THURSDAY, NOVEMBER 22, 1906.

A BIBLIOGRAPHY OF PHILOSOPHY.

Dictionary of Philosophy and Psychology. Edited by Prof. J. Mark Baldwin. Vol. iii. Two parts. Part i., pp. xxiv+542; part ii., pp. vi+543–1192. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1905.) Price 42s. net.

WITH the publication of this "Bibliography of Philosophy, Psychology, and Cognate Subjects," Prof. Baldwin's great enterprise comes to an end, and he and his collaborators are to be congratulated on the successful completion of a work that will be indispensable to the teacher and student of philosophy. The compiler of this latest volume, Dr. Benjamin Rand, of Harvard, will in particular receive the thanks of those who hitherto have painfully had to make their own bibliographies from *Jahresberichte* and various popular indexes, and who in the fulness of their ignorance have not been able to neglect even the humble catalogue of the Leipzig bookseller.

The work does not profess to give references to books and articles that have appeared since 1902; but up to that date it seems to be very complete; at any rate, a first perusal does not reveal very startling omissions. Psychology is, of course, one of the strongest features of the Dictionary, and of this present volume, of which it occupies 280 pages; and the editor points out in a prefatory note that the annual volumes of the Psychological Index from 1902 may be regarded as a supplement of this Dictionary. Accordingly, those who possess this Dictionary and secure the index each year from 1902 "will have for Psychology an exhaustive Bibliography, and for the other topics of this volume one that is selective and fairly adequate, continuing indefinitely into the future."

The scheme of the volume seems to cover all the ground, and the headings are well arranged. The first part is occupied with a few pages containing a bibliography of bibliographies; then about fifty pages of general works on the history of philosophy; then come about 500 pages on philosophers, their works, and works upon them. We note that Aristotle has twenty-four pages assigned to him, Darwin five, Kant thirty-four, and Plato nineteen. Naturally there has been some hesitation in selecting for this columbarium any but the most prominent of living philosophers; Wundt is there, and Bain (though he was alive in 1902), but not Mr. F. H. Bradley or Mr. Shadworth Hodgson. Those, however, who have not attained a place beside Plato and Aristotle, and some six hundred of the majestic dead, have tardy justice done them under the later head "Systematic Philosophy: Systems and Essays." Under systematic philosophy we have such further headings as atomism, evolution (only eight pages!), materialism, positivism, teleology, and the like. Then come the sections of logic, æsthetics, philosophy of religion, ethics, and psychology. The biologist and the student of the physical side of mental processes will note that to the brain and its functions are given fifteen pages, to heredity two, to the nervous system ten, to sensation and the senses about thirty-eight. The arrangement under each heading is, of course, alphabetical according to the names of the writers, which are generally printed in heavy type. The main references to epoch-making works—and to some not epoch-making—are followed immediately by a note of the important reviews that greeted their appearance. One must heartily commend the fulness with which, *e.g.* under atomism, we have the references to Aristotle's discussions of the topic: Phys. II., 4 196 a 25; III., 4 203 a 22. But perhaps in dealing with important Greek and Latin authors an attempt should have been made to distinguish translations and commentaries.

Without being captious, however, we must complain that the number of misprints is a little too large. It is irritating to have to inquire whether some new writer or thinker has suddenly appeared whose name differs from someone of comparative fame only in one of the initial letters, H for A, or G for S, or C for E. Such misprints must occur, but woe to the editor or proof-reader of a bibliography in which mis prints attain more than a certain proportion.

THE ROMANCE OF THE EARTH AND MAN.

The Human Epic. The Prehistoric Story of Mankind. By John Frederick Rowbotham. Pp. 214. (London: Gay and Bird, n.d.)

THE author of this remarkable publication, like the Mayor of Coquerico in "Genevieve de Brabant," is by no means averse to blowing his own trumpet; accordingly he announces to the world at large, on the title-page of his work, that it is "the twelfth Epic Poem of the world"; he also modestly states that he is "The Homer of Modern Times." Such courage deserves our applause, even if we fail to recognise the modern representative of Greek poetry in Mr. Rowbotham.

The author begins with the evolution of the earth and the origin of life, and strives to show the changes undergone by the inorganic world and the gradual appearance of lowly marine beings in the Cambrian and Silurian seas. Of poetic fancies the author nothing lacks, but of natural history lore his stock is meagre:—

"Much fear I him who armed with claws and quills
Steals stealthily along the weedy mire.
I dread the shape who bears the bristling gills
Which seem with rage and venom to respire.
But chiefly do I fear the lobster dire.
Four claws he wears, his quarry to assail,
Two spears he brandishes to wreak his ire,
Invulnerable gleams his quilted mail.
O'er such stupendous foe nought living can prevail"
(p. 27, v. 35).

We are quite at a loss to fit the author's description with any Silurian, or, indeed, any other fossil arthropod!

We are next favoured with a view of the Old Red Sandstone period and its armoured fishes; then of the "Age of Trees"—"One mighty Sunderbund earth's surface seemed . . . which with evaporating moisture steamed," but though we surmise this to be a view of the Coal period, the author does not hint at any definite geological fact, save that mosses and *bull-rushes* (query Equisetaceæ) became gigantic trees. After upheavals in the Permian period we arrive at the "Age of Monsters," by which the author means the Ichthyosaurus and the Plesiosaurus, which (after Blake's picture in Hawkins's "Sea Dragons") have a mighty battle, the Ichthyosaurus coming off conqueror. We are next introduced to "The Giant Newt" (probably the Pariasaurus?), then to the Atlantosaurus, moving with his head in the clouds! Pages of grandiloquent poetry, after the pattern of Pope's translation of Homer's Iliad, are devoted to an impossible battle between herds of armed herbivorous Dinosaurs and armies of carnivorous ones, the author apparently being unaware that the latter were extremely few in number compared with the former, just as the herbivorous mammals were as a thousand to one carnivore on the African plains before "man the destroyer" came upon the scene with his "shooting-iron."

"And howls of anguish and of beasts dismayed
Strike on the air. In crowded cohort stand
The monsters of the plains, begirt on every hand.
Their roaring foes, less huge, but of a shape
Obscene and foul beyond a parallel,
Rush on to decimate with jaws agape
The remnants thus enclosed. These slowly fell" (p. 58, vv. 40, 41).

In canto the tenth the author gives us "A Day with an Iguanodon," and with the late Mr. J. L. Toole we are inclined to exclaim, "oh! what a day we are having."

"In ten enormous strides he fared a mile.
Towering above the tree-tops as he strode
He soon was in his den amid the ferns bestowed" (p. 69, v. 31).

In the eleventh canto we reach the Tertiary period, and have the first glimpse of ape-like man reflecting on the scene from a tree overlooking a pool at which the Dinotherium, Palæotherium, Anoplotherium, Mastodon, Dinoceras, Megatherium, and Mylodon (as was their habit!) came down to slake their afternoon thirst. The author is so pleased with this idea that he repeats on pp. 76, 77, vv. 32 and 38, and p. 82, v. 15, the same scene.

He goes on (in canto thirteen) to describe "The Earthly Paradise," and on pp. 85, 86, gives an unlovely picture of humanity in its early stage, but on p. 87, vv. 27–34, evolves from the baser herd a superior pair endowed with finer instincts; but on p. 89, v. 35, he admits:—

"Yet were they both but brutish beasts, amid
That garden of delights, that Paradise," &c.

"The male on lank and shaggy shanks upreared,
Whose breast and back unsightly bristles drape,
Whose monstrous snout protuberant appeared,
Whose brutish jaws seemed evermore to gape
With teeth and tusks of dire revolting shape" (p. 89, v. 36).

The flood follows, then cave-dwellers are depicted, and the use made of stones as weapons, of skins as clothing, and the discovery of fire-making, the sling, the spear, bow and arrow, and so on.

The whole material is woven up into a poetic and exaggerated form which, to our way of thinking, renders it highly unsatisfactory. Kitchen-middens, lake-dwellings, the continent of Atlantis, the capture of the first horse, the potter's art, the origin of ornaments, of music, singing and dancing, are introduced. Then legends are touched upon, the domestication of the dog, the wandering minstrel, and, lastly, a legend of the "Ice age" into which we cannot follow the learned author. Mr. Rowbotham's legendary lore and his talent for versification may be admirable, but his geology and palæozoology are extremely shady, and we do not recommend him as a guide to follow in his reconstructions of the past history of the earth or of prehistoric man.

MATHEMATICS FOR SCHOOLS.

(1) *Elementary Geometry based on Euclid's Elements.* By F. Purser. Pp. vii+121. (Dublin: Hodges, Figgis and Co., Ltd.; London: Longmans, Green and Co., 1906.)

(2) *Geometry, Theoretical and Practical.* Part i. By W. P. Workman and A. G. Cracknell. Pp. x+355. (London: University Tutorial Press, Ltd., 1906.) Price 3*s*. 6*d*.

(3) *Elementary Geometry.* Books vi. and vii. By W. M. Baker and A. A. Bourne. Pp. 390–477. (London: G. Bell and Sons, 1906.) Price 1*s*. 6*d*.

(4) *A Shilling Arithmetic.* By S. L. Loney and L. W. Grenville. Pp. 186+xxiv. (London: Macmillan and Co., Ltd., 1906.) Price, with answers, 1*s*. 6*d*.

(5) *Junior Arithmetic with Answers.* By W. G. Borchardt. Pp. viii+221+xl. (London: Rivingtons, 1906.) Price 2*s*.

(6) *A Junior Arithmetic.* By C. Pendlebury, assisted by F. E. Robinson. Pp. xii+204. (London: G. Bell and Sons, 1906.) Price 1*s*. 6*d*.

(7) *A Preliminary Course in Differential and Integral Calculus.* By A. H. Angus. Pp. vi+108. (London: Longmans, Green and Co., 1906.) Price 2*s*. 6*d*.

(8) *A College Algebra.* By Prof. H. B. Fine. Pp. viii+595. (London and Boston: Ginn and Co., n.d.) Price 6*s*. 6*d*.

(9) *A New Trigonometry for Beginners.* By R. F. D'Arcy. Pp. viii+84. (London: Methuen and Co., n.d.) Price 2*s*. 6*d*.

(10) *Elementary Descriptive Geometry.* By C. H. McLeod. Pp. ix+118. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1905.) Price 6*s*. 6*d*. net.

(1) IN Mr. Purser's "Geometry" the subject-matter corresponds essentially with that of the first six books of Euclid, and the treatment is on similar lines, but the propositions are differently arranged, and are grouped, with the object of showing the reasons for the sequence adopted. Euclid's definitions of parallels and proportion are adhered to, though the defective statement of the former on p. 17 must be due to an oversight. No exercises are provided, and teachers will find little to induce them to adopt the book in their classes.

(2) In the "Geometry" by Messrs. Workman and Cracknell we have a very full treatment of angles,

parallels, triangles, parallelograms, and circles, with areas, loci, and symmetrical figures. There is a short introductory course of experimental geometry, followed by a preliminary chapter on the "science of geometry," in which fundamental concepts, axioms, and deductive processes are discussed. Thus prepared, practical work and logical development proceed together. There are exercises in abundance of all types, theoretical, constructive, and numerical, the answers to the latter being given. There is a useful index of terms, and a collected list of propositions very convenient for reference. The book should prove of great value to teachers and pupils alike, and seems altogether good.

(3) The new volume by Messrs. Baker and Bourne deals with the geometry of three-dimensional space. Book vi. corresponds with Euclid xi., and Book vii. gives the mensuration of the simple geometrical solids. The high standard of the authors' previous work is maintained. The treatment is clear and concise, the printing is excellent, and useful sets of exercises are provided for class work.

(4) The "Shilling Arithmetic" by Messrs. Loney and Grenville is a handy little volume intended more especially for use in secondary schools, and consisting mainly of a very large collection of graduated examples with explanatory notes. Physical as well as commercial arithmetic is represented, though examples of the latter type predominate. Answers are given at the end, and altogether the book is very suitable for its purpose.

(5) Mr. Borchardt's "Junior Arithmetic" is very like the one just noticed, but more use is made of graphs, the commercial type of exercise is less prominent, and the treatment follows more closely the scheme of the committee of the Mathematical Association. A special feature of the book is a set of 385 examples arranged as a graduated set of fifty-five test papers covering the whole subject. The course will form a good preparation for the Oxford and Cambridge locals, the London matriculation, and similar examinations.

(6) The "Junior Arithmetic" by Messrs. Pendlebury and Robinson is very similar in character to the two just mentioned, and is well suited for use under similar conditions. In all three there are too many exercises of the kind "If 120 men can build a house 60 feet high in 15 days, how many men will it take to build one 55 feet high in 10 days?" But the teacher can delete these and still have ample choice. The book can be obtained with or without answers.

(7) Many students rightly wish to acquire an elementary working knowledge of the calculus at a comparatively early stage. By such the preliminary course of Mr. Angus will be appreciated. The author confines himself to the algebraical, trigonometrical, and exponential functions, and has thus space available for ample illustration. There seems to be a want of clearness in the author's notion of a rate; for instance, on p. 27, where in the expression $dV/dD=\pi D^2/2$, relating to a sphere, V denoting volume, he puts dV equal to 7·5 *cubic inches per second*, a statement which must perplex a thoughtful student. However, the book is a good one, and can be recommended to beginners who have some knowledge of squared paper work.

(8) The "College Algebra" by Mr. Fine is a very masterly and fascinating treatment of the subject, whether from the standpoint of logical completeness or of practical computation. The book is divided into two parts, the first and smaller of which establishes the fundamental laws of operation for numbers, rational and irrational, imaginary and complex, the discussion being based "on the notion of cardinal number and the notion of order, as exhibited in the first instance in the natural scale 1, 2, 3, . . ." The second and main part of the work deals most thoroughly with the successive developments, and carries the subject so far as to include, in the later portions, the theory and solution of cubic and biquadratic equations, determinants, the binomial, exponential, and logarithmic series, the properties of continuous functions, &c. The volume is beautifully printed, and whether adopted or not as a text-book in this country, so excellent a treatise should be found in the library of every teacher of mathematics.

(9) As a first course of trigonometry for beginners the elementary text-book of Mr. D'Arcy is well conceived, the work being closely associated with quantitative practical geometry, and being carried only so far as problems on heights and distances and the solution of triangles, complex trigonometrical transformations being wisely absent. At the same time the idea of the book is not well carried out in detail. The style is unattractive, and the illustrations are not very illuminating. The figures are badly printed, and sometimes are scarcely legible. More attention might well have been given to the solution of triangles by means of right-angled triangles, and it seems a mistake to have omitted to include the four-figure tables in the text. The book is designed for candidates taking the Cambridge previous or the Cambridge general examination, and test papers at the end contain many questions selected from these examination papers.

(10) The "Descriptive Geometry" by Mr. McLeod is intended as a minimum course for engineering students. It deals in a simple and straightforward manner with elementary problems on points, lines, and planes, polyhedra, curved surfaces and tangent planes, including several skew surfaces, sections, envelopes and developments, trimetric projections, and shadows.

PHOTOGRAPHIC TOPICS.

The Complete Photographer. By R. Child Bayley. Pp. xv+410. (London: Methuen and Co, n.d.) Price 10*s*. 6*d*. net.

AFTER having read this volume, the question that naturally presents itself to the reviewer is, to what class of readers will it appeal? The author, in his preface, states that he has made no attempt to compete with the many books on photography that have already been published, whether scientific treatises upon the principles underlying the practice or manuals of practical instruction. He states, further, and quite correctly, that the formulæ given are very few, and that "it is their application to photography that has formed his topic." The student, therefore, will not always find here the practical instructions that he needs; sometimes, in fact, quite otherwise. If, for example, he wishes to varnish a negative, and turns to the page indicated in the index, he reads that "the modern dry-plate worker finds the result of the first operation is to send a stream of varnish up his arm, of the second to make a pool of it on the floor, and of the third to cement a number of dust particles to the surface of the negative, and, possibly, to set the whole of the varnish alight." As the author considers that there is no reason why an amateur photographer should varnish his negatives, he does not help him to do it.

It is essentially a personal treatise. Those subjects that commend themselves to the author he discourses on at length, and sometimes in much detail; others he merely refers to, and in most cases he expresses his own opinions in very decisive terms. There are some opinions with which we do not agree, but the volume is easy reading, and if at any time we begin to get annoyed with the expression of views that we are inclined to condemn, a page or two forward is sure to bring us face to face with a charming picture that cannot but please, though it has no connection whatever with the text, except that it is a photograph. Photography pure and simple is dealt with in nineteen chapters, then follow chapters on "Dodging and 'Faking,'" landscape, architectural work, and portraiture, "Pictorial Photography," "Exhibitions and Societies," and a few pages on photomechanical work.

We notice only a few errors, and as most of them are not obvious slips it may be worth while pointing them out. Sodium hypochlorite is included among "hypo-eliminators" of "very doubtful efficacy." As it is supposed readily to oxidise the thiosulphate to sulphate, experimental evidence should be adduced before its efficacy is doubted. The statement at p. 157 that a "focal-plane shutter allows the whole of the light which passes through the lens, to fall on any part of the plate which it uncovers" certainly needs amending. A few lines lower, a roller blind shutter with an opening that is equal in length to twice the diameter of the lens, and travelling at a uniform rate, is stated to leave "the lens fully open for exactly half the time during which it is uncovered at all." For this result the length of the opening should be three times the lens diameter. The author must have been misinformed as to the "Linked Ring," for he states that it came into existence by reason of a "personal squabble" in the Royal Photographic Society. As he goes on to say that "signs are not wanting that the 'Linked Ring' in its present form has outlived its utility," his attitude appears to be far from friendly towards this Society, but it might have been better if he had refrained from giving his opinion in this place. To those who know enough about photography to appreciate it, and there must be a very large number of persons so qualified, the volume will prove both entertaining and instructive.

POPULAR NATURAL HISTORY.

(1) *Nature's Story of the Year.* By C. A. Witchell. Pp. xii+276. (London: T. Fisher Unwin, 1906.) Price 2*s*.

(2) *Creatures of the Night.* By A. W. Rees. Pp. xix+448. (London: John Murray, 1905.) Price 6*s*. net.

(3) *The Life Story of a Fox.* By J. C. Tregarthen. Pp. viii+224. (London: Adam and Charles Black, 1906.) Price 6*s*.

(4) *The Romance of Animal Arts and Crafts.* By Dr. H. Coupin and John Lea. Pp. 356. (London: Seeley and Co., Ltd., 1907.) Price 5*s*.

(5) *Our School Out of Doors.* By the Hon. M. Cordelia Leigh. Pp. xii+141. (London: T. Fisher Unwin.) Price 2*s*.

(1) MR. WITCHELL is great as an observer. He has studied the ways of sticklebacks. With still more patience and insight he has watched the courtship of willow-wrens and of skylarks. He has much to say about the habits of swifts that is worth reading. He is at his best when he is writing about birds, though such an affectionate observer has, of course, the defect of his virtue. He sympathises so keenly with his favourites that he reads into their lives a good deal which may or may not be there. They are to him beings full of almost human thoughts and passions. But whether we go along with him in his inferences or not, he makes it plain that there is a great deal in nature that most of us fail to notice. We must regret that he feels so much contempt for comparative anatomy and classification, things of some importance, though Mr. Witchell is not alive to it. But chiefly we must regret that our author sometimes aims without success at a very high-flown style of writing. On p. 76 is a notable example. In the first chapter he is a philosopher rather than an observer, and for this *rôle* he is not so well qualified. But if his readers go on with the book they will find themselves rewarded.

(2) Mr. Rees's "Creatures of the Night" is a very readable book. It is written in good style. Though not so exciting as some books of animal biography, it has an air of genuineness and reality. Lutra is a real she-otter, Brock is a real badger, and we get interested in Brighteyes the water-vole. There is, of course, a tendency to make the heroes of these animal stories too human, but that is inevitable in literature of the kind.

(3) Mr. Tregarthen's is a book of the same class, but with this difference, that the hero, who tells his own story, is frankly and undisguisedly human. He knows, for instance, that the light in the surf on the rocks is due to phosphorescence, an astonishing piece of knowledge for a fox. But the story is so well told, is so interesting, and even exciting, that one does not stumble over unrealities of this kind. They seem merely to add piquancy. In essentials the story is true to life, and it is admirably told.

(4) "The Romance of Animal Arts and Crafts" describes the various styles of architecture adopted by different classes of animal from the beaver down to the caddis-worm. Rat-kangaroos, badgers, trap-

door spiders, pocket-gophers, robber-crabs, squirrels, ants, tree-frogs, weaver birds, scarab beetles, and many others come in turn upon the stage. From the nature of the case, a book that covers so wide a range must be in the main a compilation. But the authors add a good many observations of their own. Moreover—a very great merit this—they investigate the current animal stories before accepting them as true. There is none of the *credo quia mirabile* spirit. They tell us, for instance, that the mole's "fortress" is not the highly elaborated structure which a succession of books on natural history have each in turn still further beautified and complicated, but something much more varying and irregular. Altogether it is a very interesting book. The illustrations, not very numerous, are good.

(5) "Our School Out of Doors" is a book of a very different type. It contains a great deal of correct information on interesting subjects, but it is too miscellaneous, and it suffers from the plan on which it is arranged. Intended for the use of school teachers, it has one or more chapters for each month. This shifting from one subject to another, each very briefly and imperfectly explained, cannot be good for pupil or teacher. In May, Composite flowers are, apparently, to be studied before the pupil has any knowledge of the structure of a common buttercup. In August, five pages are devoted to "watery wonders." It would be far better to study some of the subjects more thoroughly and to neglect others altogether.

OUR BOOK SHELF.

Hints to Travellers, Scientific and General. Edited for the Council of the Royal Geographical Society by E. A. Reeves. Ninth edition, revised and enlarged. Two vols. Vol. i., pp. xi+470; vol. ii., pp. v+286. (London: Royal Geographical Society, 1906.) Price 15*s.* net.

IN editing this ninth edition of the well-known "Hints," Mr. Reeves has taken a point of view somewhat different from that of his predecessor, Mr. John Coles, in the earlier editions. He says:—"As the days of the pioneer explorer of the old type are fast drawing to a close . . . more exact surveys are required than were formerly considered sufficiently accurate for the traveller in unexplored regions." Hence, in the first and larger volume, which is, as before, wholly devoted to surveying and mapping, some of the approximate methods, and the tables connected with them, have been omitted, and a higher standard of accuracy is aimed at throughout. While it seems possible that the effect may be to discourage some travellers who could still do quite useful surveying work from attempting anything at all, and in others to transform a journey in an unexplored region into a surveying expedition pure and simple, it remains unquestionable that Mr. Reeves has produced a condensed treatise on surveying of a high order of excellence.

In the section on instruments, the chief new features are the descriptions of the applications of Mr. Reeves's devices, the "tangent-micrometer" and "endless tangent screw," to the theodolite and sextant. It may be noted that the illustrations of the transit theodolite on pp. 29 and 40 are distinctly inferior to those in the older editions, and are scarcely sufficiently clear for their purpose. Part iv. of this volume, on geographical surveying and mapping, has been practically re-written; the main heads dealt with are:—(*a*) the determination of fixed points, which includes triangulation with the transit theodolite, latitude and azimuth traverses with normals of angles from stations on the route, and latitudes and longitudes; (*b*) the filling in of detail and route surveying; and (*c*) the determination of heights. The first of these sections contains much new and useful matter relating to interpolation, reduction to centre, and geodetic computations. The fifth division, on astronomical observations, has also been to a great extent re-written; the methods of determining longitude by means of lunars, moon-culminating stars, and the eclipses of Jupiter's satellites are omitted, and the space devoted to more complete descriptions of the observations for latitude, time, and azimuth, great additional clearness being gained in the computations by the free use of diagrams and formulæ. The only absolute method of determining longitude described is that of occultations.

In the second volume the chief new feature is an extremely valuable section on archæology, by Mr. D. G. Hogarth, which gives general hints on methods of recording, cleaning, temporarily conserving, and conveying monuments and objects of antiquity.

Sechs Vorträge über das thermodynamische Potential, &c. By J. J. van Laar. Pp. viii+119. (Brunswick: Vieweg und Sohn, 1906.) Price 3.50 marks.

THIS pamphlet of close upon 120 pages really contains eight lectures, the first and second being, as stated in the expanded title, on non-dilute solutions and osmotic pressure respectively. These two introductory lectures are polemical, and attack in a lively manner the position assumed explicitly by some, implicitly by many, that the so-called osmotic pressure is a real pressure due to the molecules of the solute. The author pokes fun at the "dilute school" for pinning their faith to the first term of a diverging series, and for leaving out of account in all their theorising that most essential thing in osmosis, the semi-permeable membrane. He shows that instead of the "osmotic pressure" depending on the solute, it depends fundamentally on the solvent, being mathematically expressible to a first approximation in terms of the difference of the molecular potentials of the two solutions separated by the membrane. He makes an appeal in favour of the use of the thermodynamic potential, which is applicable to all cases, including those of weak solutions, for which alone the method of the osmotic pressure is of any real service. According to his facetious comparison, to explain the accompanying phenomena by an appeal to osmotic pressure is as if one explained an angry man's hasty speech as due to his red face. The anger is the cause of both; and in like manner the thermodynamic potential forms the basis of the true theory. Then follow the six lectures on the thermodynamic potential and its applications to the problems of chemical equilibrium.

Lecture i. begins with entropy, deduces the usual thermodynamic relations, and finishes with the general conditions for equilibrium. The next lecture contains some simple illustrations leading to the recognition of particular cases of Gibbs's phase rule. This important rule is proved in lecture iii., and more complex cases are considered of mixtures of solids, liquids, and vapours. The fourth lecture discusses the thermodynamic properties of mixtures of ideal gases, deduces Gibbs's dissociation formula, and applies it to certain simple cases. The effects of temperature and pressure changes are also considered and the usual formulæ deduced. Then follows, in lecture v., the investigation to a first approximation of mixtures of two fluids, leading to the discussion of fusion and solubility curves. Finally, in lecture vi., vaporisation curves and the theory of the galvanic cell fall to be considered. The same fundamental method is used throughout, the thermodynamic potential being first formulated, and then by differentiation the quantity known as the molecular potential. Detailed examples elucidate the method; and there is no doubt that (to paraphrase his own words) the author has demonstrated, not only the great use of the thermodynamic potential, but also the ease with which it can be manipulated. Dr. van Laar has placed in the hands of the student of thermodynamics a well-written and serviceable pamphlet.

The Family. By Helen Bosanquet. Pp. vii+344. (London: Macmillan and Co., Ltd., 1906.) Price 8*s*. 6*d*. net.

THE "Family" is a subject of far greater extent than most persons may think. Its importance to society is enormous, though, like the air we breathe, it attracts little attention. The variety in the constitution of family life in different places and at different times is extraordinary. Its peculiarity in any given case is the result of many influences, including long-standing tradition, economic causes, natural instincts, and legislation on succession of property. The author has given a valuable *résumé* of facts and opinions derived from more than thirty writers of note, and she has blended them into a pleasant and readable volume which will open out new and wide vistas of interest to most of those who study it. She says that the history of the Family "is a great work waiting for a great scholar." It is no disparagement to this book to add that she speaks truly; only it seems to the writer of this notice that a still more important requisite than scholarship is a more enlightened statistical treatment of the subject than it has for the most part yet received.

One of the many of these desiderata is an exact analysis of the effects of different forms of the Family on the eventual well-being of the race. These have a strong influence on the marriages or on the celibacy of its members. The influence of the Family inclusive of religion, in France, is such that in the year 1900, as stated, no less than sixty-four thousand women were immured for life within convent walls. Some forms of family life may be found to exert a considerable eugenic effect on the nation, others the contrary; how far has yet to be investigated. In the view of the author the power of the Family is not decaying in England. She thinks it has developed in a changed direction, through replacing a slavish submission to the head of the family by feelings of willing loyalty. The proved habit of the artisan class to contribute to the well-being of the Family is to her an evidence of the strength of the bonds that still unite its members. In conclusion, it should be said that this volume contains occasional passages of rare eloquence, such as those in p. 160 and onwards, on the very real and spiritual entity of the Family. F. G.

The Evolution of Man: a Popular Scientific Study. By Ernst Haeckel. Translated from the fifth (enlarged) edition by Joseph McCabe. Two vols. in one. Pp. xiv+364. (London: Watts and Co., 1906.) Price 2*s*. net.

A TRANSLATION of the fifth edition of Haeckel's famous book is now procurable for two shillings! It is true that the text has been somewhat condensed, and that the beautiful plates of the complete edition have had to be omitted, but the gist of the matter is here, and is illustrated by more than four hundred figures. Moreover, a library edition of the complete work is also available to English readers. As is well known, the first half of the book contains a general account of the development of vertebrates, and of man in particular, while the second half discusses the chief phyletic stages from protists to man, and the gradually increasing differentiation of the various organs and systems. There is a great deal of embryology and comparative anatomy in the book, but there is very little ætiology, and the English title "The Evolution of Man" is rather misleading. The original title was "Anthropogenie." Many parts of the book, *e.g.* those dealing with the development of the fœtal membranes and of the excretory system, are very technical and difficult; serious students of biology will find these intricate subjects more clearly discussed elsewhere, and we do not think that other readers will understand them. The translation bristles with mistakes, some of which show that even the translator has not always understood his text. The kind of mistake we allude to is translating "Rest der Chorda" as "rest of the chorda," and "Zungenbogen" as "hyaloid bone."

Untravelled England. By James John Hissey. Pp. xviii+459. (London: Macmillan and Co., Ltd., 1906.) Price 16*s*.

THE author describes how he set forth in search of unfrequented spots in his own country, and goes on to provide a pleasing and quietly entertaining account of the out-of-the-way places he visited. The start from Eastbourne in a motor car does not, it must be confessed, encourage the reader to expect much in the way of romance; but the motor car, because of its persistently satisfactory conduct, does not obtrude itself into the narrative. There is no attempt at "fine" writing, yet the author succeeds in maintaining the reader's interest in the English and Welsh villages passed through, and in conveying a pleasing impression of the characters of the natives encountered. The volume is illustrated by twenty-four half-tone reproductions from photographs taken by Mr. Hissey on the journey.

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 Japanese Singing Kettle.

THE town of Morioka is well known for the manufacture of the iron kettle which is indispensable in every Japanese household. There exist numerous forms of kettle; several dozen shapes may be counted in a single shop, but the most frequently occurring forms are cylindrical, pear-shaped, and spherical. The kettle is used for boiling water by means of charcoal fire for making tea. On approaching boiling point, some of these kettles begin to sing with quavering sound, which is a combination of different notes, peculiar to the form and size of the kettle.

There are several arrangements for producing sound, of which the following will indicate the manner in which the vibrations are produced. Inside the kettle, the bottom is nearly flat. On this four pieces of sheet iron, 15 mm. sq. and 0·4 mm. thick, are glued by means of Japan lac (*urushi*), which can well withstand the temperature of boiling water. Between the bottom and the plates is an air space nearly ½ mm. thick. The plates are nearly in a plane, and almost touch each other, leaving thin slits between them. When the kettle is full the cell is under the water, and some air remains in the cell between the plates, but as it is the part strongly heated by the fire, the cell is filled with steam, which escapes in bubbles through the slits; the water then creeps into the cell, to be converted immediately into steam. This process goes on at first intermittently, but it soon reaches a stationary state. The bubbling of steam through the slits acts as exciter, and the kettle emits sonorous notes, which may be likened to the ruffling of pine trees by a gentle breeze or the sound produced by stridulating insects. The difference of sound is mainly due to the form of the kettle rather than to the method of exciting the vibration. To make the kettle sing loudly it is necessary to regulate the fire in such a way that the expulsion of steam bubbles from the cell is in good accord with the natural period of vibration of the kettle, so that it is set in sympathetic vibration. Excessive heating is, therefore, unfavourable to singing.

Various forms of steam exciter can be easily designed, and different manufacturers seem to have their own speciality. When and where this method of exciting the vibration came into use is not well known, but as the kettles were common for many centuries, the exciter seems to have been invented by the amateurs of teaism (*chanoyu*) long before Western science was introduced to Japan.

H. NAGAOKA.

Science College, Tokyo, September 27.

Bursaries at the Royal College of Science, London.

SCIENCE scholars selected from the whole of Great Britain for their ability and promise, maintaining themselves on 17*s*. 9*d*. per week, are year by year saved from much privation by secret gifts of small bursaries—see the subjoined audited account for last year.

I have no right to ask for help from the generous men who helped me last year, but I have all the sturdiness of a chartered beggar. I ask in a good cause.

It was originally intended that these bursaries should be given only to such National Scholars as required assistance, but some of the subscribers have given me power to assist other students of the college. Also one of the two City companies has given me power to grant an occasional bursary of more than 10*l*. It is understood that every student is morally bound to repay this money to the fund at some future time.

JOHN PERRY.

November 12.

ROYAL COLLEGE OF SCIENCE.

BALANCE SHEET, BURSARIES, 1905–6.

Moneys Received and Paid by Prof. Perry from July 12, 1905, to July 12, 1906.

Received.

	£	s.	d.
July 12, 1905—Balance in hand ...	22	19	0
,, ,, ,, —Royalty on Slide Rules ...	1	4	0
Oct. 20, ,, — ,, ,, ,, ...	2	11	0
Nov. 6, ,, —Dr. Sprague ...	20	0	0
,, 13, ,, —A. T. Simmons, Esq. ...	10	0	0
,, 16, ,, —Oscar Guttman, Esq. ...	1	1	0
,, 21, ,, —The Drapers' Company ...	100	0	0
Dec. 4, ,, —Robert Kaye Gray ...	10	0	0
,, 7, ,, —Matthew W. Gray ...	10	10	0
Jan. 13, 1906—George Beilby, Esq. ...	10	10	0
,, 13, ,, —Royalty on Slide Rules ...	3	15	0
,, 16, ,, —The Goldsmiths' Company ...	100	0	0
July 6, ,, —Royalty on Slide Rules ...	1	1	0
	£293	11	0

Paid.

	£	s.	d.
July 12 to Dec. 20, 1905—			
One Bursary ...	7	0	0
Two Half-Bursaries, each £7 10*s*. ...	15	0	0
Twenty-three Half-Bursaries, each £5 ...	115	0	0
April 6 to June 15, 1906—			
Two Half-Bursaries, each £7 10*s*. ...	15	0	0
Twenty Half-Bursaries, each £5 ...	100	0	0
Balance ...	41	11	0
	£293	11	0

Audited and signed by

July 17, 1906. WILLIAM A. TILDEN.

LAKE BALATON.[1]

LAKE BALATON, the largest lake in the Hungarian Plain, occupies a basin of internal drainage at the level of 343 feet above the sea, and has an area of some 230 square miles. It is well known from the watering-places and mineral springs upon its shores. In 1891 the Hungarian Geographical Society appointed a commission to undertake a detailed investigation of the lake. The scheme was supported financially by the Hungarian Minister of Agriculture, the Hungarian Academy of Sciences, and Dr. Andor von Semsey. The results are being published in three volumes; the first deals with the geography, geology, hydrography, climate, and the physical and chemical characters of the lake water. The second volume is devoted to biology; the third to the anthropography, ethnography, archæology, bibliography, and the description of the watering-places. There is also an atlas. Several sections of the work and the topographic atlas have been issued. They contain contributions to all three volumes, and illustrate the thorough nature and wide range of the work.

The report on the ethnography, by the late Dr. Johann Jankó, translated by Dr. Willibald Semayer, is the longest contribution, and is perhaps of most general interest. It begins with a concise geographical description of all the localities around the shores of the lake, and then gives an interesting discussion of the place-names. They are mainly Magyar, with some Sclav and German additions. The place-names are classified into groups, based on orographic and hydrographic conditions, on plants, on the general features of the vegetation, on animals, on soils and rocks, on echoes (as in Ekko and Zongo odal, "the resounding side"), on industries, ecclesiastical terms, family and personal names, and races. (English occurs in the term Angol zollok, the "English vineyard," and in other names associated with gardens.) Other places are named after the days of the week, military terms, numerals, and unnatural death (such as "Olo" for murder). Historical place-names are placed as a special group, and they can be traced back to between the eleventh and fifteenth centuries; they are regarded by Dr. Jankó as of especial historical value as showing the unbroken continuity of the Magyar occupation of the Balaton district during the past nine centuries, in spite of the invasions of Tartars and Turks. The old families who have been domiciled round Lake Balaton for at least a century are mostly Hungarians; 6·5 per cent. are Jews, and 1 per cent. are foreigners. The census of 1890, enumerating a population of 55,000, gave their numerical proportions as follows:—98·809

[1] "Resultate der Wissenschaftlichen Erforschung des Balatonsees." Balatonsee-Commission der Ung. Geographischen Gesellschaft. (Vienna: Ed. Hölzel, 1902–1906.)

Vol. i. "Physische Geographie des Balatonsees und seiner Umgebung." Part iv., Sect. 3, Resultate der Phytophänologischen Beobachtungen in der Umgebung des Balatonsees. By Dr. Moriz Staub, completed by Dr. J. Bernatsky. 45 pp., 1 map. (1906.) Part v. Die Physikalischen Verhältnisse des Wassers des Balatonsees. Sect. 2 and 3, Die Farbenerscheinungen des Balatonsees, by Dr. E. von Cholnoky; Die Reflexionserscheinungen an Bewegten Wasserflächen, by Dr. Baron Bela Harkanyi. 88 pp., 2 col. plates. (1906.)

Vol. ii. "Die Biologie des Balatonsees." Part i., Die Fauna des Balatonsees. Beiträge zur Kenntniss des Planktons, by Dr. Geza Entz, Jun., and i. and ii. Nachtrag zur Aufzählung der Weichthiere, by Dr. A. Weiss and Theodor Kormos. 76 pp. (1906.) Part ii., Die Flora. Sect. 1, Die Bacillarien des Balatonsees, by Dr. Josef Pantocsek. 112 pp., 17 plates. (1902.)

Vol. iii. "Social- und Anthropogeographie des Balatonsees." Part i., Archæologie der Balatonsee-Umgebung. Sect. i., Archæologische Spuren aus der Urzeit und dem Altertum bei Veszprem. By Gyula Rhé. 33 pp., 2 col. plates. (1906.) Part ii. Ethnographie der Umwohner des Balatongestades. By the late Dr. Johann Jankó, continued by Dr. Willibald Semayer. 499 pp., 1 map. (1906.) Part v. Bibliographie des Balatonsees. By Julius von Sziklay. 65 pp. (1906.)

"Spezialkarte der Balatonsees und seinen Umgebung." By Dr. Ludwig von Loczy. 4 sheets. Scale 1 to 75,000. (1903.)

per cent. Magyar, 0·828 per cent. German, 0·081 per cent. Croat, 0·059 per cent. Slovak, and 0·005 per cent. Wend.

The description of the daily life and industries of the inhabitants of the district of Balaton is of especial interest. Some of the people live in artificial caves dug out on the hill-sides, in what, from the photographs, look like deposits of loess. Some of these cave-dwellings are high up in the face of the cliff, and they are explained by Dr. Jankó as having been occupied when a slope led up to them, and before denudation had cut back the ground and left the ends of the old excavations like hanging tunnels on the face of the cliff. The author figures the picturesque mud-walled, thatched houses, and the carved wooden furniture, and describes the industries, of which the most interesting is his account of the fishery. He describes the regulations of the Fishers' Guild, and the methods of fishing, from the fire-hollowed, flat-sterned canoes (bottich schiffe), from sledges used on the ice in winter, and by the fish traps composed of labyrinthine fences.

FIG. 1.—Ancient Artificial Cave Dwellings n the District of Lake Balaton.

The archæology of Lake Balaton is described by Gyula Rhé. There are tools and flakes of the Stone age, numerous implements and pottery of the Bronze age, and well-preserved remains of a Roman settlement at Poganytelek.

The three sections of the first volume deal with seasonal plant distribution and with the physical characters of the lake water. The work on phenology was begun by Dr. Moriz Staub, and continued by Dr. Bernatsky; extensive observations on the time of blooming of *Galanthus nivalis*, *Corylus avellana*, and *Cornus mas* have been used to map out the part of Hungary between the Danube and the Drave into seven zones, characterised by the earliness or lateness of the vegetation.

The investigation of the physical characters of the lake water has been conducted by Dr. von Cholnoky and Baron Harkanyi. The former has determined the transparency of the water under different conditions of wind and season, and its essential colour, which varies from the highest to the middle numbers (11–6) in Forel's scale. He also discusses the influence of movements of the water on its colour, and the complex colour and light effects produced by wind and ripples. The sky has an especially powerful effect on the colour, as the lake is in open plains with low banks; but different colours are seen under the same sky conditions, and they are explained as polarisation effects. The apparent uplift of hills by mirage is illustrated by a telephotograph, and by a series of views showing the different elevation of distant hills under varying conditions of refraction. The discussion of the colour effects is illustrated by excellent sketches showing colour effects on the shores of the lake under different climatic conditions, and is followed by an investigation by Baron Harkanyi on reflection effects from moving water.

The reports on the biological sections of the work are represented by two sections. A monograph of the diatoms by Dr. Josef Pantocsek gives a systematic account of the 288 species, many of which are new. The Mollusca are catalogued by Dr. Weiss and Theodor Kormos. Dr. Weiss's list raises the number

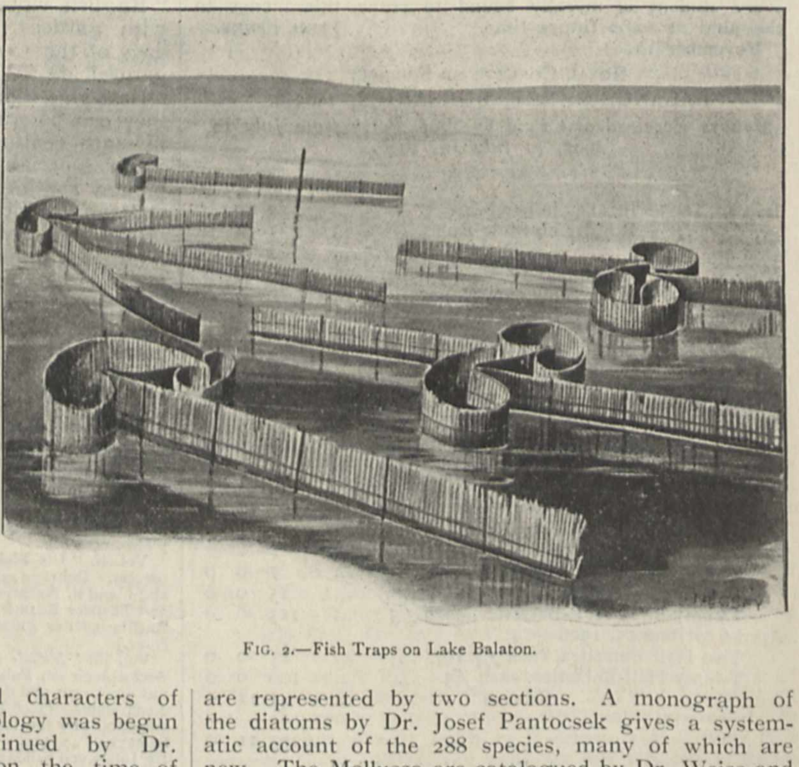

FIG. 2.—Fish Traps on Lake Balaton.

of known species in the fauna to 106. Contributions to the knowledge of the plankton are given by Dr. Geza Entz; he describes twenty-three species of Peridiniaceæ, and figures the seasonal variations of *Ceratium hirundinella*, which lives in the lake throughout the year, and is common from May to November.

The last part of the whole work, the bibliography, has been compiled by Dr. Julius von Sziklay. It enumerates all the independent works, with summaries of their contents, and has special sections for maps and for contributions in journals and serials.

The Hungarian Geographical Society is to be congratulated on this valuable contribution to natural science. The monograph on Lake Balaton will be of value to all students of the natural history and geography of Central Europe, and its summary of modern methods of research will be of use to students of lakes elsewhere. Moreover, the description of the country, revealing the quiet charm of its scenery and the many interests in the life of its people, should lead more visitors to this attractive district.

A 100-INCH REFLECTING TELESCOPE.

AS time passes and astronomical work advances there is a greater demand, year by year, for more powerful instruments of research. Fortunately, instrument makers have so far been able to fulfil the requirements for large refractors and reflectors, but a few years ago the time seemed to be reached when further progress appeared a long distance off. At the present day there are refractors in existence the object-glasses of which are as large as 30, 36, and 40 inches in diameter, while the greatest glass mirror that has been used measures 60 inches in diameter.

In the case of the largest refractor, namely, that erected in the Yerkes Observatory in America, it seems possible that the size of this form of telescope has nearly reached its limit. The reasons for this are that, not only is it extremely difficult and costly to cast and figure lenses of such dimensions, which to give the best definition must be practically flawless, but the mounting has to be so immense and strong, and consequently very expensive in proportion.

It must be remembered that in the refracting form of telescope the object-glass has to be placed at the *upper* end of a long tube, while the observer takes his place at the lower end; these ends have to be very rigidly connected together, and the whole tube mounted so as to be capable of being moved in any direction. Thus in the case of the Yerkes telescope the tube had to be 62 feet long (weighing six tons), and the whole mass of metal that required moving every time the telescope was required in a different position was twenty tons. This will give some notion of the engineering difficulties that are involved in large refractors. In reflectors, on the other hand, the mirror is placed at the *lower* end of a comparatively light tube, and as close as possible to the mounting on which it is carried. In fact, in the case of the late Dr. Common's 5-feet reflector a means was adopted of actually floating the mirror.

In considering, therefore, the construction of telescopes much larger than those that already exist, attention is naturally being paid more to the reflecting type than to refractors. Further, it is not necessary that the glass casting for a mirror should be so perfect as that required for an object-glass, for in the former case only a perfect reflecting *surface* is required, while in the latter the light has to pass through the whole mass of glass. It is obvious, then, that much larger discs of glass can be made which may be suitable for reflectors but useless for refractors. Aperture for aperture, a mirror costs about one-tenth the price of an object-glass, and this gives some idea of the extra work and risk involved in producing a good object-glass.

The expense attached to the mounting of a reflector is also considerably less than that of refractors when large instruments are in question.

Now, not only is the reflector the less expensive of the two forms of instruments, but it has many distinct advantages optically. Thus chromatic aberration is a thing unknown in reflectors. Again, light being totally reflected from the silvered surface of a mirror is not lost like it is in refractors, where it always has to pass through the object-glass, and is consequently partially absorbed.

Mirrors are, however, easily tarnished and affected by changes of temperature, but these disadvantages do not counterbalance the many points in their favour, to which reference has been made, when exceedingly large instruments are under consideration.

In the Proceedings of the American Philosophical Society (vol. xlv., No. 182, p. 44, 1906) Prof. E. C. Pickering communicated a paper entitled "An International Southern Telescope," and in it he strongly advocated the erection of a large telescope of the reflector type. His proposal was that the telescope should have a diameter of about 84 inches, and should be set up in some locality such as South America or South Africa, where the observing conditions are considered very favourable. Towards the end of the paper Prof. Pickering referred to the important work that could be accomplished by means of such a large reflector, and mentioned that the name of a donor "could in no way be better immortalised than by associating it with such a real advance in the greatest problem to the solution of which the mind of man has aspired—the study of the sidereal universe."

We learn now from the current number of the *Astrophysical Journal* (vol. xxiv., No. 3, October) that Mr. John D. Hooker, of Los Angeles, who on former occasions has rendered financial assistance to astronomy, has presented to the Carnegie Institution of Washington the sum of forty-five thousand dollars to purchase a glass disc 100 inches in diameter, 13 inches thick, and 50 feet focal length, and to meet other expenses incident to its construction. These latter will include the erection of a building in which the mirror can be ground, figured, and tested; the construction of a large grinding machine, with crane for lifting the mirror (4½ tons); the provision of a 54-inch glass disc to be made into a plane mirror for testing purposes, and other necessary items.

The large mirror is intended for use at the Solar Observatory of the Carnegie Institution situated on Mount Wilson, in California, and under the directorship of Prof. G. E. Hale. This observatory has already a 60-inch mirror in its optical shop, and at the present moment it is being tested. In the case of the new 100-inch reflector, we are told the St. Gobain Company expresses its deliberate opinion that such a disc, 13 inches thick, can be produced, and that the Company will be able to carry out the order which has been given to it.

The grinding and figuring will be entrusted to Prof. G. W. Ritchey, and no unsurmountable difficulty is anticipated by him in bringing such a mirror to a high order of perfection. The 60-inch mirror, now nearly completed, is the largest he has yet attempted, and this is now nearly ready for mounting.

At present no financial provision has been made for the mounting and housing of this 100-inch reflector, but as the mirror will take, as we are told, about four years to complete, there is no immediate hurry.

The experience gained by the form of mounting adopted for the 60-inch mirror will be valuable when the time comes for the erection of the 100-inch mirror, and funds will no doubt soon be found when the right moment arrives.

Already the United States is the possessor of the two largest refractors and silver-on-glass reflectors. This new monster will afford her another means of greatly extending astronomical knowledge, which has made such vast strides during the last decade owing to these increased aids to observation.

AN EXPERIMENT IN INSECT-EXTERMINATION.[1]

IN the year 1900 the sugar-cane planters of Hawaii were seriously alarmed by the appearance in considerable numbers in their plantations of an introduced hemipterous insect allied to the cicadas and commonly known as the cane leaf-hopper, but designated scientifically *Perkinsiella saccharicida*. Since that date the pest has increased to an enormous extent, with an estimated loss of many millions of dollars to the planters. Fortunately, the leaf-hopper has a certain number of enemies among the insects indigenous to Hawaii, since had it not been for the extent to which it was held in check by their attacks it seems probable that sugar-growing would by this time have become absolutely impossible in the islands.

These indigenous enemies were, however, utterly unable to cope in a thoroughly efficient manner with the swarms of the leaf-hopper, and it became apparent that unless some other means of diminishing its numbers were discovered the sugar industry of the Sandwich Islands would be practically ruined. Accordingly, the officials of the Entomological Division of the Planters' Association at Honolulu set to work with commendable energy and enthusiasm to endeavour to find an efficient and satisfactory remedy. It appears to have been soon decided that such a remedy would most likely be discovered in the form of insects which would prey upon the leaf-hoppers with greater vigour than any Hawaiian species; and in 1903 and the two following years expeditions were organised to North America, Australia, and Fiji with the view of discovering such insects.

In due course a number of species inimical to the cane leaf-hopper were brought to light, and the present elaborate bulletin (of which one part has been already briefly noticed in our columns) is devoted to the description and life-history of leaf-hoppers and their enemies, together with an account of the experiments which have been made in introducing and acclimatising certain of the latter into Hawaii.

The list of insects parasitic on leaf-hoppers is a very long one, and comprises representatives of several orders, although the great majority belong to the Hymenoptera. For our present purpose attention may be concentrated on the few species it has been found advisable to introduce into Hawaii. In the case of the introduction of such parasites four points are essential:—(1) Their effectiveness as destroyers of the pests; (2) the possibility of successful transportation; (3) the probability of their thriving in the new country; and (4) their rapidity of increase when introduced. The choice was soon narrowed down to certain minute Hymenoptera which feed upon the eggs of leaf-hoppers, namely, to species of Anagrus and Paranagrus in the family Myrmaridæ and to one of Ootetrastichus among the Eulophidæ. The members of the two first genera complete their life-cycles in about three weeks, breed at about the same rate throughout the year, and are largely parthenogenetic. Ootetrastichus, on the other hand, takes fully twice as long to complete its cycle, but produces twice as many eggs, and is wholly parthenogenetic. *Caeteris paribus*, the products of the myrmarids at the end of six months will, however, be a million times more numerous than those of the other genus. On the other hand, the ootetrastid is not only more hardy, but has the advantage that each individual is bred at the expense of the whole contents of the egg-chamber of the leaf-hopper instead of destroying only a single egg.

Of the four species introduced one of Paranagrus is at present the most effective, but the Ootetrastichus is slowly but surely increasing in numbers, and is eventually expected to prove the most effective. For further details respecting these interesting and to a great extent even at present successful experiments, our readers must be referred to the Bulletin itself.

R. L.

[1] "Leaf-hoppers and their Natural Enemies." Edited by R. C. L. Perkins. Bulletin No. 1 of the Experiment Station of the Hawaiian Sugar Planters' Association, Honolulu, 1905–06. 10 parts. Pp. xxxii + 499; illustrated.

THE FLIGHT PROBLEM.

THE real "flights," not "jumps," which Mr. Santos Dumont has been making at Paris with his new aëroplane have directed the attention of the whole aëronautical and motor world in the direction of the problem of flight. Further, tempting prizes have now been offered which will undoubtedly stir up other workers to take up the problem and so increase the chance of rapidly advancing the progress of aërial navigation.

In addition to the Archdeacon prize of 2000*l.* for a half-mile course and to the enterprising offer of the *Matin* of 4000*l.*, which was subsequently increased to 10,000*l.* by public subscription, for the first traveller who succeeds in covering the distance between Paris and London in 1908, the *Daily Mail* has now come forward with the offer, open to the world, of 10,000*l.* to the first person who shall fly by aëroplane from London to Manchester in twenty-four hours, including two stops to take in supplies of petrol.

Such large prizes will certainly go a long way towards giving a strong impetus to the manufacture of aëroplanes, and also to the motor industries to produce the lightest forms of petrol engines. In fact, a great number of people will almost immediately set about experimenting with aëroplanes in order to compete for the prizes. We read that already Mr. Santos Dumont has given an order for a lighter and more powerful engine, namely, a 100 horse-power motor which will weigh no more than 200 lbs.

Since Mr. Santos Dumont's successes were announced, several references have been made to the experiments which have been carried out by the brothers Wright in America, but very little is known about their results, since they have purposely avoided publicity; according to the views of Sir Hiram Maxim, as stated in the *Daily Mail*, they have a new motor to their aëroplane which is twice as effective as their previous one, and they hope to "fly with it 200 to 300 miles without stopping."

Up to the present time there has not been any great inducement for workers to come forward and demonstrate publicly the capabilities claimed for their machines. The rewards now offered will no doubt serve as an incentive to them, and possibly others, to enter the arena and prove in open competition the efficiency of their designs.

NOTES.

THE meetings for the discussion of important contributions to meteorological literature, arranged by the director of the Meteorological Office, will be resumed on Monday, November 26, at 5 p.m., with a discussion of Mr. J. Aitken's paper "On Dew."

A REUTER message from Toronto records that on November 19 electrical energy generated at Niagara Falls, eighty miles away, was delivered there for the first time. A supply of 40,000 horse-power is available.

CAPTAIN AMUNDSEN, the leader of the *Gjoa* Polar Expedition, and his companions arrived at Christiania on November 20. Among the large number of people who assembled on the landing stage to receive the explorer were the President of the Storthing, the members of the Government, and the magistracy, the President of the Municipal Council, the admirals of the station, the general in command of the capital, and the president of the Norwegian Geographical Society.

ON November 13, at 11 p.m., a sharp shock of earthquake was felt both in the south and the north of Jamaica. It was immediately followed by a second shock, the heaviest experienced in Kingston for many years. From Perth, Western Australia, it is reported that an earthquake was felt at 3.20 p.m. on November 19 along the whole of the coast from Albany to Sharks Bay. The shock was very severe at Perth, Busselton, Geraldton, and Marble Bar.

THE spermatogenesis of one of the swallow-tailed butterflies (*Papilio rutulus*) forms the subject of a long article by Dr. J. P. Munson in the Proceedings of the Boston (U.S.A.) Society of Natural History (vol. xxxiii., part iii.).

IN the *Irish Naturalist* for November Mr. R. J. Ussher gives an account of the excavation of certain "hyæna-dens" in the Mammoth Cave near Doneraile, county Cork. The discovery of the system of caves of which this forms a part is recorded in the Proceedings of the Royal Irish Academy for November, 1904. Seventy-six baskets of bones and teeth were obtained from the Mammoth Cave and dispatched to the Dublin Museum. All the remains identified appear referable to the ordinary cavern species; but the remains of the cave hyæna are the first record of the occurrence of that species in Ireland.

TWO articles are included in vol. lxxxiv., part iv., of the *Zeitschrift für wissenschaftliche Zoologie*, one by Mr. F. Hempelmann on the morphology of two marine annelids of the genus Polygordius, and the second by Dr. E. Zander on the filtering apparatus of the gills of teleostean fishes. In 1903 the latter author discovered a certain appendage to the gill-filters of fresh-water fishes, and the present paper is based on a fuller study of this structure, more especially in marine species, of which a large number has been examined. It has been found that the development, and in some degree also the function, of the filtering apparatus vary considerably according to the mode of life, bottom-dwelling species using it to aid in the supply of nutriment.

AN interesting article on entomological photography appears in *Focus* of November 21. The object of the article is to show how photographs of many kinds of insects may be taken in all stages of their existence from living specimens in captivity, and in some instances amid imitations of their natural surroundings. When aquatic insects form the subject of the experiment, a narrow and deep tank is, of course, essential. When dealing with butterflies, it is found most advantageous to take them just after leaving the chrysalis, or, failing this, they may be made quiescent by the application of a small quantity of chloroform. The photograph of a group of five "tortoise-shells" appears very successful. In the case of night-flying moths, it is impossible to display the full characters of the species from living specimens when at rest, while to depict them flying is likewise an impossibility. To overcome these difficulties the photographer has resorted to the plan of first photographing mounted specimens in the positions desired, and then combining the photograph thus obtained with one of a suitable background. If a suitable landscape-negative has been previously taken, by placing this behind the focusing screen the moths can be arranged in such a position that they will appear exactly in the right place in the compound picture.

IN the course of a paper on the papillary ridges and papillary layer of the skin of the hand and foot of mammals other than man, published in vol. xli., part i., of the *Journal of Anatomy and Physiology*, Dr. Walter Kidd points out that these structures attain their maximum development in the lemurs and their relatives. "These characters suggest very clearly that in this group of animals the sense of touch is extremely important. . . . If one bears in mind that three [groups] of them are nocturnal and arboreal and the other two diurnal and arboreal, one can gather from these facts the great importance to them that their sense of touch should be very acute. A continual need of their arboreal lives is that they should maintain by reflex means their equilibrium, and I would suggest that in their highly developed papillary ridges and papillary layer of the corium they possess most efficient structures for the transmission of impulses to their nerve-centres for the performance of this important function." To the same issue Mr. E. J. Evatt contributes a paper on the development of these structures. The other articles are mainly devoted to the description of various monstrosities and other abnormalities.

IN the Proceedings of the American Academy for October there is an interesting study of inheritance in fishes, by Mr. A. P. Larrabee. In the majority of the teleosts, the fibres of the two optic nerves do not interlace at the chiasma, but remain distinct, and it has been shown for certain species that specimens in which the nerve running to the right eye is dorsal, and specimens in which the reverse is the case, are almost equally frequent. The present investigation, commenced by Dr. W. E. Castle and completed by Mr. Larrabee under his direction, was undertaken with the view of determining whether this character is heritable, and if so in what manner. Crossings were made with the brook trout and with the cod, and the rather remarkable conclusion is reached that the character is not inherited at all. Of 971 trout, for instance, in both the parents of which the right nerve was dorsal, 52 per cent. had the right nerve dorsal, while of 1519 with unlike parents, 56 per cent. had the right nerve dorsal. The character does not appear to be affected by gravity; the dimorphism is not due to an earlier development of one of the optic nerves, and in monstrous two-headed specimens of the trout the two heads differ in structure as often as not; practically speaking, it seems to be a matter of chance which nerve is dorsal. There is, however, a curiously persistent preponderance of cases with the right nerve dorsal, and Dr. Castle, in a footnote, directs attention to the apparent similarity of the phenomenon with the more frequent occurrence of polydactylism in guinea-pigs on the left side of the body.

IN the first part of vol. xxxvi. of Gegenbaur's *Morphologisches Jahrbuch* Prof. Schmaltz, of Berlin, furnishes further information with regard to the assertion (mentioned some months ago in these columns) that a pleural cavity is lacking in the Indian elephant. The author's observations are based on dissections of four elephants, one from the Berlin Zoological Gardens and three from a circus. In each instance the structure of the pleural viscera was of the same type. The heart was normal. The lungs possessed a dense fibrous capsule, but between their outer surface and the wall of the thorax occurred a homogeneous mass of connective tissue, completely filling the cavity of the chest. The connective tissue presented no signs of being a pathological product, and, in the author's opinion, it must consequently be accepted as a fact that a pleural cavity is absent in the Indian elephant. In a second article Mr. A. Rauber records and figures two instances of the occurrence of an "intermetatarsal bone" in the foot of the human subject. The bone in question is an ossicle wedged in between the entocuneiform of the tarsus and the bases of the first and second metatarsals. The number of recorded cases of a similar abnormality is now brought up to eighty-eight, and the author concludes by discussing the bearing of this feature on the theory of a lost digit. The contents of the same issue also include an article, by Dr. C. Gruber, on the structure and development of the reproductive organs of the guinea-pig; a second, by Dr. W. Braun, on the development of the pancreas in the midwife-toad; and a third, by Mr. Max Borchert, on the central nervous system of the torpedo.

THE *Philippine Journal of Science* for September (i., No. 7) contains a long paper on beri-beri by Mr. M. Herzog, who believes that this disease is an infective one, the organism of which has yet to be discovered; notes on Philippine and other birds, by Mr. R. C. McGregor; and a description of a new genus and species of Culicidæ, by Mr. C. S. Banks. This mosquito (*Worcesteria grata*) does not bite, and its larvæ destroy numbers of noxious forms of Culicidæ. The genus is near the genera Megarhinus and Toxorhynchites. The number is well illustrated with many plates, and is a most creditable production.

IN the Bulletin of the Johns Hopkins Hospital for November (xvii., No. 188) Dr. C. W. Eliot discusses the future of the medical profession, and concludes that in the course of time it will have the satisfaction, not only of ameliorating the condition or prolonging the life of the suffering individual, but also of exterminating or closely limiting preventable diseases. Notes on the International Congress of Tuberculosis, Paris, 1905, are contributed by Dr. H. B. Jacobs, and on the advantages of local sanatoria in the treatment of consumption by Dr. D. R. Lyman. Governor John Winthrop, jun., of Connecticut, a physician of the seventeenth century, is the subject of a paper by Dr. W. R. Steiner, and Prof. Welch's address on the unity of the medical sciences, delivered at the dedication of the new buildings of the Harvard Medical School, is published in full.

THE issue of selected papers on rubber from the *Kew Bulletin* as No. 7 of the additional series is opportune at the time when this product is receiving so much attention. Not only do the papers furnish a historical account of the gradual accumulation of knowledge that is bearing fruit at the present day, but old facts served up as new, such as the artificial production of rubber, are here placed in proper perspective. The most recent papers are the synopses of the genera Kickxia and Funtumia, by Dr. O. Stapf, published in the *Kew Bulletin*, 1905, and a note on the rise and fall in prices of Para rubber contributed by Mr. J. H. Hillier to the part lately issued.

A CATALOGUE of botanical slides issued by Mr. A. Peniston, Montpelier Terrace, Leeds, can be recommended to the notice of those desiring microscopical slides of practical educational value, illustrating the chief features in the taxonomy and anatomy of plants. Of the slides examined, the root apices showing mitoses and the transverse section of Equisetum root were especially good, and all were satisfactory. Messrs. Clarke and Page, of London, supply botanical and geological preparations, but make a greater speciality of marine slides, which, judging from specimens seen, will be found suitably and well prepared.

THE annual report for 1905 of the Royal Botanic Gardens, Ceylon, contains eight reports by assistants, in addition to the general report by the director, Dr. J. C. Willis. The branch gardens at Badulla and Anuradhapura were closed in favour of a botanic garden at Maha-iluppalama, where an experiment station has already been established. Rubber has, of course, monopolised most attention, but the production of the oils of cocoa-nut, citronella, and cinnamon shows a considerable increase, and in the market for coca leaves Ceylon provides the standard. The curator of the Peradeniya gardens records the failure of the attempt to propagate Hevea by cuttings; as a substitute for boxwood edgings in tropical gardens he recommends cuttings of *Malpighia coccifera*.

THERE are several facts and observations, interesting to botanists, on the subject of xerophytes and plant transpiration in the publication No. 50 of the Carnegie Institute of Washington entitled "The Relation of Desert Plants to Soil Moisture and to Evaporation," representing investigations by Dr. B. E. Livingston at Tucson, in Arizona. With regard to the soil, it was found that the deeper layers contained an adequate supply of water even at the end of the dry season, this being due partly to the formation of a dust mulch. Cacti showed no greater osmotic pressure in the cell-sap than plants in humid regions. An ingenious evaporimeter, consisting of a porous clay cylinder attached to a burette and water receiver, was devised for comparing evaporation with transpiration. The author expresses the opinion that air temperature, and not light, is the main controlling factor in the rate of transpiration.

PROF. POTONIÉ, of Berlin, contributed a paper (an abstract of which has now reached us) to Section K at the York meeting of the British Association, in which he pointed out the strict parallelism that exists between the different kinds of peat and the different kinds of coal (which is simply fossil peat). When conditions are such that organic remains collect under terrestrial conditions we have ordinary peat formed. This corresponds exactly with "bright" coal. When, on the other hand, organic remains collect under water, the result is an organic slime which the author calls "sapropel," becoming of a gelatinous consistency ("saprokoll") when subfossilised. This, according to Prof. Potonié, is exactly equivalent to the "dull coal" or "cannel coal" of Carboniferous age. When terrestrial and aquatic conditions have alternated during the accumulation of organic remains, we obtain "strata-peat" or "strata-coal," *i.e.* interbedded saprokoll and peat, or "bright" and "dull" coal. The chemical and physical properties of these varieties correspond very closely, the cannel coal being gas coal and saprokoll containing much more gas than genuine peat. The author regretted that living peat bogs were so extensively killed by drainage, and pointed out that we were thus destroying a possible source of fuel supplies when our coal should be exhausted.

THE Channel tunnel project forms the subject of an article in the *Engineer* (vol. cii., No. 2654). Particulars are given of what has been accomplished, from an engineering and scientific point of view, upon the other side of the Channel towards the solution of the great international problem.

AT the Institution of Civil Engineers on November 13 a paper was read on single-phase electric traction, by Mr. C. F. Jenkin. A paper on electric traction on railways, by Messrs. Mordey and Jenkin, was read before the institution in 1902. The object of the present paper was first to bring the previous account of the different systems up to date, and to show how far the conclusions then arrived at have to be modified in the light of recent experience, and then to describe the equipment required for single-phase working and to discuss the different problems which arise in connection with it. Little advance has been made in continuous-current working. The voltages have risen a little, and in a few cases pressures of 1000 and 3000 volts are in use. The principal advances in three-phase working have been the completion of the Zossen experiments, the opening of the Valtellina line, and the adoption of three-phase working for the Simplon Tunnel. Experience has confirmed Messrs. Mordey and Jenkin's conclusion that the single-phase is the only system which can satisfy all the requirements of a general system.

ACCORDING to the official statistics published in the Mines and Quarries General Report (part iii., 1906) the output of coal in Great Britain in 1905 was the highest hitherto recorded, being as much as 236,128,936 tons. Of this total, 47,476,707 tons were exported, and 19,255,555 tons were used in the manufacture of pig-iron. The home consumption was 3·91 tons per head of population. Statistics relating to the manufacture of coke and briquettes were collected for the first time, the production of coke in 1905 having been 18,037,985 tons, and that of briquettes 1,219,586 tons. There were 31,060 coke ovens in operation. Of these, 25,514 were of the beehive type; and there were 2233 Coppée ovens, 726 Simon-Carvés ovens, 503 Otto-Hilgenstock ovens, 470 Semet-Solvay ovens, 72 Koppers ovens, 52 Bauer ovens, and 1490 other kinds. The production of iron ore was 14,590,703 tons, which yielded nearly one-half of the total quantity of pig-iron (9,608,086 tons) made in the country. Copper, lead, silver, and tin show an increase on the figures of 1904, both in the amount and in the value of the metal obtained.

A SIMPLIFIED method of transforming readings of the Fahrenheit thermometer into centigrade values and *vice versâ* is given by Dr. Hellmann in No. 38 of the *Naturwissenschaftliche Rundschau*. The ordinary formulæ, for example $C=5/9\,(F-32)$, are not adapted for rapid calculation. The modified formulæ

$$C=(\tfrac{1}{2}-\tfrac{1}{2}\cdot\tfrac{1}{10}-\tfrac{1}{2}\cdot\tfrac{1}{100})(F-32), \text{ and } F=(2-\tfrac{2}{10})C+32,$$

on the other hand, containing decimal fractions, lend themselves much more readily to the purpose. To transform, for example, 110° F., we have $110-32=78$, and the centigrade value becomes $39+3{\cdot}9+0{\cdot}4=43^{\circ}{\cdot}3$.

A REVISION of the atomic weight of bromine made by Mr. Gregory P. Baxter in the chemical laboratory of Harvard College is published in the Proceedings of the American Academy of Arts and Sciences (vol. xlii., No. 11). Considerable uncertainty exists as to the purity of the materials employed in several of the earlier determinations, owing principally to the fact that while it is easy to eliminate metallic impurities from silver, it is not so easy to ensure the absence of occluded gas. Two different methods were adopted in the determinations: in one, highly purified silver was converted into silver bromide; in the other, the ratio of silver bromide to silver chloride was determined by acting on the former with purified chlorine. As many different methods of purification as possible were employed for the materials used. Eighteen determinations by the first method gave a value of the atomic weight varying from 79·950 to 79·955, silver being taken as 107·930; thirteen determinations by the second method ranged from 79·951 to 79·955. The average of both series was 79·953.

A VOLUME of essays, or rather lectures, by the late Lieut.-General A. Lane-Fox Pitt-Rivers, edited by Mr. J. L. Myres, will be issued immediately by the Oxford University Press. Mr. Henry Balfour, the curator of the Pitt-Rivers Museum, has written an introduction to the volume, which is entitled "The Evolution of Culture."

THE eleventh volume of the complete works of Christiaan Huygens, which are being published from time to time by the Société Hollandaise des Sciences, is in course of preparation, and will, it is expected, be ready in about a year. The tenth volume of the works was reviewed in our issue for August 17, 1905 (vol. lxxii., p. 362). Meanwhile, an extract from the eleventh volume has been issued separately under the title "Travaux divers de Jeunesse, 1645–1646"; it is edited by M. D. J. Korteweg, and published by M. Nijhoff, of the Hague. Several papers written by Huygens in 1645 and 1646—that is to say, in his seventeenth and eighteenth years—are included in this preliminary publication.

MESSRS. WILLIAMS AND NORGATE have sent us a prospectus of "The Paintings of Antiquity," edited by Herr Paul Herrmann, and published by Herr F. Bruckmann, of Munich. The work is to be published in sixty parts, and will contain about 600 plates, of which twelve to fifteen will be coloured. Six parts will be published annually. The nucleus of the collection of pictures is formed by reproductions of wall paintings removed from their original positions in houses at Pompeii, Herculaneum, and Stabiæ, and taken to the Museo Nazionale at Naples. A limited selection of mosaics will be included. Whatever paintings have been preserved of the ancient Greek and pre-Hellenic periods will be comprised in the collection; and the work will also include the most important of the mummy portraits from the Fajûm.

OUR ASTRONOMICAL COLUMN.

ANOTHER NEW COMET (1906*h*).—A telegram from the Kiel Centralstelle announces the discovery of a comet on November 14 by Mr. Joel Metcalf, of Taunton (Mass.). Its position on that date at 10h. 0·4m. (Taunton M.T.) was R.A.=4h. 4·6m., dec.=2° 16′ S., and the apparent direction of its motion is given as south-west. This position is about half-way between 35 and ξ Eridani, and crosses our meridian shortly after midnight. The comet's magnitude is given as 12·0.

A second telegram states that this object was observed by Mr. Hammond at Washington on November 16, its position at 11h. 38m. (Washington M.T.) being

R.A.=4h. 4m. 11·4s., dec.=2° 46′ 55″ S.,

and its magnitude 11·0.

COMET 1906*g*.—From observations made on November 10, 11, and 12, Herr M. Ebell has calculated a set of elements and an ephemeris for comet 1906*g*, the discovery of which was announced in these columns last week. The elements show that this comet passed through perihelion on November 7.

Ephemeris 12h. Berlin.

1906	α (true) h. m. s.	δ (true) ° ′	1906	α (true) h. m. s.	δ (true) ° ′
Nov. 20	10 0 55	24 28·1	Nov. 28	10 41 34	34 10·6
24	10 20 51	29 24·7	Dec. 2	11 2 57	38 38·5

The brightness of this object is now decreasing, and will be 1·04 times that at the time of discovery on November 24, when its magnitude was 8·5 (Kiel Circular, No. 92). In announcing the discovery of this comet last week, it was stated that the magnitude was not given in the Kiel telegrams. Prof. Kreutz writes to point out that the magnitude was given; and we regret that the group of figures containing it was mistranscribed whilst decodifying the message.

HALLEY'S COMET.—In vol. cxv., part v., of the *Sitzungsberichte der kaiserlichen Akademie der Wissenschaften*, Dr. J. Holetschek discusses the probable time at which Halley's comet may be looked for with reasonable chance of success during its forthcoming return. By reason of a particular combination of perturbations, the present period of revolution (74½ years) is the shortest observed since 1531, but after determining the comet's distance from the earth and the sun during the oppositions of 1906–9, Dr. Holetschek concludes that there is no great likelihood of this object being re-discovered before the latter part of 1908. At the end of 1909 it should certainly be easily observable, and during the second half of March, 1910, it should become a naked-eye object. According to the elements published in the *Connaissance des Temps* (1900), the comet is due to pass through perihelion on May 16, 1910.

A BRIGHT METEOR.—An exceptionally beautiful meteor was observed by Mr. Rolston at the Solar Physics Observatory, South Kensington, at 13h. 26·5m. on November 17. The approximate positions of the beginning and end of the trail were $\alpha=75\frac{1}{2}°$, $\delta=+24°$, and $\alpha=88°$, $\delta=+14°$, respectively. The narrow, fan-shaped head was nearly as bright as Jupiter, and left behind it a shimmering trail of a reddish colour, similar in appearance to the shower of sparks which come from a suddenly-braked train wheel. The duration of the meteor's flight was little more than one second, and the trail died away immediately.

THE UNITED STATES NAVAL OBSERVATORY PUBLICATIONS.—We have received from the U.S. Naval Department a copy of part iv., vol. iv. (second series), of their Publications, containing, in addition to a profusely illustrated account of the 1900 and 1901 eclipse expeditions, previously described by Dr. W. J. S. Lockyer (NATURE, vol. lxxiii., p. 486, March 22, 1906), a number of tables for use in the reduction of astronomical observations. The reduction tables for transit-circle observations contained in part ii. are only suitable for the Naval Observatory, with the exception of the refraction tables, which are based on the Pulkowa values.

Part iii. contains reduction tables for equatorial observations, including those for differential refraction and instrumental corrections. In part iv. there is a very interesting discussion of the present status of the use of standard time, in which a fairly complete account of the standard times in use in every part of the earth is given.

The conversion tables, and the summaries of the time in each country, giving the standard meridians and the relation to the standard times of other countries, should prove very useful for reference purposes.

THE ACTION OF TRAM-CAR BRAKES.

THAT steep gradients can be overcome by mechanically-propelled tram-cars—as compared to ordinary railway trains—and that street-cars are driven on public thoroughfares, more or less crowded with other traffic, renders the brake question one of considerable importance. The lamentable accident that occurred at Highgate last June affords strong evidence of this. On June 23 a double-deck bogie car became unmanageable, and ran at a great pace for a distance of about three furlongs down the hill extending southwards from Highgate Archway to the Archway Tavern. The gradients here, though considerable, are not excessive for tramway work when the cars are operated with due care. The lines have an inclination of about 1 in 22½ on the hill, but in other parts of the line the gradient is 1 in 18, whilst gradients of 1 in 9 have been authorised. Colonel Yorke, to whose full and admirable report on the accident we shall make frequent reference, has said that the Board of Trade insists on track brakes being fitted to all cars running over gradients of 1 in 15, the speed being limited to six miles an hour. Of the passengers on the car, only a few were slightly injured, but three persons in the street were killed and twenty were injured, some seriously. The runaway car collided with a hearse, a furniture van, a motor-omnibus, and another van, being finally brought to rest by a stationary car at the terminus. The chief lesson to be gained from the disaster is connected with the action of brakes on vehicles of this description.

The car would carry thirty passengers inside and thirty-eight on the top. It was of the double-bogie type, with eight chilled cast-iron wheels and maximum-traction trucks, the small wheels leading. There was a 35-h.p. motor on each bogie truck, the motors being geared to the axles of the large driving wheels. The general design appears, from the descriptions given in Colonel Yorke's report, to be of a well-known type in which the effort is made to get the maximum weight for adhesion on the driving wheels without the use of a motor on each axle, the latter being an arrangement which, with a double-bogie car, would need four motors. With this design the distribution of weight becomes a matter of great importance. The car in question weighed twelve tons unladen, and the engineer to the owners, the Metropolitan Electric Tramway Company, has estimated that four tons were carried upon each of the driving axles, and two tons upon each of the pony axles.

The car had hand brakes, of the usual description, working brake blocks on all eight wheels, and was also fitted with electromagnetic track brakes having two shoes on each bogie. There were also four sand-boxes operated from the driving platform.

The track brake has been introduced at a comparatively recent date, and is especially for tramway work. Its failure to stop the car in the instance under consideration is therefore a circumstance worthy of close inquiry. There are two leading descriptions of electromagnetic track brake or slipper brake, but Colonel Yorke's report does not specify the type fitted, although the description fairly well indicates which was used. There are certain features common to both types, and each acts by the brake shoes being strongly attracted to and pressed on the rails by magnetic force. The magnets formed by the brake shoes are energised by current generated by the car motors. Colonel Yorke gives a concise description of the brakes on the car under notice. Each brake shoe consisted of two narrow steel plates 15 inches long, placed side by side, with a small interval between them, thus forming the poles of a powerful electromagnet, excited by current supplied by the motors acting as generators. The shoes of the brakes in question were also connected to the brake blocks which formed part of the hand brakes, so that the latter pressed against the wheels, and therefore automatically came into play when the track brakes were applied. This is a usual arrangement. With electromagnetic brakes of this description there is a retarding action due to the motors running as generators, and therefore putting a braking action directly on the axles. It will be understood that the hand brakes can be operated without putting the magnetic brake in action. Resistances are provided between the motors and the magnets so as to regulate the current in the latter. In this way magnetic adhesion can be controlled at will. It is further claimed that an advantageous effect is produced by the pressure on the rails by the wheels, due to the attraction of the magnets. The electromagnetic brake clearly supplies a most important means for checking the speed of a car. Colonel Yorke describes it as "one of the most modern, and, when properly used, one of the most effective devices for controlling tram-cars."

The car had been recently overhauled, and was apparently in good condition. New brake blocks had been fitted to the driving wheels, the clearance being 1/16th of an inch when off. The driver stated that one of the sanders was not in good condition, but there appears to have been some doubt on this point; in fact, the balance of evidence is that the driver was mistaken. The driver also stated that he had had trouble with his hand brakes previously to the accident; the wheels, he said, seemed to skid directly the brakes were applied, and, when released, did not immediately revolve even when sand was used.

It was a regulation of the company that all cars should be brought to rest at the top of the hill, but when the driver attempted to stop his car with the hand brake the wheels skidded, owing, as he said, to the rails being greasy from having been recently watered. Upon this he released the hand brake and tried the magnetic brake, but as the wheels continued to revolve the magnetic brake was useless, and the result was that the car ran past the Archway without stopping, and came on to the gradient of 1 in 22. The speed having increased so that the car was getting beyond control, the driver signalled to the conductor to apply his hand brake, but this having no effect the conductor released it again. The driver then reversed his motor, thus causing the automatic switch to blow, after which he moved the controller handle to the position in which the motors would generate current against each other in order to produce a powerful braking action. These efforts, however, had little effect on the speed of the car, which dashed down the hill, with the terrible results before mentioned, until brought to rest by running into the empty car at the bottom of the hill. Before this the driver had jumped off, abandoning the car to its fate, his desertion being more disastrous as there was no one to ring the bell, a circumstance which, in Colonel Yorke's opinion, led to the large number of persons being injured. The fact seems to suggest the need of an automatic continuous striking bell which would be put in operation only upon emergencies. This would have the additional advantage of relieving the driver of one operation at times when he would be hard pressed.

It will be gathered from what has been said that the electromagnetic brake is only brought into play when the motors are acting as generators, and therefore it evidently cannot be used when current is being supplied to the motors from the overhead conductor. The motors become generators through the action of the road wheels, and, therefore, as soon as the latter cease to revolve the current required to energise the brake magnets ceases to be generated. This is the weak point of the arrangement, for if the hand brakes are put too hard on the wheels will skid, or be locked, and the rail brake become useless. The loss of the assistance of the magnetic brake owing to the skidding of the wheels is more serious because the fact of skidding reduces very greatly the retarding effect of brakes upon a car.

The experiments made in 1878 on the Brighton Railway by Sir Douglas (then Captain) Galton, Mr. Stroudley, and Mr. Westinghouse are fairly well known to railway engineers. Apparatus was designed by Mr. Westinghouse by means of which, through water pressure and Richards indicators, there were recorded the retarding force which the friction of brake blocks exerted on wheels, the force with which the blocks pressed against wheels, and the force required to drag the van. These experiments clearly proved that when the wheels of a car are skidded, or blocked by the brakes, the retarding effect is very much less than when the brake shoes are pressed on the wheels with a force just short of that needed to cause skidding. The fact was known previously; indeed, in 1846 Mr. J. V. Gooch issued an order to the men on the South-Western Railway that wheels were not to be skidded; and the result might have been deduced from the experiments of Prof. Fleeming Jenkin on the effect of friction.

Although a skidded wheel does not afford the same resistance to the forward movement of the car as does one which continues to revolve, yet the brake shoes must be pressed on to the wheel with sufficient force to produce an effective braking action. This action is by far the most effective just at the instant that skidding commences, there being then a very sudden rise in tangential resistance. Just at the moment the brakes are released—the wheels being skidded—there is another rise in tangential force caused by the brake blocks. Prof. Fleeming Jenkin's experiments on the effect of friction at different speeds may be consulted with advantage in connection with these results. Although the ordinary brakesman does not carry out quantitative experiments by the aid of elaborate apparatus, he finds by experience that his brakes are most effective when the critical point is approached. The most skilled men will manipulate their brakes with great effect, getting the greatest retarding action for the car without skidding the wheels. The best way in which to work brakes, therefore, is to apply a considerable force at first, releasing it as the skidding point is almost reached.

Another point in connection with brake action, which almost follows from what has been said, is that although a good deal of pressure on the blocks is needed to make a wheel skid, a comparatively moderate force is needed to keep the blocks on when the wheels have once stopped revolving. Still another point bearing on the question under consideration is the decrease of friction that takes place with increase of speed of movement between rail and wheel. This is contrary to what is observed with lubricated surfaces, but, as Sir Alexander Kennedy has pointed out, it bears out the smaller experiments of Prof. Fleeming Jenkin. On the Brighton Railway Company's trials the effect was clearly proved. The experimental van was drawn alone by a powerful express engine, and was thus able to maintain a high speed with the brake on, and it was clearly shown that there was greater adhesion between rails and skidded wheels at high speeds than at low speeds. In some cases the tangential-force diagrams showed a rise in adhesion of 100 per cent.

The bearing of these facts on the present case is plain. That a driver of a car will go as near skidding as possible is apparent, and an unskilled man will often pass the critical point. Then the wheels will cease to revolve, and no current will be generated to energise the electromagnet; consequently the rail brake will be out of action, and, as a skidded wheel does very little to check the momentum of the car, all the elements of a serious catastrophe are present when descending any considerable incline. Beyond this, the rail brake cannot hold a car stationary on a hill when once it has been brought to rest.

These defects would be overcome if the main current from the overhead conductor were available for energising the electromagnet. This would introduce some complication and extra fittings, but there does not appear to be any insuperable difficulty. The fact that the present electric-rail brake is liable to fail just when it is most needed—as shown by the Highgate tragedy—and the remembrance of the terrible results of a heavy car rushing down uncontrolled amongst traffic, make it plain that considerable sacrifice is warranted if the powerful rail brake can be brought more readily into play at a time when it is most efficient, namely, before the travel of the car has acquired a high velocity.

The particulars we have already of the accident form a practical illustration of the bearing of the experimental data collected on the Brighton Railway trials. Whether the skidding of the wheels of the car—which undoubtedly took place, as flats were afterwards found on the tread of the wheels—was due to want of skill on the part of the driver or to injudicious rigging of the brake is a matter of interest rather than importance, for drivers are as liable to be flurried or unskilful as brakes are likely to be improperly rigged. In regard to the first proposition, the driver's training in the present case consisted of eleven lessons of about one hour each in a school, and twelve lessons on the road. This appears to have been considered sufficient instruction to entitle the driver to hold a certificate of "thoroughly instructed in the duties of a motor-man and now competent to take charge of a car." After that he had three days' practice on the Archway route with another motor-man, including one day's instruction with the motor brake. He had been in regular work for twenty days at the time of the accident.

We are not aware whether this driver had had any mechanical training, or had been employed about the mechanism of motor vehicles, before he began his driving career, but if not the course of instruction appears insufficient. This was borne out by his evidence at the inquest, for he was not aware that the magnetic brake acted independently of the current from the trolley-wire, a fact quite sufficient to account for him attempting to apply the magnetic brake when the wheels were skidded. In regard to the hypothesis that the accident was due to improper fitting of the hand brakes, Colonel Yorke says that the shoes, which cleared the wheels 1/16th of an inch, as stated, were new and of cast-iron. The rubbing surface would therefore have the rough skin characteristic of iron castings, and friction would be greater than when the blocks had been worn smooth by use. A very slight pressure would cause the wheels to skid, and as the springs which pull the brake off had only 1/16th inch compression, the brake might remain on after the driver had moved the brake lever to the release position. The position of the brake blocks, in regard to the vertical component, may also have had an effect in keeping them on, as Colonel Yorke points out in his report. The blocks were hung so that they would be below the centre of the wheels, and therefore the upward movement of the periphery of one wheel in each pair would tend to force the brake on when once it had made contact. Colonel Yorke very properly condemns this arrangement, as it prevents the brakeman from using any nice adjustment such as is needed to prevent the wheel from skidding. Sir Douglas Galton, in his paper before the Institution of Mechanical Engineers, recommends half an inch clearance between the wheels of a railway coach and the brake blocks, and it is usual in railway practice to place the blocks level with the wheel centres, or somewhat higher. The nice adjustment of control needed for working hand brakes efficiently, especially when rails are greasy, and therefore easily skidded, is hardly possible with brake rigging such as was used. The transmission was by a chain wound upon a spindle and through a series of rods and levers, "often roughly shaped to size and length in a forge, and connected by ill-fitting pins and joints, or by short lengths of chain," as the Board of Trade report states. It is easy to understand that lost motion, due to such rigging, would account for a good deal of lag even if the gear were new.

AN EDUCATIONAL GAP.[1]

FOR many years past the attention of those who have been giving serious consideration to the complex educational problems which arise in this country has been directed to the gap which exists between the time at which pupils ordinarily leave the public elementary schools and that at which a very small proportion of them appear as students at our technical institutions and at various evening classes. Many attempts have been made to bridge over this gap by continuation classes of various kinds and under various conditions, but these attempts cannot be said to have been successful in the past to any extent commensurate either with the importance of the problem or with the amount of care which has been bestowed upon it. The causes of failure are deeply rooted in our social and economic organisation, whether we consider the large towns, the country districts, or the intermediate districts which are partly urban and partly rural. In the large towns, for instance, as soon as a lad is released from compulsory attendance at school, either by age or by the attainment of the necessary standard, his services have a market value which his parents are usually very unwilling to forego, though its immediate sacrifice may have an important effect upon the ultimate success of the youth in after life. The consequence is that, especially in London, large numbers of these boys take positions as van boys, errand boys, and in similar occupations, in which for a few years they can earn wages up to or exceeding 10*s*. per week. By the time, however, that they reach the age of eighteen or nineteen they cease to be eligible for such work, and, not having utilised the intervening years since leaving school in attaining expertness in any skilled occupation, there is no other course open to them but to join the ranks of unskilled labour, whence the step to those of the unemployed and unemployable is easy, especially as they have reached the age at which their parents can no longer be expected to contribute to their maintenance. In the country, other causes lead to somewhat similar final results.

The inquiry of the consultative committee deals in great detail with one series of suggestions and experiments for bridging this gap for a minority of the pupils referred to. The particular problem minutely examined is that of providing slightly "extended facilities" (in a secular sense) for the best pupils, who would otherwise leave the elementary schools at the usual age of fourteen years or earlier, and whose parents would be subjected to the temptations mentioned above. The question inquired into is how best to establish a type of school capable of educating such children, the parents being willing to maintain them for the necessary time, to a somewhat higher standard without trenching on the proper province of the secondary schools, on the one hand, or of the training which prepares specifically for a definite career on the other.

The problem is one well suited for the consideration of the consultative committee on account of the wide and varied educational experience of its different members. To strengthen its hands, and to obtain the necessary information which might not be available within the four corners of its own membership, it has examined a carefully selected number of representative official and non-official witnesses, twenty-five in all. For obvious reasons the names of the official witnesses are withheld, and therefore no names whatever are given; nor is the evidence published in full, but ample quotations are made from it wherever they are deemed necessary and relevant to support the arguments of the report. The only criticism one has to make upon the selection of the witnesses is that so few as five employers of labour can scarcely have had sufficiently varied individual experience to supply materials for dealing with so large a problem.

That the present is a time of transition and experiment, and that the points of view from which educational problems are being attacked are rapidly changing, could receive no greater exemplification than is conveyed by this report. The gradual change of the official attitude towards such problems has been very apparent to outside observers during the last four or five years in the different reports, prefatory notes to codes, and other official publications issued by the Board of Education from time to time. This report deals in full detail with numerous points brought into view by the new standpoints, and it is to be hoped that the conclusions of the committee on these and cognate matters may be fully adopted by the Board in shaping its policy, without, however, rushing into opposite extremes.

The swing of the pendulum from the time when "payment by results" was the fashionable official system has indeed been great, and every page of this report bears evidence of the distance which has been travelled from those "dark ages." In point of time, however, the period referred to is sufficiently close to have left a legacy, which forms a factor in the present problem, in the shape of a body of teachers some of whom still find it difficult to realise that they are "freed from the trammels they have been accustomed to all their lives," and who have "a certain stock-in-trade which they think can be used anywhere."

The chief value of the report consists in the recognition, and some of the consequences of that recognition, of the proper function of education, in the root sense of the word, as a training of the moral qualities, the formation of habits of mind being regarded as more important than the acquirement of mere knowledge. Prominence is given to the importance of the development of self-activity and resource and powers of observation, the fostering of intelligence and interest in the work, and that training of the eye and the hand in conjunction with the brain which leads to "general handiness." These are some of the points dwelt upon, not once or twice, but many times and in varied aspects, in the pages of the report.

The report also puts its finger upon some of the most glaring defects of the present and previous systems of education, both elementary and secondary. The results, which have long been painfully evident to those who in any form have been entrusted with the further education of the pupils turned out, are that these pupils have not

[1] Report of the Consultative Committee upon Questions affecting Higher Elementary Schools. (Adopted by the Committee May 24, 1906, and issued, with a Prefatory Note, by the Board of Education, July 20, 1906.)

been taught "how to learn," that they are deficient in resource, in self-help, in curiosity of the right kind. In the majority of cases they are quite incapable of thinking for themselves, and in a large number of cases they cannot express their ideas, if they have any, in simple English. Such consequences necessarily follow from the old bad system of "payment by results" in the elementary schools, and from obsolete and defective methods of teaching, coupled with the worship of examinations, in the secondary schools.

The type of school proposed for filling the "gap," under whatever name it may be known, is one which aims at taking the best children of the elementary schools sufficiently early in their career to enable them to reach a somewhat higher standard of attainment than is aimed at in the elementary schools themselves. For good reasons, which are set forth in the report, the age at which the change from the elementary school should be made is considered by the committee to be not less than twelve years. At this age the best pupils of the schools, selected by some simple qualifying examination combined with reports from the head teachers, are to be drafted into the new type of school. In this school the length of the course is to be three years, so that the pupils should remain there until they are fifteen years old. To ensure this, it is felt that the parents of all pupils so transferred should be put under a moral obligation to maintain them at the school until the completion of the period, though it is recognised that it is not practicable to make the obligation a binding one in the legal sense.

The curriculum in the new type of school will differ within certain limits according to the needs of the locality in which it is placed, being different for (*a*) country districts, (*b*) the smaller towns of 20,000 to 50,000 inhabitants, and (*c*) large towns. Whilst specialised instruction such as is proper to the technical institute or the trade school is excluded, the aim of the school, in whichever of the above environments it may be placed, is to prepare the pupils more thoroughly for their life-work. Speaking generally, the curriculum is to consist (1) of what are usually classed as humanistic subjects; (2) of scientific and mathematical subjects; and (3) of manual instruction, with some physical training. In the humanistic section the English language and literature is to form the basis of the instruction, it being recognised that it is not possible to teach a foreign language effectively under the conditions, and Latin is of course excluded. History and geography are taken as subdivisions of the main subject. Class singing and religious instruction come under the same section, to which, on the whole, about one-third of the teaching time is to be devoted. In the scientific and mathematical subjects are included arithmetic, algebra, and the principles of geometry, all as applied to practical calculations; account keeping, as distinct from book keeping; graphical methods of calculation, mensuration, and elementary natural science, with experimental work done by the pupils and varied according to the environment. To this group of subjects another third of the time is to be given. The manual instruction includes, for boys, general wood and metal work, treated from an educative standpoint, and aiming at the training of hand, eye, and brain; in addition there is definite instruction in drawing of the non-professional kind, machine drawing, for instance, being excluded. For girls this manual instruction is replaced by training in domestic subjects and housecraft. Finally, about two hours per week are to be devoted regularly to physical training, which, of course, will differ, not only as between boys and girls, but also in different localities.

One great difficulty in carrying out this scheme is that of obtaining the right kind of teachers. It is insisted upon more than once that what is important is the method of teaching rather than the matter. The ideal teacher, it is pointed out, should be a man of character and ability, with freshness of mind, thoroughly alive to the environment, and thoroughly sympathetic with his pupils; he should be quite free from the old trammels which grew up in the dark ages referred to above, in which it will be remembered that the teacher who wished to rise to the higher posts in his profession was encouraged to pile certificate upon certificate in a great variety of subjects, in few, if any, of which, as results showed, was he really qualified to teach. Suggestions are made as to the training of these teachers, some of which appear to the writer not to be very practicable, more especially the suggestion that the teachers should spend one year in actual workshops. Apart from the difficulty of getting employers to be bothered with such men in their factories, the writer is of opinion that the year could be far more profitably employed in other directions, as the smattering obtained by so short an experience and so limited a view of commercial life is apt to be more harmful than useful. It is important to notice that the report emphatically recognises that for special technical subjects special teachers are required; but then these subjects are ruled out of the curriculum of the schools under consideration, and, indeed, such subjects as shorthand, machine drawing, book-keeping, industrial chemistry, and typewriting, some of which even modern schoolmasters are often inclined to view with favour, are set aside as unsuitable in any scheme of general education, whether secondary or elementary.

Considerations of space will not allow us to dwell upon many other important matters of detail which are handled in a masterly manner in this valuable report; suffice it to say in conclusion that it will well repay careful study, and certainly ought to be perused by everyone who is interested in the rapid developments which are taking place in the educational world.

R. M. W.

ELECTRIC TRAMWAYS.

THE leading feature of the current issue (No. 180, vol. xxxvii.) of the Journal of the Institution of Electrical Engineers is the paper on the overhead equipment of tramways by Messrs. R. N. Tweedy and H. Dudgeon, especially in view of the fact that the overhead system has been so abused of late years by the general public, and thousands of pounds sunk in other schemes of electric tramways which might have been enormously reduced if the prejudice which exists against the overhead system on account of its supposed "danger" had been removed. The authors throughout the paper make a strong appeal for more economy in the capital outlay of tramway equipment, and show how in their opinion this may be brought about in the case of the overhead system.

Dealing with the size of pole to be employed, the authors are strongly of the opinion that we err seriously on the side of using too heavy and too strong poles, straining them too much, and consequently having larger span wire and more concrete for fixing than is necessary. Also they would do away with the usual cast-iron bases which protect the poles, as being not only a waste of money—being unnecessary—but also an actual source of danger, in that they prevent the pole within them from being painted when the outer portions are done—unless the box is lifted, a costly process—and allow water to accumulate inside the case which causes the pole to rust badly.

The same remarks apply to the collars which it is customary to place round the joints in the poles, and water is liable to do much damage here also. If the bases are not done away with they must be ventilated and drained, so as to prevent the accumulation of water from sweating. The collars also must be drained properly. More economy is to be brought about in the trolley-wire itself, as in the authors' opinion too large a section is now being used, and they think that from 56*l*. to 80*l*. per mile may be saved on this charge alone. Again, referring to the "hangers," the authors strike out strongly for the use of malleable iron in place of bronze and gun-metal fittings, which are so dear to some engineers—and are also dear in price as compared with malleable iron properly galvanised.

No local action takes place—with the malleable iron hanger—between the span wire and hanger as is the case with bronze hangers, and from experience iron hangers have been found to last longer than bronze or brass ones, though the oxidation of the iron bolts is one of the difficulties attendant on the overhead system. The authors suggest three methods of overcoming the difficulty:—

(*a*) The insertion of a shield between trolley-wire ear and the hanger to prevent the trolley wheels throwing water up into the interior of the hanger—thus keeping the bolt dry—and "neither rust nor electrolysis can corrupt."

(*b*) A different form of hanger—simply a metallic link between the ear and span wire, and insulated by two or three independent external insulators.

(*c*) The hanger to be composed of glazed porcelain with a plain metal bolt passing through, but the porcelain must be kept dry and sheltered from rain.

Several other points of interest are touched upon by the authors, and the discussion which followed the reading of the paper by Mr. Tweedy proved that the opinions on the points raised by the paper were very varied, and led to a keen criticism. The idea of a shield was generally welcomed, and a suggestion was made that it should be manufactured in such a form as to be readily adjusted to existing hangers, without having to dismantle the same.

On the subject of the strength of poles, however, the majority was against any reduction in size, and the question of the Standard Committee's "standard pole" provoked an animated discussion.

The subject of the paper is one which for a long time has needed discussion, and the interest in it was shown by the fact that, after the paper was read and discussed at the Birmingham local section's meeting, it was rediscussed in London later in the session, and we may hope that the many points and facts brought forward will help to mitigate the present existing difficulties of the overhead system, and at the same time help to reduce the capital expenditure on tramway schemes that may be undertaken by local authorities.

SOME ASTRONOMICAL CONSEQUENCES OF THE PRESSURE OF LIGHT.[1]

JUST a year ago Prof. Nichols gave here an account of the beautiful experiment carried out by himself and Prof. Hull which, with the similar experiment of Lebedew, proved conclusively that a beam of light presses against any surface upon which it falls. Not only did Nichols and Hull detect the pressure, which is difficult enough, so minute is it, but they measured it with extraordinary accuracy, and confirmed fully Maxwell's calculation that the pressure on 1 sq. cm. is equal to the energy in 1 cubic centimetre of the beam.

Thus we have a new force to be reckoned with. It is apparently of negligible account in terrestrial affairs, partly in that it never has free and uninterrupted play. But out in the solar system, where there is no disturbing atmosphere, and where it may act without interruption for ages, it may produce very considerable results. Even here, so minute is the force that it need only be taken into account with minute bodies. Prof. Nichols in his discourse told how it may possibly account for the formation of comets' tails if these tails are outbursts of finest dust. To-night I shall try to show how it may be of importance with bodies which, though still minute, are yet far larger than the particles dealt with by Prof. Nichols. Such small bodies appear to abound in our system, and to reveal their existence on any starlight night when perishing as shooting stars.

We are to examine, then, how the pressure of light, or more generally the pressure of radiation, from one end of the infra-red to the other end of the ultra-violet spectrum will affect the motion of these small bodies.

I think we get a clearer idea of the effects of light or radiation pressure if we realise from the beginning that a beam of light is a carrier of momentum, that it bears with it a forward push ready to be imparted to any surface which it meets.

Thus, let a source A (Fig. 1) send out a beam to a surface B, and to bring out this idea of carriage of momentum let A only send out light for a short time, so that the beam does not fill the whole space from A to B, but only the length CD. While the beam is between A and B, B feels nothing. But as soon as D reaches B, B begins to be pushed, or it receives momentum in the direction AB, and will continue to feel the push or receive momentum until C has reached B, when the push will cease. The existence of this push on B is definitely proved by the experiments of Lebedew and Nichols and Hull. Now, unless we are prepared to abandon the conservation of momentum, this momentum must have existed in the beam CD and have been carried with it, and it must have been put into the beam by A while it was sending forth the waves. A, then, was pouring out forward momentum, and was feeling a back push while it was radiating. This back push against the source has not, I think, been proved to exist by direct experiment, though an indirect proof may perhaps be afforded by the case of reflection. When a

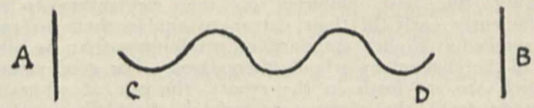

FIG. 1.

beam is totally reflected, the push measured in light-pressure experiments is double that when it is absorbed, that is, there is a push by the incident beam and an equal push by the reflected beam, and we may perhaps regard the reflected beam as starting from the reflector as source, and then we have a push back against the source. But whether this be proof or not, I do not see how there can be the slightest doubt that the pressure against the source exists, and that for the same intensity of beam it is equal to that against a receiving surface.

Some experiments which have been made by Dr. Barlow

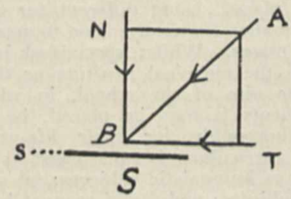

FIG. 2.

and myself appear to bring to the front this conception of light as a momentum carrier. When a beam falls on a black surface it is absorbed—extinguished—and its momentum is given up to the surface. In a beam of light AB (Fig. 2) the momentum is a push forward in the direction AB, and if it falls on a black surface S it gives up this momentum to S. The total push which is in the direction AB may be resolved into a normal push N and a tangential push T. If S can move freely in its own plane, and only in that plane, T alone comes into play, and S will slide towards *s*.

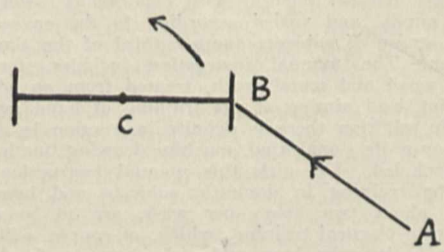

FIG. 3.

To show this effect we fixed two glass discs at the end of a short torsion rod hung by a fine quartz fibre, the discs being perpendicular to the rod, and the face of one of them being blackened. Fig. 3 shows a plan of the arrangement. The apparatus was enclosed in a glazed case, which was exhausted to about 2 cm. pressure of mercury. On directing a horizontal beam AB at 45° on to the black surface B, the normal force merely pressed B back, but the tangential force turned B round the point of suspension C away from AB. It is difficult to make the disc quite symmetrical and the beam quite uniform, and

[1] Discourse delivered at the Royal Institution on May 11, by Prof. J. H. Poynting, F.R.S.

unless these conditions are fulfilled the disturbing forces due to heating of the surface, convection currents and radiometer effects may easily have a large moment either way round C. But these disturbing forces take time to develop, as Nichols and Hull showed, while the tangential push of the light acts instantly. Always when the beam is first directed on to B the motion in the first second or two is away from AB.

It has been urged that this experiment is not conclusive in that the lampblack is granular, and the force observed may be due to normal pressure against the sides of the grains. But if the back surface of the disc is blackened, so that the surface is much smoother, the action is as great.

Another form of the experiment which we have lately

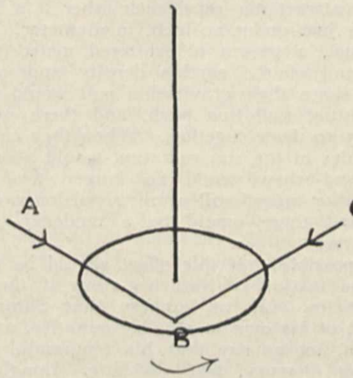

FIG. 4.

made is perhaps better. A horizontal disc of mica, about 2 inches in diameter, is suspended in the case by a quartz fibre (Fig. 4). The disc is blackened on its under face. If a beam of light AB is incident at 45° at B, it tends to push the disc one way round. The gas action due to heating may possibly, and sometimes does, act against this push. But if an equal beam CB is sent from the other side instead of AB, the heating, and therefore the gas action, is the same, while the tangential push is in the opposite direction, and the deflection now is always less in the direction of the arrow than it was before, and the difference gives twice the effect due to the tangential push of either.

Another experiment, rather different in kind, even more clearly shows that light carries a stream of momentum.

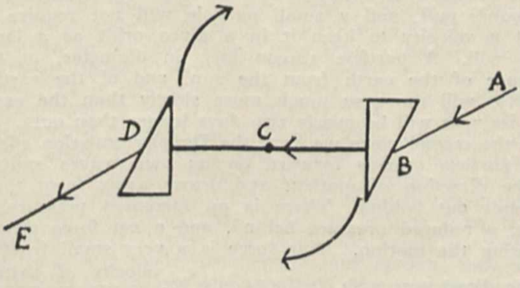

FIG. 5.

Two glass prisms BD (Fig. 5) were fixed at the end of a torsion arm and suspended by a fibre from C. A beam of light AB was directed horizontally so as to pass through the two prisms and emerge parallel to its original direction along DE. Always the torsion arm turned as indicated by the arrow, just as a pipe would tend to turn if it were bent as the beam of light is bent and carried a stream of water—a stream of forward momentum.

I will not now dwell on the interesting modification of the third law of motion which we must make to reconcile with it these experiments on light. It is enough to say that we must admit the luminiferous medium into momentum transactions just as long ago we admitted it into transactions with energy.

Let us now see how this way of regarding a beam of light leads us to expect a modification of the pressure when the receiving or the emitting surface is moving.

First, let us suppose that the receiving surface is moving towards the source. Let A (Fig. 6*a*) be the source. Let

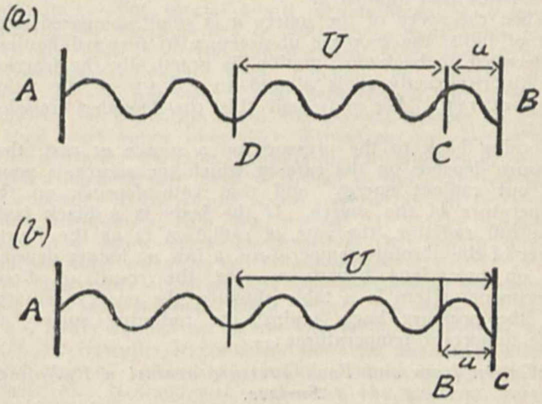

FIG. 6.

B be the receiving surface, moving towards A with velocity u. If B were at rest at C it would receive in one second the radiation and the momentum in length $CD = U$, the velocity of light. But when a given wave starts from D, let the surface start from B, and let them meet at the end of a second. Then B has evidently absorbed the momentum in length $BD = U + u$, and it has received more than it would have done if at rest in the ratio $U + u : U$. The pressure, therefore, is increased, and by the fraction u/U. It is easy to see from Fig. 6*b* that if B is moving away from the source it receives less momentum, has less pressure than if it were at rest, and the decrease is again by the fraction u/U. We may call this the "Doppler reception effect," "Doppler" since he was the first to point out the effect of motion on radiation.

If the source is moving there is a nearly equal effect upon it. The pressure is increased if it advances and is decreased if it retreats, but the effect arises in a different way. It is now due to alteration of wave-length. The source crowds up and shortens the waves it sends forward, putting into them more energy and more momentum, and so suffering an increase in pressure, while it draws away from and lengthens the waves it sends backward, putting into them less energy and momentum, and so suffering a decrease in pressure. The alteration of pitch produced in sound by motion of the source is familiar to all.

We can easily deduce the alteration in pressure if we make the reasonable assumption that the amplitude, the height or depth of the waves sent out from the source, depends on its temperature alone, and not on its motion.

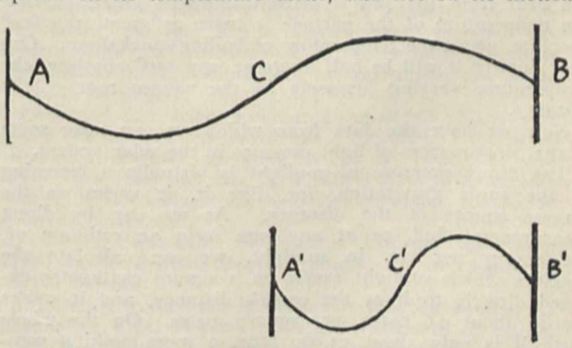

FIG. 7.

Let us imagine, by way of illustration, that the source moves with half the velocity of light, so that a wave which would be ACB (Fig. 7) is packed into half the space A′C′B′. With waves of the same height, the energy in a given length is inversely as the square of the wave-length, so that A'C'B' has four times the energy and momentum that ACB has *in the same length*, or the wave A'C'B' has twice the energy and twice the momentum of the wave ACB sent out in the same time, and the pressure against A' is twice that against A.

When the speed of the source *u* is small compared with that of light, the increase of pressure in forward motion, or decrease in backward motion, is practically the fraction u/U (more exactly it is altered to $U/U \pm u$ of the value when at rest). We may call this the Doppler emission effect.

Coming back to the pressure on a source at rest, that pressure depends on the rate at which the source is pouring out radiant energy, and that rate depends on the temperature of the source. If the body is a black body or a full radiator, the rate of radiation is as the fourth power of the absolute temperature, a law no longer depending on precarious hypotheses, but the result of direct experiment. Here is a table showing the energy radiated and the pressure back against the radiating surface at three important temperatures:—

Radiation from and Back Pressure against a Radiating Surface.

Absolute temperature	Energy emitted in ergs per second per sq. cm.	Back pressure in dynes per sq. cm.
0°	0 ...	0
300° (Earth) ...	$4 \cdot 3 \times 10^4$ ...	$9 \cdot 6 \times 10^{-6}$
6000° (Sun) ...	$6 \cdot 9 \times 10^9$ ...	1·5

A black surface on the earth, then, is pushed back with a force of 1/100,000 mgm. per sq. cm. by its own radiation, while the surface of the sun is pushed back with a force of a milligram and a half on the square centimetre. This table helps us to realise the exceeding minuteness of the forces with which we have to deal.

While we are considering the connection between radiation and temperature, it will be useful to see how the temperature of an absorbing particle depends on its distance from the sun. Take first such a particle, at the distance of the earth from the sun. If the sky were completely filled with suns it would be at the temperature of the sun, and give out the corresponding radiation. But the sun only fills 1/200,000 of its sky, so that the particle only receives and gives out 1/200,000 of that radiation. Its temperature is therefore $\sqrt[4]{200,000}$, say about twenty times less than that of the sun. We can form a tolerably good estimate of the temperature of the particle, since the rotation of the earth and its circulating atmosphere make its mean temperature, which is nearly 300° absolute, the same as that of the particle. So that the temperature of the sun is probably about 6000° absolute, or at any rate gives out as much radiation as a full radiator at that temperature.

If we move the particle in to, say, one-quarter the distance, a little within the nearest approach of Mercury, the heat from the sun is sixteen times as great, so that the temperature of the particle is twice as great, say 600° absolute, about the temperature of boiling quicksilver. Out near Jupiter it will be half as great, say 150° absolute, the temperature varying inversely as the square root of the distance.

Now we have the data from which we can trace some of the consequences of light pressure in the solar system.

The direct pressure of sunlight is virtually a lessening of the sun's gravitation, for, like it, it varies as the inverse square of the distance. As we can by direct measurement find, or at any rate form an estimate of, the energy per c.c. in sunlight, we can calculate the pressure which sunlight exerts on a square centimetre exposed directly to it at the earth's distance, and it works out to about 0·6 mgm. per square metre. On the whole earth it is only about 75,000 tons, a mere nothing compared with the sun's pull, which is forty billion times greater.

But if we halved the radius of the earth we should have one-eighth the gravitation, while we should only reduce the light pressure to one-quarter, or one would be only twenty billion times the other. With another halving it would be only ten billion times as great, and so on until, if we made a particle a forty-billionth of the radius of the earth, its gravitation would be balanced by the light pressure if the law held good so far.

This effect of diminution of size applies to the radiating body as well. If we halved the radius of both earth and sun, the gravitative pull would be one sixty-fourth, while the light pressure would be one-sixteenth, or we should in each halving reduce the ratio of pull to push twice as much, and should much sooner reach the balance between the two, and, of course, the balance would be reached sooner the hotter the bodies. Thus two bodies of the temperature and density of the sun, and about 40 metres in diameter, would neither attract nor repel each other. Two bodies of the temperature and density of the earth would neither attract nor repel each other if a little more than 2 cm., or just under an inch, in diameter.

Suppose, then, a swarm of scattered meteorites 1 inch in diameter and of the earth's density approaching the sun. Out in space their gravitation pull would be greater than their mutual radiation push, and there would be a slight tendency to draw together. When they came within 100 million miles of the sun radiation would about balance gravitation, and they would no longer tend to draw together. As they moved still nearer repulsion would exceed gravitation, and there would be a tendency—slight, no doubt—to scatter.

It appears possible that this effect should be taken into account in the motion of Saturn's rings if these consist of small particles. Let us suppose that Saturn is still giving off heat of his own in sensible quantity, and, merely for illustration, let us say that his temperature is about that of boiling mercury, 600° absolute. Imagine one of a thinly scattered cloud of particles near the division of the rings. At such a distance from the sun the particle will be receiving nearly all its heat from the planet, which will occupy about one-sixteenth of its sky. If the planet filled the whole sky the particle would be at 600°, and give out corresponding radiation. But filling only one-sixteenth of the sky it gives to the particle, and the particle gives out again, only one-sixteenth of the 600° radiation. It is therefore at $\sqrt[4]{1/16}$, or half the temperature, 300° absolute, the temperature of the earth. Particles in the ring, then, about 1 inch in diameter would neither attract nor repel each other, and each would circle round the planet as if the rest were absent.

Passing on from these mutual actions, let us see how radiation pressure will affect a spherical absorbing particle moving round the sun. We have already seen that the direct pressure of sunlight acts as a virtual reduction of the sun's pull, and a small particle will not require so great a velocity to keep it in a given orbit as a large body will. A particle 1/1000 inch in diameter, at the distance of the earth from the sun, and of the earth's density, will move so much more slowly than the earth that its year will be nearly two days longer than ours.

In the second place we have the Doppler emission effect. The particle crowds forward on its own waves emitted in the direction of motion, and draws away from those it sends out behind. There is an increased pressure in front, a reduced pressure behind, and a net force always opposing the motion. This force is a very small fraction of the direct sun push, in fact only $\frac{1}{3} \times \frac{\text{velocity of particle}}{\text{velocity of light}}$ of that push.

But, unlike that force, it is always acting against the motion, always dissipating the energy. The result is that the particle, losing some of its energy, falls in a little towards the sun, and moves actually faster in a smaller orbit. The particle we are considering would fall in about 800 miles from the distance of the earth in the first year. Next year it would be hotter, the effect would be greater, and it would move in further. I think it would reach the sun in much less than 100,000 years. As the effect works out to be inversely as the radius, a particle an inch in diameter would reach the sun in much less than a hundred million years.

There is another Doppler emission effect which must be mentioned. If the whole solar system is drifting along relatively to the ether, there is a Doppler resistance to the drift utterly negligible on the sun and planets, but quite appreciable on meteoric dust. I confess that I am utterly unable to tackle the equations of motion when this force is taken into account, but if we make rough approximations it seems possible that it too would lead to a gradual approach to the sun. The most obvious method of approximation in dealing with a small disturbing force is to omit it. Let us adopt this method here, and turn to another effect which can be tackled—a Doppler reception effect, which only comes into play when a particle is changing its distance from the sun.

Imagine a particle moving in an elliptic orbit to be coming towards the sun. The sun pressure against it is slightly increased by the motion, or, virtually, gravitation is lessened. When the particle has swung round the sun and is retreating, the sun pressure is slightly lessened, or, virtually, gravitation is increased. That is, there is always a force tending to resist change of distance from the sun, tending, I take it, to make the orbit less eccentric, more circular.

Now let us see how these forces will act on a comet, supposing a comet to consist of a somewhat thinly scattered cloud of particles of various sizes down to, say, a ten-thousandth of an inch in diameter. Somewhat below that size the particles would be repelled and never tend to approach the sun at all, and would be weeded out of the comet as it first came into our system. Let us suppose that, to begin with, the various sizes are well mixed up. Then at once a sorting action will begin. The direct sun pressure will lengthen out the year of the finer particles more than that of the coarser, and they will gradually trail behind in the orbit.

Then the Doppler emission effect will gradually damp down the motion, again more markedly with the finer particles, and they will tend to spiral in towards the sun and shorten the period of revolution. Then the Doppler reception effect will tend to make the orbit ever less elliptic, and again with the smaller particles the action will be more rapid.

In any single revolution the effect will no doubt be small, even on the smaller particles, but after thousands or millions of revolutions the particles of different sizes may move in orbits so different that they may not appear to have any connection with each other. In course of ages all the smaller particles, and if we have a sufficient balance in the bank of astronomical time even the larger particles, will end their course in the sun itself.

There is one member of our system, Encke's comet, which at first sight looks as if it were manifesting these actions even in the short time, less than a century, that it has been under observation. Its motion is commonly interpreted as a shortening of its period by 2½ hours in each revolution of 3⅓ years. But Mr. H. C. Plummer has investigated its case, and finds such difficulties, difficulties with which I need not now trouble you, that I fear the obvious explanation that the Doppler resistance is the cause must be abandoned. But though we may not notice the effects in any short time, I see no escape from the conclusion that if comets are clouds of small particles brought into, and made members of, our system, they at once begin to undergo a sorting action, the finer particles drawing inwards more rapidly, and ultimately ending their career in the sun. Possibly the Zodiacal Light is the dust of long dead comets.

Where our ignorance is complete and unbounded hardly any supposition can be ruled out. Let me, then, in conclusion, make one wild suggestion. Suppose that a larger planet, still so hot as to be a small sun, succeeds in capturing a cloud of cometary dust. Just the action I have been describing should go on. The cloud would gradually spread into a long trail, the larger particles leading, the smaller dropping behind and moving in, and ultimately we might have a ring round the planet, a ring tending to become more and more circular as time went on, with the larger particles outside and the finer particles forming an inner fringe. With different grades of dust we might have different rings. Is it possible that Saturn has been wild enough to have adopted this suggestion?

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The special board for mathematics is now submitting for the approval of the Senate regulations for part i. and part ii. of the mathematical tripos embodying the resolutions which were adopted by Senate on October 25. It has been found necessary to make provision for the transition from the present system to the new one, and some temporary provisions are suggested for this purpose. In other respects all the regulations now submitted have already been published in the draft regulations appended to the report above referred to. It is these detailed regulations that the master of Sidney Sussex College and some other members of the Senate have announced their intention to "non-placet."

The observatory syndicate has been considering the great increase in astrophysical work which has been in the last few years carried on in the University observatory by Mr. H. F. Newall. It considers the time has come when an assistant of university standing should be appointed to assist Mr. Newall, and announces the generous offer of Mr. Newall to find 100*l.* a year for five years toward the stipend of such an assistant. The syndicate recommends (1) that for a period of five years, from January 1, 1907, there be appointed at the observatory an assistant, to be entitled "the assistant in astrophysics," who shall be under the general direction of the Newall observer; (2) that the assistant in astrophysics be appointed by Mr. Newall with the consent of the Vice-Chancellor, and be removable in like manner; (3) that a stipend of 100*l.* per annum, payable from the University chest, be assigned to the assistant in astrophysics, Mr. Newall having undertaken to augment the stipend by an annual sum of 100*l.* for a period of five years from January 1, 1907.

Two largely signed memorials have been presented to the council of the Senate. The first urges (1) that a paper or papers in natural science shall be included amongst the compulsory subjects of any examination which may be substituted for the present previous examination, and (2) that in the classical part of such an examination no separate paper in Greek and Latin grammar shall be set. The second requests the council of the Senate to appoint a syndicate to consider the advisability of instituting a diploma in architecture in view of the great importance of architectural studies, which has already been felt in other universities, where such studies have been successfully organised.

The following have been nominated examiners in the mechanical sciences tripos:—Prof. Hopkinson, Prof. W. E. Dalby, and Mr. C. E. Ingles; in State medicine, Dr. Anningson, Prof. Nuttall, Dr. J. Lane Notter, Dr. R. D. Sweeting, and Dr. A. Newsholme; in the diploma of tropical medicine and hygiene, Prof. Nuttall, Mr. C. W. Danields and Mr. W. B. Leishman.

The board of agricultural studies, in consultation with the president of the Royal Agricultural Society, has appointed Major P. G. Craigie, C.B., to be Gilbey lecturer on the history of the economics of agriculture for three years from January 1.

A syndicate has been nominated to obtain plans and estimates for the extension of the Cavendish Laboratory on the site recently assigned it by a Grace of the Senate. This extension has been rendered possible by the generosity of Lord Rayleigh, who has presented the Nobel prize to the University.

Mr. Aubrey Strahan, St. John's College, has been approved by the general board of studies for the degree of Doctor in Science.

A University lectureship in botany is now vacant by the resignation of Prof. Seward. The general board of studies will shortly proceed to appoint a lecturer to hold office from Christmas, 1906, until Michaelmas, 1911. The annual stipend is 100*l.* Candidates are requested to send their applications, with testimonials if they think fit, to the Vice-Chancellor on or before November 30, 1906.

Mr. R. P. Gregory, of St. John's College, has been appointed senior demonstrator in botany until September 30, 1911.

Mr. A. Hutchinson, of Pembroke College, has been appointed chairman of the examiners for the natural sciences tripos, 1907.

DR. H. E. ANNETT has been elected to the newly-established chair of comparative pathology in the University of Liverpool.

THE second award of the Vulcan fellowship in engineering of the Victoria University of Manchester will be made this session. Applications should be made to the registrar on or before December 10. The fellowship, which is of the annual value of 120*l.*, offers exceptional opportunities for research in engineering. It is tenable for one year, but may be renewed for a second, and in special circumstances for a third, year.

THE *Times* states that the trustees of the late Mr. T. Graham Young have presented to the governors of the Glasgow and West of Scotland Technical College a sum of 10,000*l.* to assist in making provision for the teaching of dyeing and bleaching in connection with the chair of technical chemistry in the college. Mr. Young's trustees have also voted a sum of 850*l.* for the equipment of the laboratory for the chair.

THE regulations for admission to the schools of mines at Clausthal and Berlin, and to the mining and metallurgical department of the Aachen Technical School, have been brought into unison. Hitherto, at Clausthal and Berlin, on matriculation twelve months' practical experience was demanded, whilst at Aachen no previous practical training was required. Moreover, at Aachen the length of the course was three years, whilst at Clausthal and Berlin it was four years. Henceforth no practical experience will be demanded for entry at Clausthal and Berlin, but on entering for the first examination students will be required to furnish evidence of six months' practical work. At Aachen the course will in future cover four years.

THE London County Council has decided to expend 37,500*l.* in acquiring sites for secondary-school and training-college purposes in the districts of Clapham, Wandsworth, North London, and Tooting. The schools are needed for the scholars elected under the council's new scholarship scheme. It is proposed to erect six schools on the sites, three for boys and three for girls, and to adapt as a training college a mansion at present standing on one of the sites. The cost of erecting the six schools will be about 160,000*l.*, and that of adapting the mansion 8000*l.* It is anticipated that four more schools will be needed to provide for the full number contemplated by the scholarship scheme. The total expenditure upon the council's proposals with regard to secondary schools is estimated at 575,000*l.*

A MOVEMENT has been started for the reconstitution of Queen's College, Cork, and its conversion into a university centre for Munster. Speaking at a meeting convened on Saturday last by the Lord Mayor of Cork and Mr. McDonald, chairman of the County Council, Mr. William O'Brien, M.P., said it is proposed to do in Cork what has been done in Birmingham. The institution to be set up will be purely democratic. It will belong to the people, and will be governed by the people's representatives. The governing purpose of the university will be to open up a career in life to every gifted child in the province. Mr. O'Brien and his wife have decided to bequeath on their demise practically all their property as a contribution towards the endowment of a Cork University. Mr. O'Brien said it should be possible to arrange, if the borough and county councils of the province are willing to assume a temporary burden, which will be an exceedingly slight one, and every shilling of which will be repaid at his and his wife's death, that a sum of 50,000*l.* can be at once made available.

THE recently published annual report on the work of the Glasgow and West of Scotland Technical College supplies as an appendix a report on a visit to American educational institutions, presented to the governors by Mr. H. F. Stockdale, the secretary and director of the college. The subject of the director's inquiry was especially the equipment of the engineering schools visited, with a view to the economical and judicious expenditure of the grants made to the engineering departments of the Glasgow college. Mr. Stockdale insists that the only points where the superiority of American schools must be admitted are those in which the weight of money turns the scale. The laboratory equipments are generally far more extensive and include more costly apparatus than is within the means of most British colleges. The environment of certain American institutions, such as that of the University of Wisconsin and of Cornell University, is, too, a great advantage. The director was much impressed by the facilities in the States for the study of railway mechanical engineering, and he points out that this seems to be a field in which the Glasgow college might do good work. An Englishman in charge of a section of the metallurgical department of Columbia University alleged that many British students proceed to the States to study metallurgy. Like other British visitors to America, the Scottish director saw and heard with envy the large number of able men on the staff in nearly all the best colleges in the States, and noted that the heads of departments are allowed plenty of time for research. The circumstance that the large staffs make it possible for professors to engage in outside professional practice, to the advantage of the work of their colleges, is also commented upon. Mr. Stockdale has written a very useful report, which will repay attention from educational authorities.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, November 1.—Prof R. Meldola, F.R.S., president, in the chair.—A development of the atomic theory, which correlates chemical and crystalline structure and leads to a demonstration of the nature of valency: W. **Barlow** and W. J. **Pope.** The authors represent atoms in the combined state by "spheres of influence." An examination of the geometrical properties of closely-packed assemblages of spheres shows that the atoms of the elements must be represented by spheres of influence directly proportional in volume to their fundamental valencies, and that a closely-packed assemblage built up of spheres of the appropriate sizes, so as to represent some particular compound, can be partitioned into units identical with the chemical molecule, and possesses symmetry and dimensions compatible with those of the crystalline substance. In addition, it is shown that close-packed homogeneous assemblages of spheres possess other properties which lead to simple interpretations of multivalency and tautomerism, and that ethylenic and acetylenic bonds and isomerism have complete analogues in peculiarities of homogeneous assemblages of spheres.—Synthesis of carvestrene. Preliminary notice: W. H. **Perkin,** jun., and G. **Tattersall.**—Some derivatives of catechol, pyrogallol, benzophenone, and of some substances allied to the natural colouring matters: W. H. **Perkin,** jun., and C. **Weizmann.** This communication contains descriptions of the preparation and properties of a number of new substances obtained at different times in connection with researches on the constitution of brazilin, hæmatoxylin, and other natural colouring matters.—Experiments on the synthesis of the terpenes, part ix., the preparation of *cyclo*pentanone-4-carboxylic acid and of cyclohexanone-4-carboxylic acid (δ-ketohexahydrobenzoic acid): F. W. **Kay** and W. H. **Perkin,** jun.—The hydrolysis of "nitrocellulose" and "nitroglycerine": O. **Silberrad** and R. C. **Farmer.** The hydrolysis is complicated by the simultaneous reduction of the nitric acid, and intermediate products are formed, which are gradually acted upon by the alkali; these are practically insoluble in water, and do not give rise to free acid when left in contact with water for several days.—The acidic constants of some ureides and uric acid derivatives: J. K. **Wood.** In compounds which contain the grouping .CO.NH.CO.NH.CO., there appears to be a mutual reinforcement of the imino-groups by the carbonyl groups present analogous to that exhibited by the carboxyl groups in succinic acid.—The affinity constants of xanthine and its methyl derivatives: J. K. **Wood.** The results of determinations of the basic and acidic constants of xanthine, 7-methylxanthine, the three isomeric dimethylxanthines, and caffeine are described.—The explosive combustion of hydrocarbons, ii.: W. A. **Bone**, J. **Drugman**, and G. W. **Andrew**. The "inflammation" of mixtures of ethane or ethylene and oxygen has been studied. In each case, steam, aldehydes, ethylene, and acetylene are prominent during the initial stages of combustion, whilst carbon is a later product.—Contributions to the theory of solutions, i., the nature of the molecular arrangement in aqueous mixtures of the lower alcohols and acids of the paraffin series; ii., molecular complexity in the liquid state; iii., theory of the intermiscibility of liquids: J. **Holmes**.—The relation between natural and synthetical glyceryl-phosphoric acids, part ii.: F. **Tutin** and A. C. O. **Hann**. It is concluded from the results obtained that the natural and synthetical glyceryl-phosphoric acids are differently constituted mixtures of the α and β acids.—Thiocarbonic acid and some of its salts: Miss I. G. **O'Donoghue** and Miss Z. **Kahan**. The acid has the formula H_2CS_3. The salts are very unstable even in a vacuum.—Studies in optical superposition, part ii.: T. S. **Patterson** and J. **Kaye**. The optical properties of di-*l*-menthyl-*l*-tartrate, di-*l*-menthyl diacetyl-*l*-tartrate, and sodium *l*-menthyl *l*-tartrate have been examined.—Optically active dihydrophthalic acid: A. **Neville**. When the hydrogen strychnine salt of *trans*-$\Delta^{3:5}$-dihydrophthalic acid is fractionally crystallised from alcohol, the acid is resolved into its *laevo*- and *dextro*-isomerides, which are described.

Entomological Society, November 7.—**Mr. F.** Merrifield, president, in the chair.—*Exhibitions*.—H. J. **Lucas**: Photograph of *Panorpa germanica*, practically immaculate, from Sutherlandshire, and a typical form for comparison, corresponding apparently to the *borealis* of Stephens. Also a series of the genus to illustrate the range of spotting on the wings of both sexes.—G. C. **Champion**: A long series of a Henicopus (probably *H. spiniger*, Duval), from El Barco, Galicia, Spain, to demonstrate the dimorphism of the females.—H. St. J. **Donisthorpe**: Seven specimens of *Prionocyphon serricornis*, Müll., bred from larvæ taken in the New Forest in July, live larvæ, and a larva and pupa, figured, of the same, with a note on the species.—Dr. T. A. **Chapman**: (1) A collection of butterflies, made in Galicia (lat. 42° 16′ N., long. 6° 44′ W.) last July, including *Lycaena idas*, hitherto reported only from the Sierra Nevada, in the south-east of Spain. (2) *L. argus* (*aegon*) from the same district, which, though very close to the vars. *hypochiona* and *bejarensis*, differed in a certain proportion of the specimens presenting the red of the marginal "peacock eyes" on the upper surface of the hind wings of the males.—Hon. N. C. **Rothschild**: Branches of *Viburnum lantana* showing the mines of *Sesia andreniformis*, now discovered as the food-plant of the species in Britain for the first time.—E. D. **Jones**: Two species of the genus Mollipa bred from Brazilian larvæ which were identical in form; also photographs of the larvæ *in situ*.—Dr. F. A. **Dixey**: A case of female Pierine butterflies to illustrate various conditions under which white pigment might be replaced by black. He said that though melanism may occur as a sport, it owed its establishment to the principle of selective adaptation.—The **President**, mentioning a bug which Mr. Cecil Floersheim had found very destructive to the eggs of *Papilio machaon* and *P. asterias*, said that it was remarkable to find one of the Heterotoma as a carnivorous species.

Faraday Society, November 13.—Dr. F. Mollwo Perkin, treasurer, in the chair.—Some investigations relative to the depreciation of electrolytically produced solutions of sodium hypochlorite: W. P. **Digby**. This deals, in the first place, with depreciation taking place in bottles of various colours, in which dark amber bottles gave the best results, the loss in 1817 days being about 40 per cent. for a solution containing 4·216 grms. of available chlorine per litre. The corrosive action of hypochlorite solutions upon various metals is then discussed, and the depreciations due to graphite, copper, zinc, lead, and iron plates immersed in such solutions are set forth for a period of 480 hours. A much greater depreciation takes place, due to galvanic action, when two dissimilar metals immersed in the liquid are connected by an insulated wire; the paper gives records in the case of twenty-one different couples. When iron is present as one metal in such a couple, the depreciations are generally greater than for any two other metals.—The Hermite electrolytic process at Poplar: C. V. **Biggs**. This paper is a contribution to the data at present available on the subject of the electrolytic productions of hypochlorites. It consists of a description of the plant in use at Poplar for the preparation of a solution containing about 4·5 grms. of available chlorine per litre, for use as a disinfectant in the borough. The author concludes that the magnesium hypochlorite, as made at Poplar, is sufficiently stable for practical purposes, and that it could be made in a warm climate without necessarily rapid deterioration.—The electrochemistry of lead: Dr. A. C. C. **Cumming**.

CAMBRIDGE.

Philosophical Society, October 29.—Dr. Fenton, vice-president, in the chair.—The procession of *Cnethocampa pinivorax*: H. H. **Brindley**. The processionary larva of this moth, one of the Eupterotidæ, which is common in the *Pinus maritima* districts of the Landes, marches in single file both in its nocturnal excursions from its nest in the pine to feed on the young leaves and also in the journey from the nest tree to pupate in the sand. The primite spins a thread which is added to by the satellites in succession. Fabre ("Souvenirs entomologiques," ser. vi.) describes many observations made in his laboratory near Avignon with imported families. The author found a procession of 114 larvæ in the Cap Ferret Woods, Arcachon, on April 2, in the final procession for pupation. Interruptions and rearrangements of the procession were made with results in the main in accord with Fabre's account, but in spite of much contact with bare hands the irritation from the poison hairs, found by Fabre to be at a maximum in this stage, was not noticed. Also the number of contiguous individuals removed was found to affect the mode of re-forming the procession. The procession was being attacked by a Tachinid fly, probably *Dexodes machairopsis*, endeavouring to lay eggs in the larvæ, and these seemed afraid of the hairs, though one fly ran over the back of a larva and lanced it near the hind end. As a rule, a fly propped itself on the edges of its wings and faced the larva, pushing it with its legs as it passed, and apparently trying to insert its ovipositor ventrally between the propodia. Failures to insert the eggs seemed very numerous. The larvæ evidently felt the lancing acutely, always starting violently when it succeeded. The intention to burrow seemed very little interfered with by interrupting the chain; daughter chains started in different directions, the primite soon burrowing in the nearest depression and disappearing in ten to fifteen minutes, while the satellites quickly followed his example. The complete procession, and the daughter ones made by interference, seemed to march towards the greatest sunlight.—A note on a collection of Oribatidæ from British Guiana: C. **Warburton** and N. D. F. **Pearce**. Our knowledge of such microscopic land animals as the Oribatidæ rests almost entirely on European and North American forms, because it is impracticable on scientific expeditions to collect individually creatures so minute. It has been found, however, that moss or other material in which the mites live, if packed in air-tight (preferably soldered) tins, reach England from the most distant countries in such a satisfactory condition that the animals in it may be examined alive. Some moss received in this way from British Guiana last June yielded a result which strikingly illustrates the importance of this method of collection. About forty species new to science were found in it—a fact the more remarkable in that the total number of satisfactorily established species of Oribatidæ previously known did not exceed 250. Some of the new forms are extremely interesting, and will certainly necessitate a revision of the existing genera.—The influence of spectral colours on the sporulation of various species of Saccharomyces: J. E. **Purvis** and G. R. **Warwick**. The light of a strong lamp was filtered through various coloured screens and played upon the surfaces of several species of pure cultures of Saccharomyces in an incubator at a definite temperature of 24° C. to 25° C. The results were compared with the effect of ordinary white light from the same lamp and also when the yeasts were allowed to sporulate in the dark, but at the same temperature as the yeasts sporulating under the influence of the spectral colours of red, green, blue, and violet. The conclusions were (1) red rays appeared to accelerate the formation of spores more quickly than white light; (2) the green rays retarded the development of the spores; (3) the blue and violet rays retarded the development more than the green rays; (4) the violet and ultra-violet rays were still more effective, and they appeared to break down and disintegrate the vitality of the cells when the latter were kept for some time under their influence.

PARIS.

Academy of Sciences, November 12.—M. H. Poincaré in the chair.—Observations relating to equilibrium and reciprocal displacements between glycerol and other alcohols: M. **Berthelot**. The author refers to his experiments made between 1853 and 1862, and doubts the utility of the introduction of the words hydrolysis and alcoholysis.—A new and rapid method for the determination of the errors of division of a meridian circle: M. **Loewy**. A mathematical development of the method described in previous papers.—Some products of the fumerolles of the recent eruption of Vesuvius, with particular reference to the minerals containing arsenic and lead: A. **Lacroix**. The most abundant solid products of the fumerolles are those commonly found in all eruptions of Vesuvius, chlorides of iron, sodium, potassium, magnesium, and calcium, none of them well characterised from a mineralogical point of view with the exception of erythrosiderite. These chlorides are covered locally with realgar. The presence of galena has also been noted, the first time this mineral has been associated with the products of eruption of Vesuvius. Accompanying the galena were found magnetite, magnesioferrite, hæmatite, pyrrhotite, and pyrites.—Contribution to the study of the calorific emission of the sun: C. **Féry** and G. **Millochau**. A discussion of the results obtained by methods described in earlier papers. The measurements showed that there exists a distinct radiation outside the sun's disc, partly due to the dimensions of the thermocouple, but partly also to a calorific emission external to the solar image. On the assumption that the sun's nucleus acts as a black body, an attempt is made to correct the observed values for the absorption due to the solar atmosphere; the temperature obtained in this way lies between 5963° and 5888° absolute. The absolute error in the determination of a temperature in the neighbourhood of 6000° abs. is estimated to be of the order of 15°.—The photographic study of the telluric lines in the infra-red spectrum: Milan **Stefánik**. A description of observations carried out at the summit of Mt. Blanc. A comparison of two spectra obtained with a grating, one about noon and the other at 6 p.m.—Observations of the sun made at the Observatory of Lyons during the third quarter of 1906: J. **Guillaume**. The results are exhibited in three tables, showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—Groups of functions: Frédéric **Riesz**.—Differential equations of the second order and of the first degree the general integral of which is at fixed critical points: M. **Gambier**.—The relative value of standards of light: Carcel, Hefner, and Vernon Harcourt: A. **Perot** and M. **Laporte**. Taking the Harcourt lamp as unity, the Carcel is 0·996 and the Hefner 0·0931. The experiments brought out the difficulties inherent to the use of flame standards, and show the necessity of having an absolute standard as independent as possible of external conditions, such as the Violle standard.—The reduction of molybdic acid in solution by molybdenum, and the titration of reducing solutions by permanganate: M. **Guichard**. The brown solution obtained by the reduction of an acid solution of molybdic acid by molybdenum contains, not a salt of the dioxide, but a salt of the oxide Mo_2O_5. The conclusion is drawn that the dioxide of molybdenum does not form salts. The use of iron reduced from the pure oxide is recommended for standardising permanganate solutions.—The heat of combustion and of formation of some amines: P. **Lemoult**.—Xanthone and xanthydrol: R. **Fosse**. It is known that xanthone, although containing a ketonic oxygen, does not form directly a phenylhydrazone or an oxime. The reduction product of xanthone, xanthydrol, on the other hand, reacts directly with hydroxylamine and with semicarbazide.—The condensation of *o*- and *p*-nitro-benzyl chloride with acetylacetone: H. **Mech**.—The existence in Corsica of alkaline quartz porphyry, and a remarkable layer of orthose: M. **Deprat**.—The reproduction of the fig: Leclerc **du Sablon**.—The motor equivalent of resistant work in animal energetics: Jules **Lefèvre**.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 22.

ROYAL SOCIETY, at 4.30.—Studies on the Development of Larval Nephridia, Part ii., Polygordius: Dr. Cresswell Shearer.—The Structure of Nerve Fibres: Prof. J. S. Macdonald.—On Opsonins in Relation to Red Blood Cells: Dr. J. O. Wakelin Barratt.—On the Inheritance of Certain Invisible Characters in Peas: R. H. Lock.—The Influence of Increased Barometric Pressure on Man, No. 2: Leonard Hill, F.R.S., and M. G. Greenwood.—The Influence of the Kidneys on Metabolism: Dr. F. A. Bainbridge and Dr. A. P. Beddard.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Selection and Testing of Materials for Construction of Electric Machinery: Prof. J. Epstein.

FRIDAY, NOVEMBER 23.

PHYSICAL SOCIETY, at 5.—On the Electrical Radiation from Bent Antennæ: Prof. J. A. Fleming.—Auroral and Sun-spot Frequencies contrasted: Dr. C. Chree.—The Electrical Resistance of Alloys: Dr. R. S. Willows.

SATURDAY, NOVEMBER 24.

ESSEX FIELD CLUB (at Essex Museum of Natural History, Stratford), at 6.30.—Report of Club's Delegate at York Meeting of British Association: F. W. Rudler.—Various Exhibits from Essex.

MONDAY, NOVEMBER 26.

SOCIETY OF ARTS, at 8.—Artificial Fertilisers; the Fixation of Nitrogen: A. D. Hall.

LONDON INSTITUTION, at 5.—Egypt, Past and Present: Raymond Blathwayt.

INSTITUTE OF ACTUARIES, at 5.—Inaugural Address by the President, F. B. Wyatt.

TUESDAY, NOVEMBER 27

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Talla Water-supply of the Edinburgh and District Waterworks: W. A. P. Tait.—Repairing a Limestone-concrete Aqueduct: M. Ratcliffe Barnett.—The Yield of Catchment-areas: E. P. Hill.

ZOOLOGICAL SOCIETY, at 8.30.

WEDNESDAY, NOVEMBER 28.

SOCIETY OF ARTS, at 8.—Patent Law Reform: J. W. Gordon.

FRIDAY, NOVEMBER 30.

ROYAL SOCIETY, at 4.—Anniversary Meeting.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Applications of Electricity in Printing-works: P. A. Spalding.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Steam as a Motive Power for Public Service Vehicles (Discussion): T. Clarkson.

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