have to deal with perfectly still air, and the inquiry had therefore to be extended to the influence of *moving* air currents on the thermal emissivity of leaves.

This was investigated by observing the differential temperature and differential transpiration when the two pairs of leaves were placed in a shaft through which a current of air was passed having a definite and steady velocity. The results of two such experiments with leaves of *Liriodendron tulipifera* and *Helianthus multiflorus* are given in the figure. It will be seen that the effect of the cooling or heating due to the air is a linear function of the velocity, the coefficient of thermal emissivity of the leaf-surface increasing at the rate of 0·017 calorie per square centimetre per minute for an increased velocity of the air current of 100 metres per minute. This effect of moving air in dissipating the excess of radiant energy falling on a leaf is a very important fact in the economy of some plants in which transpiration is reduced to a minimum, and it is one of nature's means for preventing the rise of temperature in strongly insolated plants from reaching a dangerous point.

We must now turn our attention to the thermal relations of a leaf to its surroundings when it is receiving direct solar radiation, and here again, for the purpose of simplifying my argument, I must ask you to imagine an ideal set of conditions under which a healthy leaf, well supplied with water, is exposed to sunlight of constant intensity, and that there is no variation in the temperature, humidity, or degree of movement of the surrounding air, or in the dimensions of the leaf stomata.

As in the previous case, a state of thermal equilibrium will be speedily established between the leaf and its environment, when the simultaneous loss and gain of energy will just balance.

When this condition is attained, let R represent the total radiation falling on 1 square centimetre of the leaf

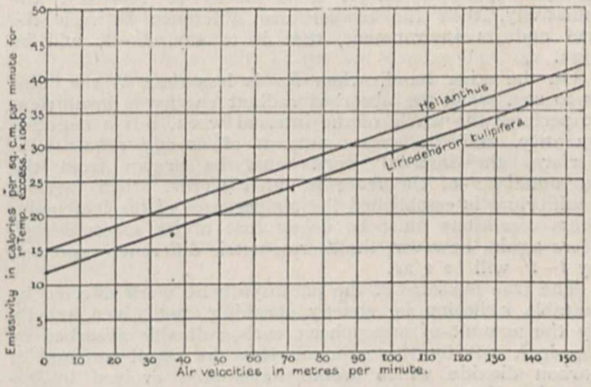

FIG. 1.—Influence of moving air on the thermal emissivity of leaves.

in one minute, and, further, let the "coefficient of absorption" of the leaf for this radiation be represented by a; then Ra will represent the radiant energy absorbed per square centimetre of leaf-lamina per minute.

At this stage it is of some interest to give absolute values to R and a in order to see what would be the thermometric effect produced on a leaf by ordinary sunshine in default of there being some ready means of dissipating the absorbed energy.

If we denote the mass of a square centimetre of the leaf-lamina by m, and its specific heat by s, then on the above assumption the rise of temperature of the lamina per minute will be represented by Ra/ms.

Let $R=0{\cdot}8$ calorie per square centimetre per minute, which represents the intensity of ordinary summer sunshine in these latitudes.

Let a, the coefficient of absorption, be 0·78, a value which is determinable by a method presently to be described; further, let the mass, m, of a square centimetre of leaf be 0·020 gram, and its specific heat $s=0{\cdot}879$, then the rise of temperature of the leaf under the conditions postulated will be at the rate of

$$0{\cdot}8\times0{\cdot}78/0{\cdot}02\times0{\cdot}879=35^{\circ}{\cdot}4\ \text{C. per minute,}$$

a result which would be speedily fatal to the leaf.

The dissipation of the absorbed energy necessary to keep the temperature of the leaf within working limits is provided for, on the one hand, by the internal work of the leaf, consisting mainly of the vaporisation of water, and to a less extent of the endothermic process of photosynthesis, and on the other hand by the losses due to thermal emissivity, which even in still air are considerable, and may assume large dimensions if the air is in movement.

First, as regards the energy used in internal work, that portion which produces the vaporisation of water, and which I will denote by W, is determinable from the weight of water lost by a given area of the leaf in a given time, and from the known latent heat of water-vapour. On the other hand, the amount of the absorbed energy which is used up in the photosynthetic process, and which I will denote by w, is deducible from the actual amount of carbon dioxide which enters the leaf, on the legitimate assumption that the synthesised product is a carbohydrate, the heat of formation of which is approximately known.

The generalised form of the thermal equation of a leaf which is receiving solar radiation, and has acquired a state of thermal equilibrium, may therefore be represented by $Ra = (W + w) \mp r$.

When Ra is greater than $W + w$, that is to say, when the energy absorbed by the leaf in a given time is more than sufficient to perform the whole of the internal work, r is a positive quantity, and represents in absolute units the sum of the losses due to radiation and convective cooling, and it is the only portion of R which can produce a rise of temperature in the leaf.

Provided we know the thermal emissivity of the particular leaf which we are using, the actual rise of temperature of the leaf-lamina above its surroundings can be determined from r; for if e is taken to represent the emissivity, then the temperature difference between the leaf and its environment, that is to say, $t' - t$, will be $r/2e$.

On the other hand, when Ra is less than $W + w$, that is to say, when the absorbed radiant energy is insufficient to perform the whole of the internal work, r is a negative quantity, and the excess amount of energy requisite to perform the internal work must be drawn from the surroundings of the leaf; in other words, when thermal equilibrium is established the temperature of the leaf under these conditions must be *below* that of its surroundings. Here again, however, the thermometric difference expressed by $t - t'$ will be $r/2e$.

The true measure of the photosynthetic work effected by suitable radiation is, strictly speaking, not given exactly by the amount of atmospheric carbon dioxide absorbed by the leaf, but by this amount *plus* the small amount of carbon dioxide which would have been evolved by respiration if photosynthesis had been in abeyance. This is a correction which has to be taken into account in certain special cases, but it does not affect the generalised thermal equation I have given, since the heat of respiration is opposite in sign to that of the heat of re-formation of the carbohydrate, and these values, representing a concurrent gain and loss of energy by the leaf, must exactly balance each other if the carbohydrates standing at the two ends of the reversed process are identical, and if they are not identical the difference in their thermal relations must be so small as to be inappreciable.

Before proceeding to show how these general views can be applied to the construction of a revenue and expenditure account of energy for a leaf, I must briefly refer to the mode in which the various factors have been determined. We have already considered the manner in which the thermal emissivity of the leaf e is determined, a value which is all-important in considering the temperature of the leaf, and I have also sufficiently indicated how we can determine the work of transpiration, and consequently the value of W.

R, the intensity of the solar radiation falling on the leaf-surface, was measured by means of a specially constructed Callendar's radiometer, the coils of which were enclosed in a flat rectangular case mounted on an adjustable stand so that the orientation of the receiving surfaces could be made to correspond with that of the leaf under experiment. The radiometer was connected with a Callendar's recorder furnished with a planimeter which automatically integrated the curve recorded on the drum.

The constants for the instrument were determined for us by Prof. Callendar, and the planimeter readings were readily convertible into water-gram-units of energy incident on unit area of surface in unit of time, thus giving a mean value of R.

The proportions of the radiant energy of sunlight respectively absorbed and transmitted by the leaf-lamina were determined with the same instrument by observing in steady sunlight the amount of radiation which reaches the radiometer with and without the interposition of the leaf. This gives a measure of the coefficient of absorption of the leaf a with a close approach to accuracy, if we neglect the amount of reflected radiation, which is very small in cases of perpendicular incidence.

The coefficient of absorption, as might be expected, varies considerably with leaves of different species of plants, as shown in the following table, and there are also small individual differences in leaves of the same plant.

Coefficients of Absorption (a) *and Transmission* ($1 - a$) *of the Radiant Energy of Sunlight for Leaves.*

Plant	Coefficient of absorption (a)	Coefficient of transmission ($1 - a$)
Helianthus annuus	0·686	0·314
Polygonum Weyrichii	0·647	0·353
Polygonum Sachalinense	0·691	0·309
Petasites officinalis	0·728	0·272
Silphium terebrinthaceum	0·699	0·391
Arctium majus	0·728	0·272
Verbascum olympicum	0·758	0·242
Senecio grandifolius	0·774	0·226

In the generalised thermal equation the value w, representing the amount of energy expended in photosynthesis, measures the effective internal work of a useful and constructive kind, for the due performance of which the leaf may be said to exist, and the relation which this bears to the total energy flowing into the leaf gives an estimate of the true *economic coefficient* when the leaf is regarded as a thermodynamic engine.

In the five or six years during which these researches occupied Mr. Escombe and myself at the Jodrell Laboratory, a large share of our attention was given to determining the best means of estimating the rate of photosynthesis in green leaves exposed to sunlight in air containing the normal amount of carbon dioxide.

At the time we commenced our experiments the only practical method was a gravimetric one introduced by Sachs, by which the amount of material assimilated by a leaf in a given time is deduced from variations in the dry weight of known areas of the leaf-lamina. Unfortunately, we found that the errors to which this method is liable tend on the whole too much in one direction, and their sum, which frequently exceeds the value we are trying to estimate, is swept into the final result.

The method which we finally adopted was one based on the measurement of the intake of carbon dioxide at a partial pressure somewhere near that at which it exists in normal air, *i.e.* 3/10,000 of an atmosphere.

It is evident that such experiments must be conducted on a relatively large scale, both as regards the area of leaf-surface exposed and the volume of air passed over it.

(The nature and disposition of the apparatus were shown in a diagram on the screen.)

The leaf, which, if desired, may still remain attached to its plant, is enclosed in a glazed case through which a stream of air is drawn by a water-pump, the volume of the air being measured by a suitable meter. Between the leaf-case and the meter there is a Reiset's absorption-tube filled with a solution of caustic soda, which ensures the complete absorption of the carbon dioxide remaining after the air has passed through the case.

A duplication of the meter and absorption apparatus allows of a simultaneous determination of the carbon dioxide in the air before it passes over the leaf, and the difference between these values measures the carbon dioxide taken up by the leaf. This is referred to unit area of the leaf by measuring, by means of a planimeter, the area of the photographic impression of the lamina on sensitised paper.

A very delicate method was used for titrating the absorbed carbon dioxide in the alkali, and when all proper precautions are taken the errors of experiment are small.

and with certain modifications there is practically no limit to the scale on which the experiments can be conducted.

It is evident that with this apparatus the mean carbon-dioxide content of the air in contact with the leaf must be somewhat less than that of the entering air, so that a correction of some kind is necessary in order to obtain an estimate of the rate of assimilation under free-air conditions. This is afforded by the fact, established early in our work, that when all other conditions are the same, the rate of assimilation by the leaf is *directly proportional to the partial pressure of the carbon dioxide*, provided this does not exceed five or six times that of the carbon dioxide of normal air.

In deducing the amount of energy used up in the photosynthetic work from the amount of carbon dioxide absorbed by the leaf, we have assumed, as we are entitled to do, that the product of assimilation is a carbohydrate. If the particular form of carbohydrate is known, the amount which corresponds to a definite mass of carbon dioxide absorbed by the leaf is of course determinable; and, further, the energy used up in synthesising this amount of carbohydrate will be represented by its heat of combustion.

No sensible error will be introduced into this calculation by selecting one of the carbohydrates existing in a leaf in preference to another. We have based our calculations on the assumption that we have to deal with a *hexose* having a heat of combustion of 3760 calories per gram. On this basis the assimilation of 1 c.c. of carbon dioxide corresponds to the absorption of 5·02 water-gram-units of energy; hence by multiplying this value by the number of c.c. of carbon dioxide assimilated per unit area of leaf in unit of time we obtain the value of w for the generalised thermal equation.

In using the apparatus I have just described we found, amongst other things, that the actual rate of photosynthesis induced in a leaf which is bathed by ordinary air remains practically constant within very wide limits of insolation. This is due to the fact that the special rays which produce photosynthesis are present in solar radiation of even moderate intensity far in excess of the demands of the assimilatory centres for dealing with the atmospheric carbon dioxide which reaches them by the process of diffusion. The proof of this is afforded in the first place by the enhanced assimilatory effect which is produced by increasing the partial pressure of the carbon dioxide in the air surrounding the leaf, and, secondly, by the fact that we can reduce the intensity of ordinary summer sunlight to a very considerable extent by using revolving radial-sectors placed in front of the leaf, without sensibly affecting the rate of photosynthesis.

It follows from this that the *economic coefficient* of the leaf, which is the ratio of the energy utilised for photosynthesis to the total radiation falling on the leaf, must necessarily increase with diminished insolation, until a point is reached at which practically the whole of the special rays which are active in producing assimilation are utilised. At this point the economic coefficient of the leaf must be at a maximum with respect to a given partial pressure of carbon dioxide; in other words, the leaf regarded as a thermodynamic engine is then working with the least possible waste of energy.

In order to illustrate this I will take the case of a leaf under the influence of moderate sunlight of an intensity of 0·50 calorie per square centimetre per minute, and assimilating at the rate of 2·07 c.c. of carbon dioxide per square decimetre per hour. This corresponds to an economic coefficient of 0·34 per cent. On gradually diminishing by suitable means the radiation falling on the leaf, it was found possible to reduce it to 1/12 of the original amount before any appreciable difference in the rate of assimilation was observed. The economic coefficient was thereby raised to the maximum of a little more than 4·0 per cent. This 4 per cent. will also approximately measure the proportion of the special grade of energy in the original radiation which is capable of inducing photosynthesis.

It is, however, only under very exceptional conditions that we can obtain anything like this maximal "duty" from the leaf.

The following table, showing the results with leaves of *Polygonum Weyrichii* under varying degrees of insolation, will give some idea of the values of the economic coefficient ordinarily met with:—

The Economic Coefficient of Leaves of Polygonum Weyrichii under Various Degrees of Insolation.

Radiant energy falling on 1 sq. cm. of leaf per minute, in calories R	Economic coefficient $w/R \times 100$
0·612	0·42
0·194	1·59
0·150	1·66
0·143	1·32

Turning once more to the generalised thermal equation

$$Ra = (W + w) \mp r,$$

we must not lose sight of the fact that this represents a set of conditions in which all the determining factors, both internal and external, remain constant for a sufficient time to allow of the attainment of steady *thermal equilibrium* between the leaf and its surroundings.

In practice this ideal state is never attainable. In the first place the incidence of solar radiation is subject to rapid oscillations of considerable magnitude, even under the most fair-weather conditions, and every variation of this kind necessarily alters the value of Ra, the energy absorbed by the leaf, and will produce its effect on r, on which the temperature of the leaf depends. This, again, will influence the amount of water-vaporisation, and so affect the value of W. In addition to this, complex disturbances may be introduced by the automatic opening or closing of the stomata, by variations in the hygrometric state of the air, and, perhaps more important than all, by changes in the velocity of the air blowing over the leaf, which will alter its rate of emission.

With all these varying factors acting and reacting on each other in endless complexity, it will be readily understood that under natural open-air conditions the thermal relation of a leaf to its surroundings must be undergoing constant re-adjustment, and that the point of thermal equilibrium must change from moment to moment with every passing cloud, with every gust of wind, and with each change of inclination of the leaf-lamina to the incident radiation.

In the absence of means for instantaneously recording all these variations, it is manifestly impossible to determine the thermal conditions for any particular moment of time, and perhaps there would be no special advantage in doing this even if it were possible. It is, however, quite practicable to determine the *mean* values of the varying factors and the average effects which they produce during a period of time, say of several hours' duration, and we can then introduce these mean values into our equation, which will thus give us all the information we require.

I will now proceed to illustrate the application of these general principles by the consideration of a few concrete examples.

The first is that of a leaf of the sunflower, in which the experiment lasted for about four hours. The results are expressed in water-gram-units (calories), and the units of area and of time are the square centimetre and the minute respectively.

The conditions were such that the total solar radiation absorbed by the leaf was in excess of that required to perform the internal work of transpiration and photosynthesis; in other words, Ra was greater than $W + w$. Hence r was a positive quantity, and the temperature of the leaf was consequently somewhat higher than that of its environment.

CASE A.—*Leaf of Helianthus annuus.*

Total solar radiation	$R = 0{\cdot}2569$ calorie.
Coefficient of absorption, $a = 0{\cdot}686$, ∴ solar energy intercepted, ...	$Ra = 0{\cdot}1762$,,
Water vaporised $= 0{\cdot}000209$ gram, ∴ W, the internal work of vaporisation $= 0{\cdot}000209 \times 592{\cdot}6$	$0{\cdot}1243$,,
Rate of photosynthesis $= 0{\cdot}000355$ c.c. CO_2, hence w, absorption of energy due to assimilation $= 0{\cdot}000355 \times 5{\cdot}02$ ... $=$	$0{\cdot}0017$,,

$$Ra = W + w + r$$

$$0{\cdot}1762 = 0{\cdot}1243 + 0{\cdot}0017 + 0{\cdot}0502$$

Velocity of wind = 25·7 kilometres per hour = 428 m. per minute.

Thermal emissivity of leaf-surface in still air = 0·0150 cal.

Thermal emissivity (e) in air of velocity of 428 m. per minute = 0·0150 + 0·00017 × 428 = 0·0577 calorie.

Hence mean temperature of leaf *above* that of surroundings = $r/2e$ = 0·0502/2 × 0·0577 = 0°·43 C.

The disposal of the incident radiant energy deduced from these data is given in the next table, the total incident energy R being taken at 100.

CASE A.—*Disposal of Incident Solar Energy by leaf of Helianthus annuus.*

w	Energy used for photosynthesis 0·66	
W	„ „ transpiration 48·39	
W + w	Total energy expended in internal work ...	·05
R − Ra	Solar energy transmitted by leaf	31·40
r	Energy lost by thermal emission	19·55
		100·00

We will not consider another case in which the facilities for the performance of the internal work of vaporisation of water were more than sufficient to use up the whole of the direct solar radiation absorbed by the leaf, *i.e.* Ra was less than W + w.

Such conditions are afforded by fully opened stomata, high temperature, and a low degree of humidity of the air. The leaves used were again those of the sunflower, but in this case one-half of the solar radiation was intercepted by the revolving sectors.

CASE B.—*Helianthus annuus.*

Solar radiation incident on leaf R ... ... = 0·2746 calorie

Coefficient of absorption, a = 0·686, ∴ solar energy intercepted, Ra ... ... = 0·1884 „

Water vaporised = 0·000618 gram, ∴ W, the internal work of vaporisation = 0·000618 × 592·6 ... ... = 0·3668 „

Rate of photosynthesis = 0·000657 c.c. CO_2, hence w, absorption of energy due to assimilation ... . = 0·0033 „

$$Ra = (W + w) - r$$
$$0·1884 = 0·3668 + 0·0033 - 0·1817$$

Velocity of wind = 12 kilometres per hour = 200 m. per minute.

Thermal emissivity of leaf-surface in air of this velocity = 0·015 + 200 × 0·00017 = 0·0490 calorie.

Hence mean temperature of leaf *below* that of surroundings = $r/2e$ = 0·1817/0·0490 = 1°·84 C.

CASE B.—*Disposal of Energy Received by Leaf from Solar Radiation and from Heat Conveyed from Surroundings.*

R + r = 100.

w	Energy used for photosynthesis 0·72	
W	„ „ transpiration 80·38	
W + w	Total energy expended in internal work ...	81·10
R − Ra	Solar energy transmitted by leaf	18·90
		100·00

During the time at my disposal I have only been able to give a brief outline of the general principles underlying an attempt to deal with the main functions of a foliage leaf from the point of view of its energetics, and I must refer those of my hearers who are specially interested in the subject to the papers themselves for the further elaboration of the argument and for the facts on which it is based. I trust, however, that this short account of the work may be sufficient to indicate that we have experimental means of studying quantitatively the reception of various grades of energy by a leaf, the proportion of this which is utilised for the two main kinds of internal work, and also the thermal relations of a leaf to its surroundings under given conditions.

In conclusion, I wish to anticipate a possible objection which may be raised on theoretical grounds to some of the views I have expressed. I have assumed throughout that the second law of thermodynamics is applicable to the phenomena we have been discussing. The statement of that law by Lord Kelvin limits its application to "inanimate objects," and doubtless if the living elements of the leaf-cells possess any power of dealing with the individual molecules of the surrounding medium so as to select and utilise the kinetic energy of those which are moving faster than the "mean square speed," it may well happen that a leaf may be able to perform some kind of internal work without there being any difference of mean temperature between it and its surroundings. In this event the views I have put forward would doubtless require some slight revision, but I think we may well wait until this restriction of the second fundamental principle of thermodynamics has received some experimental support.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. H. O. ARNOLD-FORSTER, M.P., will distribute the medals, prizes, and certificates at Woolwich Polytechnic on Saturday, April 1.

DR. E. O. LOVETT, professor of mathematics of Princeton University, has been elected professor of astronomy in succession to Prof. C. A. Young.

THE Prince of Wales is to visit Cardiff toward the end of June, when he will lay the foundation stone of the Welsh University College in Cathays Park.

DR. PETER THOMPSON has been appointed professor of anatomy, and Prof. Arthur Dendy, of the South African College, Cape Town, professor of zoology, at King's College, London.

THE celebration of the jubilee of the Cheltenham Ladies' College and the opening by Sir Henry Roscoe of the new science laboratories and lecture rooms will take place on Friday and Saturday, May 12 and 13. The Marquis of Londonderry, President of the Board of Education, has promised to be present.

PRIVATE munificence has provided further sums for the promotion of higher education in the United States. We learn from *Science* that by the death of Mrs. George L. Littlefield, Brown University becomes the recipient of the bulk of the Littlefield estate, estimated at 100,000*l.* The will provides that the corporation shall apply the money as it sees fit, except that 20,000*l.* shall be used for the establishment of the George L. Littlefield professorship of American history. By the will of the late Mr. William F. Milton, of New York, his estate will go to Harvard University on the death of Mrs. Milton. The daily papers state that it is worth between 200,000*l.* and 400,000*l.* Columbia University has received 20,000*l.* from Mr. Jacob H. Schiff to endow a chair of social work, and the new professorship has been filled by the appointment of Dr. Edward T. Devine.

IN the House of Commons on Monday Mr. Clancy asked the First Lord of the Treasury whether there are any requirements, statutory or otherwise, in the case of grants in aid of university colleges in England, that four times the amount is required from local subscriptions before anything is derived from the public funds. In reply, the Chancellor of the Exchequer said that there has been such a requirement in regard to the grant in past times. But proposals in regard to the future allocation of the grant are now under the consideration of the Government. Mr. Clancy asked whether it was not proposed that there should be a grant of 100,000*l.* a year to the university colleges mentioned in the report; and whether there was any requirement, statutory or otherwise, in regard to this grant. The Chancellor of the Exchequer answered: There is a proposal by the committee that the distribution should be governed by the amount of voluntary subscriptions obtained by these colleges. The Government has not yet come to a decision on the subject.

AT a meeting of the Association of Teachers in Technical Institutes on March 25, Mr. W. J. Lineham, chairman of the association, delivered an address on technical training in

England. He insisted that in considering the future education of a boy who has completed his primary education—say, at thirteen—the subject must be regarded from the point of view of his future livelihood. Mr. Lineham sketched what he called an ideal scheme of technical education. After the child has followed a good primary education from the ages of six to thirteen, his education must be continued with some idea of his future occupation. If he is to be educated for a commercial pursuit he should now attend a purely secondary school; but if he is to enter a trade or technical profession he should attend what is known as a day technical school until the age of sixteen, having spent three years therein, the first part of which should be mainly literary, the middle scientific, and the last technical. His apprenticeship should then begin. But the apprentice must not now lose the lessons learnt in the technical day school. On the contrary, he must continue his studies to an even higher level by attendance at an evening technical school simultaneously with his apprenticeship. As to the apprenticeship itself, its character should entirely depend upon the trade or profession to be followed.

SOCIETIES AND ACADEMIES.

LONDON.

Anthropological Institute, March 14.—Sir T. H. Holdich, K.C.M.G., K.C.I.E., in the chair.—Manners and customs of the Melanesians: Rev. W. H. **Edgell.** The ethnographical objects and lantern slides shown included views of the different types of people, and illustrated the development of canoes and houses. One of the finest of the slides illustrated a Melanesian waiting to shoot a fish. He was poised on one leg, and the lecturer stated that he had seen natives waiting motionless for hours by the side of the rivers waiting for an opportunity to shoot. Of particular interest was the lecturer's statement that some of the natives have entirely lost the art of canoe making, although they still make paddles, which they use to propel rafts made of bamboos.

Entomological Society, March 15.—Mr. F. Merrifield, president, in the chair.—*Exhibits.*—Butterflies from Natal presented by Mr. G. A. K. Marshall to the Hope Department at Oxford: Dr. F. A. **Dixey.** Dr. Dixey read a note upon his experiments conducted with a view to ascertaining whether the assumption of the wet or dry season form of various African butterflies could be controlled by exposure in the pupal state to artificial conditions of temperature and moisture.—Drawings of the genitalia of noctuid moths, and also a number of slides showing the respective peculiarities of many members of the genus: F. W. **Pierce.** Among other things, attention was directed to the fact that in the case of the Tæniocampidæ the genitalia were widely dissimilar, while the author's investigations had led him to conclude that Ashworthii, at present ranked as an Agrotis, should more properly be included in the Noctua group.—A specimen of the North American longicorn, *Neoclytus erythrocephalus,* discovered in a sound ash tree in the neighbourhood of St. Helens, Lancashire: W. E. **Sharp.** Some palings of American ash in the vicinity suggested the origin of the progenitors of the colony, but it was not known how long they had been erected. The beetles were taken in their galleries in the summer dead, which seemed to indicate a weakening of the species under the conditions in which they found themselves. Mr. Sharp also showed examples of *Amara anthobia,* Valle, new to the British list (with a series of *A. familiaris,* Duf., and *A. lucida* for comparison) from Leighton-Buzzard, where they occurred not infrequently at the roots of grass in sandy places.—Mutilated Stenobothrus from the Picos de Europa, Spain: M. **Burr.** These grasshoppers were taken at a height of about 1300 metres, on turfy ground exposed to north wind from the Atlantic, and covered with tufts of a short, dense, tough, and spiky shrub, together with heather. Of the grasshoppers occurring on this spot, almost every specimen had the wings and elytra more or less mutilated, sometimes actually torn to shreds, entirely altering their appearance. A notable exception was *St. bicolor,* of which no single specimen was found mutilated.

PARIS.

Academy of Sciences, March 20.—M. H. Poincaré in the chair.—Thermochemical researches on brucine and strychnine: MM. **Berthelot** and **Gaudechon.**—A determination of the heats of combustion and formation of the two alkaloids, together with measurements of the heats of neutralisation with various acids. The equilibrium between strychnine and ammonium salts was also studied thermochemically.—On the variations of brightness and the total eclipses of primary images formed on the retina by very feeble luminous sources of constant value: A. **Chauveau.** A discussion of a recent paper by M. Lullin, in which the latter describes an experiment with phosphorescent screens, the visibility of which depends on the visual angle, and on the duration of the observation.—On the valency of the atom of hydrogen: M. **de Forcrand.** A discussion of the assumptions upon which the monovalency of hydrogen is based. The author brings forward the cases of Ag_2F, Ag_4O, ICl_3, and others, and suggests that the difficulty of explaining these can best be met by adopting the convention that the hydrogen atom is divalent.—On the photography of the solar corona at the summit of Mont Blanc: A. **Hansky.** Hitherto, attempts to photograph the solar corona at other times than during a total eclipse have not met with much success. By the use of a disc of blackened brass, the diameter of which is a little larger than that of the image of the sun at the focus of the telescope used, combined with coloured screens capable of absorbing the spectrum about up to $\lambda=660\ \mu\mu$, photographs of the solar corona have been obtained.—Remarks on the preceding note: J. **Janssen.** Reproductions of two of the photographs mentioned in the preceding paper are given.—The notion of distance in the functional calculus: Maurice **Fréchet.**—On the calculation of closed arcs: M. **Pigeaud.**—The distribution and control of actions produced at a distance by electric waves: Édouard **Branly.** The three effects chosen for control at a distance by means of electric waves are the starting of an electric motor, lighting incandescent lamps, and producing an explosion. Details are given of the apparatus by which this has been done in the laboratory. The succession of the effects can be varied at will.—On the variation of the specific inductive power of glass with the frequency: André **Broca** and M. **Turchini.** Glass Leyden jars may be used in the production of currents of high frequency, between the limits 10^5 and 3×10^6 per second, on condition that the capacity introduced into the formulæ is about one-half that measured with charges of 0·1 sec., or 0·7 of the capacity measured with the frequency of an ordinary rotating sector.—On the coefficient of specific magnetisation and magnetic susceptibility of salts: Georges **Meslin.** The results of measurements for a considerable number of paramagnetic and diamagnetic salts are given.—On photographic halation. Reply to a note of M. A. Guébhard: P. **Villard.** The author regards the explanation of his experiments given by M. A. Guébhard as inapplicable. Particulars of an experiment are given for which an explanation is at present wanting.—On the ionisation produced between parallel plates by the radium emanation: William **Duane.**—The diazoamines of diphenylamine, derivatives of the homologues of aniline and naphthylamines: Léo **Vignon** and A. **Simonet.**—The characterisation of lactones by means of hydrazine: M. **Blaise** and A. **Luttringer.** The lactone is heated on the water bath with a slight excess of hydrazine hydrate. The crystalline mass which separates on cooling is re-crystallised from boiling ethyl acetate, and its melting point, which is usually well defined, serves to characterise the lactone. The melting points of six of these compounds are given.—On menthone derived from the hexahydrothymols: Léon **Brunel.** In a preceding note the preparation of two thymomenthols has been described; the present paper describes the thymomenthone obtained by the oxidation of these products.—On monobromoacetal: P. **Freundler** and M. **Ledru.** By attention to some details the yield of bromoacetal by Fischer's method has been raised from 50 per cent. to 115 per cent. of the acetal employed. Magnesium reacts violently on this bromine compound at 110°, giving rise to vinyl ethyl ether.—Remarks on the diphenylamine reaction with nitric acid: Isidore **Bay.** The blue coloration is produced by a large number of oxidising agents, and is not characteristic of nitric acid.—On the antiseptic properties of certain kinds of smoke and on their utilisation: A. **Trillat.** In previous papers the author has shown that formaldehyde is a constant constituent of chimney smoke. He now finds that a polymerised formaldehyde is always present in soot, in proportions varying from 0·28 per cent. to 0·34 per cent.—The effects of phosphorus on the coagulation of the blood. The origin of fibrinogen: M. **Doyon,** A. **Morel,** and N. **Kareff.**—The duration of the process of stimulation for different muscles: M. and Madame L. **Lapicque.**—On the anatomical and functional independence of the lobes of the liver: H. **Sérégé.** The arguments from the anatomical and physiological points of view are summarised and shown to be all in favour of the independence of the lobes.—An experimental study of the relations between the arterial pressure and the pulmonary circulation in anæsthesia by chloroform. The determining cause of chloroform accidents: J. **Tissot.**—On the measurement of disposable energy by a self-registering integrating dynamometer: Charles **Henry.** The apparatus consists essentially of a rubber ball filled with mercury. The pressure of the hand on this raises a mass of iron up and down a graduated tube, this iron being connected with the registering apparatus. The area registered measures the statical work done by the pressure of the fingers.—The cardiac area in cured consumptive cases: H. **Guilleminot.**

DIARY OF SOCIETIES.

THURSDAY, MARCH 30.

ROYAL SOCIETY, at 4.30.—On the Observations on Stars made in some British Stone Circles (Preliminary Note): Sir Norman Lockyer, K.C.B., F.R.S.—On the Distribution of Velocity in a Viscous Fluid over the Cross-section of a Pipe, and on the Action at the Critical Velocity: J. Morrow.—The Direct Synthesis of Ammonia: Dr. E. P. Perman.—The Determination of Vapour Pressure by Air Bubbling: Dr. E. P. Perman and J. H. Davies.—Note on Fluorescence and Absorption: J. B. Burke.—The Determination of the Specific Heat of Superheated Steam by Throttling and other Experiments: A. H. Peake.—The *Rôle* of Diffusion in the Catalysis of Hydrogen Peroxide by Colloidal Platinum; G. Senter.—The Theory of Photographic Processes. Part II. On the Chemical Dynamics of Development, including the Microscopy of the Image: S. E. Sheppard and C. E. K. Mees.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

FRIDAY, MARCH 31.

ROYAL INSTITUTION, at 9.—The Scientific Study of Dialects: Prof. J. Wright.

SATURDAY, APRIL 1.

ROYAL INSTITUTION, at 3.—Some Controverted Questions of Optics: Lord Rayleigh.

MONDAY, APRIL 3.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—On the Formation of Sulphuric Esters in the Nitration of Cellulose and their Influence on Stability: C. Napier Hake and R. J. Lewis.—The Proof of Percussion Caps: H. W. Brownsdon.

SOCIETY OF ARTS, at 8.—Telephony: H. L. Webb.

VICTORIA INSTITUTE, at 4.30.

TUESDAY, APRIL 4.

ROYAL INSTITUTION, at 5.—Tibet: Perceval Landon.

FARADAY SOCIETY, at 8.—Alloys of Copper and Antimony and Copper and Bismuth: A. H. Hiorns.—Refractory Materials for Furnace Linings: E. Kilburn Scott.—Electrically Heated Carbon Tube Furnaces. Part I.: R. S. Hutton and W. H. Patterson.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Continued Discussion*: Coolgardie Water-Supply: C. S. R. Palmer.

WEDNESDAY, APRIL 5.

GEOLOGICAL SOCIETY, at 8.—On the Divisions and Correlations of the Upper Portion of the Coal-measures, with Special Reference to their Development in the Midland Counties of England: R. Kidston, F.R.S.—On the Age and Relations of the Phosphatic Chalk of Taplow: L. Treacher and H. J. O. White.

ENTOMOLOGICAL SOCIETY, at 8.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Determination of Higher Alcohols in Spirits. I.: Dr. Philip Schidrowitz and F. Kaye.—The Action of slightly Alkaline Waters on Iron: C. H. Cribb and F. W. F. Arnaud.—Notes on Preservatives: E. G. Clayton.

SOCIETY OF ARTS, at 8.—Ancient Architecture of the Great Zimbabwe: R. N. Hall.

THURSDAY, APRIL 6.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: On Reciprocal Innervation of Antagonistic Muscles, Seventh Note: Prof. C. S. Sherrington, F.R.S.—The Influence of Cobra-Venom on the Proteid Metabolism: Dr. James Scott.—Further Experiments and Histological Investigations on Intumescences, with some Observations on Nuclear Division in Pathological Tissues: Miss E. Dale.—On the Toxin-Antitoxin Reaction, with Special Reference to the Neutralisation of Lysin by Antilysin: J. A. Craw.—On the Nature of the Silver Reaction in Animal and Vegetable Tissues: Prof. A. B. Macallum.

CHEMICAL SOCIETY, at 8.—The Basic Properties of Oxygen at Low Temperatures. Additive Compounds of the Halogens with Organic Substances containing Oxygen: D. McIntosh.—Note on the Interaction of Metallic Cyanides and Organic Halides: N. V. Sidgwick.—The Chemical Dynamics of the Reactions between Sodium Thiosulphate and Organic Halogen Compounds. Part II. Halogen-substituted Acetates: A. Slator.—The Chemical Kinetics of Reactions with inverse Reactions. The Decomposition of Dimethylcarbamide: C. E. Fawsitt.—The Tautomerism of Acetyl Thiocyanate: A. E. Dixon and J. Hawthorne.—A Method of Determining the Specific Gravity of Soluble Salts by Displacement in their own Mother Liquor, and its Application in the Case of the Alkaline Halides: J. Y. Buchanan.—The Combination of Mercaptans with Unsaturated Ketonic Compounds: S. Ruhemann.—A new Formation of Acetylcamphor: M. O. Forster and Miss H. M. Judd.—Preparation and Properties of 1:4:5-Trimethylglyoxaline: H. A. D. Jowett.—Bromomethylheptylketone: H. A. D. Jowett.—On the Existence of a Carbide of Magnesium: J. T. Nance.—The Action of Carbon Monoxide on Ammonia: H. Jackson and D. N. Laurie.—Isomeric Salts of the Type $NR_1R_2H_3$. A Correction. Isomeric Forms of *d*-Bromo- and *d*-Chloro-camphorsulphonic Acids: F. S. Kipping.—Isomerism of α-Bromo- and α-Chloro-camphor: F. S. Kipping.—*l*-Phenylethylamine: F. S. Kipping and A. E. Hunter.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Discussion of the Report to Council on the International Electrical Congress at St. Louis, by W. Duddell, and of Papers on Systems of Electric Units Published in Part clxx. (last issue) of the *Journal*.

ROYAL INSTITUTION, at 5.—Synthetic Chemistry: Prof. R. Meldola, F.R.S.

RÖNTGEN SOCIETY, at 8.15.—Exhibition Evening.

LINNEAN SOCIETY, at 8.—Intra-axillary Scales of Aquatic Monocotyledons: Prof. R. J. Harvey Gibson.—A further Communication on the Study of *Pelomyxa palustris*: Mrs. Veley.

SOCIETY OF ARTS, at 4.30.—The Prospects of the Shan States: Sir J. George Scott.

FRIDAY, APRIL 7.

ROYAL INSTITUTION, at 9.—American Industry: Alfred Mosely.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Cofferdams for Dock Use: R. G. Clark.—Bath Corporation Waterworks Extension: J. R. Fox.

SATURDAY APRIL 8.

ROYAL INSTITUTION, at 3.—Some Controverted Questions of Optics: Lord Rayleigh.

THE ESSEX FIELD CLUB, at 6.30. (At Essex Museum of Natural History, Stratford).—Twenty-fifth Annual Meeting.—Natural History Museums: F. W. Rudler.

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