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FRESH-WATER FISH-CULTURE IN FRANCE.

Encyclopédie agricole. Pisciculture. By Georges Guénaux. Introduction by Dr. P. Regnard. Preface by M. Charles Deloncle. Pp. xii+489. (Paris: Baillière et Fils.) Price 5 francs.

THIS is a comprehensive, compact, and eminently practical handbook on all matters relating to fresh-water pisciculture. Much of the information and criticism which it contains applies almost equally to England as to France, since most of the fishes dealt with are found in our islands, and the almost complete neglect of fresh-water pisciculture—except in the case of the Salmonidæ—is as characteristic of this country as of that. What is true of the depopulation of the French watercourses is partly true of our own. In France the depopulation and its neglect were due partly to obvious causes inseparable from industrial progress, such as the opening of canals, the development of navigation, and the establishment of manufacturing works and chemical factories on the river banks, and partly to lack of enthusiasm following on historical events. The means adopted to arrest the depopulation, much less to restock the waters, have been, and continue to be, utterly disproportionate to the extent of the waters and to the magnitude of the task.

The results of this neglect are:—(1) That France consumes extremely little fresh-water fish, either absolutely, or relatively to the consumption of marine species; and (2) that the great bulk of what little she does consume is derived from adjacent countries, principally Germany, where the rearing of carp especially has been developed into a paying industry by long years of experience and the application of scientific methods. While it is possible, as hinted by the author, that a protective tariff might do a little to obviate this unsatisfactory state of affairs, the only complete solution of the problem is for France to grow her own fish. These French watercourses (our own rivers and broads also to some extent) are capable of producing an abundance of highly nutritious food. In both countries there are numerous fresh-water species the *chaire* of which, M. Guénaux assures us, is *excellente*, and would form a pleasing variant to the marine species which at present more or less flood the fish markets and almost exclusively appear on our tables. Clearly something should be done to develop this branch of food production, and to some extent M. Guénaux's practical text-book points the way.

But although fresh-water fish-culture is in the main neglected in France, there are a few salmon- and trout-hatching establishments, which seem to cost very little and pay remarkably well; also several laboratories connected with schools of agriculture, which contribute to the repopulation of the waters. Finally, attached to the Universities of Grenoble, Clermont-Ferrand, Toulouse, and Dijon are scientific laboratories for the study of fresh-water biology which pursue a double aim, scientific and practical. The University of Toulouse in particular has a large institution, started in 1903, devoted entirely to fresh-water pisciculture and hydrobiology, with museums, aquarium, and laboratories. In this matter England has something to learn from France, since, to the best of the reviewer's knowledge, the only station devoted to fresh-water hydrobiology in this country is a small private one on a Norfolk broad.

In writing a book on the whole subject it has been necessary for its author to combine the knowledge and qualities of a naturalist with those of an engineer and "practical man." This unusual demand on one's capacity and versatility has been met by M. Guénaux with conspicuous success. A critical inspection of the text of this book shows that its author is almost equally familiar with the morphological characteristics, taxonomic relations, and bionomical reactions (including feeding and spawning habits and requirements) of each species of fresh-water fish as he is with the merits and demerits of different kinds of salmon ladders, or the latest devices connected with egg-hatching apparatus, while he is evidently thoroughly *au fait* with the French laws relating to fresh-water fisheries, the weaknesses of which legislation he criticises in a characteristically practical manner.

The book opens with a brief account of the general anatomy of fishes, proceeding to take up each group in its natural order, explaining their taxonomic relations, and then giving a concise description (with good figures) of the distinguishing features and natural history of all the principal species, the most important features, namely, the feeding and spawning peculiarities of each, receiving particular attention. Then follows the subject of pisciculture proper, which forms the bulk of the volume. There are two kinds of pisciculture—natural and artificial. The object of natural pisciculture is to multiply the more valuable species by favouring their conditions of existence. Under this heading come such matters as the effects of navigation, canal-making, and industrial works, and the methods of combating these effects, and of restoring natural conditions, the planting of canals and dykes with plants on which the useful species may deposit their eggs, or seek shelter, the erection of ladders, and the construction of ponds, &c. By "artificial pisciculture," on the other hand, is meant the artificial fertilisation and hatching of the ova and the subsequent rearing of the fry. With the principal technical details of both kinds of pisciculture M. Guénaux deals exhaustively in a methodical and discriminating manner. As has been said, this is a thoroughly practical handbook, abounding in figures from statistics, measurements, and the critical comments of one who has had much first-hand experience of every branch of the business. There are plenty of good wood-cuts to illustrate construction of apparatus, &c. A succinct but fairly comprehensive account of aquatic invertebrate fauna and the flora next follows, and there is, finally, an excellent section on the parasitic diseases of fresh-water fishes and of injurious insects, reptiles, birds, and mammals. These chapters are also amply illustrated.

But even M. Guénaux's knowledge and versatility have their limitations, and when he passes from fresh to salt water (metaphorically speaking) he appears somewhat "out of his element." Otherwise he would not have quoted antiquated and rejected notions regarding the growth of salmon after its migration to the sea in the face of the well-ascertained results of a vast amount of more recent research. Again, the author's account of the life-history of the eel is not abreast of current knowledge, since he makes no mention of the most important and not so very recent discovery of the breeding-grounds of this species all along the eastern shelf of the Atlantic basin. Reading M. Guénaux's account, one would suppose that the latest word on the subject of the eel had been said by Signors Grassi and Calandruccio, which is not so.

Then, again, the fear (casually expressed, it is true) lest certain species of pelagic sea fishes, such as the pilchards (sardines) off the west coast of France, be in danger of extermination through over-fishing is probably unwarranted, and argues a lack of knowledge of the conditions of life in the sea. Finally, returning to the salmon, it will surely surprise anyone who has some knowledge of the Highlands of Scotland and of the rigorous restrictions to which salmon-fishing is subjected in this region at the present day, to be told that:—

"*Aujourd'hui,* c'est dans ce pays [viz., Scotland] que les domestiques sont obligés de stipules à l'avance que le saumon no paraîtra trop fréquemment dans leur ordinaire!"

These happy days are almost ancient history. But such matters are, after all, quite on the fringe of M. Guénaux's subject. Enough has been said to indicate that the book is a small mine of information, and should be consulted by all whose business or pleasure brings them face to face with any of the difficult problems connected with fresh-water pisciculture.

WILLIAM WALLACE.

A CYCLOPÆDIA OF AGRICULTURAL CHEMISTRY.

Kleines Handwörterbuch der Agrikulturchemie. By Dr. Max Passon. Two vols. Erster Teil, Aadl-kynurensäure. Pp. iv+454. Zweiter Teil, Lab-zymogen. Pp. 415. (Leipzig: Verlag von Wilhelm Engelmann, 1910.) Price 22 marks.

THESE two volumes bear striking testimony to the enormous strides made during the last twenty years in agricultural chemistry. Only within very recent times has the need for a cyclopædia been felt; previously the chemist could always pull through if he possessed one of the larger analytical treatises and had access to a set of the *Jahresberichte* for agricultural chemistry. Rapid progress set in when the subject was emancipated from the analytical stage; when the chemist, instead of being confronted with an interminable succession of analyses of manures, feeding-stuffs, and soils, was free to study the numerous problems presented by the plant in its relation to the soil, on the one hand, and the animal on the other.

To the popular mind the agricultural chemist is still an analyst, and beyond doubt the analyst is more necessary than ever he was; but the distinction between the two is fast becoming as sharp as in pure chemistry. This process of segregation is going even further, and already men are specialising in the various branches of agricultural chemistry itself. Hence the need of reference books like the present volumes.

One of the features of the book is the treatment of laboratory operations. The ordinary methods are dealt with in some detail, there are numerous illustrations, and, where necessary, tables of figures. Even such minor but important processes as the recovery of platinum, silver, &c., from their residues find a place. In addition, a number of tests are given, and methods for finding whether nitrogen is present as an amide group, an amino-acid, or an ammonium salt. Although these are probably the fullest articles in the volumes they are rather restricted in their scope, attention is devoted almost exclusively to German methods, little space being given to those in use elsewhere. In several instances the book suffers in consequence. Thus we find the methods for the mechanical analysis of soils are very incomplete; the separations are carried only far enough to include material more than 0·2 mm. in diameter, all below this limit being grouped together as fine sand, &c. This is very unfortunate, because it is now known that the finer fractions—those falling between 0·2 and 0·04 mm., between 0·04 and 0·01 mm., between 0·01 and 0·002 mm., and below 0·002 mm.—really play a controlling part in soil fertility; indeed, no soil analysis can be fully interpreted without knowing them.

The book is, however, more than a laboratory manual, and space is found for some of the great generalisations and theories that have played a part in the development of the subject. The treatment is all too brief, especially when one remembers the importance rightly attached in Germany to theoretical considerations. Liebig's famous "law of the minimum" is stated, but its modern developments are not mentioned. "The growth of the plant is governed by the quantity in the soil of that food constituent which is present in the smallest amount." This generalisation has proved of great value in agriculture, but it is now merged in the wider conception of limiting factors, which we should like to have seen discussed in the book. It is now recognised that certain requirements must be fulfilled before plants will grow well—there must be ample water, air, warmth, food, light, and no injurious substance must be present. Any increase in one of these factors may lead to an increased crop production, but the increase is soon limited by the insufficiency of some one or more of the other necessary factors. If all are increased, the limit is finally set by the plant itself. In general, however, modern hypotheses are not given; we have been unable to find any mention of the well-known toxin-excretion theory of Whitney, which supposes that infertility arises through the excretion of toxic substances by plant roots. Whether it ultimately turns out correct or not, this theory has led to so much investigation that it deserved a place.

A critic could easily point out much more that has been omitted. But he would find it difficult to see how it could be otherwise within the limits of two volumes, the available space of which has been still further reduced by the numerous good illustrations the editor gives us. There are, however, cases where the really important information is not given. Take, for instance, the note on *Molinia coerulea.* We are told that it has the power of absorbing considerable quantities of the salts of heavy metals, and a case is quoted where the ash contained 2·041 per cent. of lead oxide, 0·266 per cent. of copper oxide, and 0·265 per cent. of zinc oxide; further, we are told that it is regarded as a bad pasture grass. Now molinia is a weed and not a cultivated crop, and the things the chemist wants to know about it are these: What soil conditions does the presence of molinia indicate? and has molinia ever been observed to produce any ill-effect on animals? if so, what is the harmful constituent? Information could have been given on the first point that would have been valuable, for molinia is a useful "indicator" plant. Again, we are given analyses of animal excreta, but no mention is made of the fact that the composition is very variable, nor are we told whether the figures represent means of many analyses or only one or two determinations.

A more serious defect, however, is the omission of references. The student is rarely told where to go for fuller information, and it is practically impossible for him to check the data given in the article unless he knows his way about the literature of the subject. It is inevitable that dictionary notes should be short and should omit much; their great value ought to be the guidance they afford to the man who wants to learn more. But even with this defect the volumes are very useful, and will prove a distinct acquisition to the agricultural chemist. E. J. RUSSELL.

RADIO-CHEMISTRY.

Radiochemistry. By A. T. Cameron. Pp. viii + 174. (London: J. M. Dent and Sons, Ltd., 1910.) Price 2*s.* 6*d.* net.

THIS book purports to be an "exact account of our present knowledge of the chemical properties of the radioactive substances and their chemical effects," and in the preface much stress is laid on the "accuracy" of the facts and theories here presented. It is further stated that the subject is "treated from a chemical standpoint," while "the physical side is introduced only so far as is necessary to explain the special experimental methods." As to how well the author has attained the latter object can be best judged from two examples, one a description (quite incorrectly asserted to be "that in Rutherford's 'Radio-activity,' p. 86") of a Wilson type of electroscope (p. 10), where, in addition to a very extraordinary earth connection, the movement of the aluminium leaf is observed by a "telescope" which "carries a scale," a distinctly inconvenient and unusual arrangement; and the other a description of a Dolszalek electrometer (p. 13) having "one pair of quadrants connected to earth, the other to an insulated metallic plate facing a second which carries the radioactive matter to be tested." "Through action similar to that in the case of an electroscope an electric stress is set up between the two pairs," and "the needle, previously charged to a very high potential, is repelled from one pair of electrodes towards the other"!

The chapter on the "Classification of the Radioactive Elements—their Physical and Chemical Properties" might be expected to justify the title chosen for the book, but it is disappointing to an extreme extent; the chemical properties of uranium, for example, being dismissed with the bare statement that "it belongs to the iron group of elements and is precipitated by ammonium carbonate." The discussion of the identification of ionium is quite misleading, and the account of the chemical properties of the other radio-elements of a very superficial character. The statement that thorium "occurs chiefly in Ceylon" is certainly surprising. It is doubtful whether anyone not already somewhat familiar with the subject could separate or identify a single radio-element from the directions which are given.

Errors and misleading statements are not uncommon. Thus (p. 17) the simple exponential equation $I_t = I_0 e^{-\lambda t}$ is given in an inverted and incorrect form, which again appears later (p. 90). Further examples are the statements (pp. 56, 141) that radiothorium "is precipitated with barium," "resembles radium in every respect," and has an activity "several hundred thousand times that of radium"; that in the separation of uranium X by treatment with a mixture of ether and water (p. 39) "the ether layer contains most of the photographic or β-ray activity"; that the active deposit from the radium emanation (p. 51) "decays to half value in twenty-eight minutes, but the decay curve is very irregular"; and that "the actinium products have all extremely short lives so that the maximum activity is quickly reached (p. 56). The mention of the "decay curve of a *radioactive child*" (p. 17) certainly suggests the most gruesome possibilities!

B. B. BOLTWOOD.

EGYPTOLOGICAL RESEARCHES.

Egyptological Researches. By W. Max Müller. Vol. ii., Results of a Journey in 1909. Pp. v + 188 + 47 plates. (Washington: Carnegie Institution, 1910.)

FOUR years ago Herr W. M. Müller, now of Philadelphia, published a first volume of "Egyptological Researches," brought out at the expense of the Carnegie Institution of Washington, which had borne the expense of the journey to Egypt in 1904 the results of which were thus published by Herr Müller. In 1906 Herr Müller undertook a second journey to Egypt, and now publishes a second volume of these "Researches."

Herr Müller's chief aim on both journeys was to pick up as much as possible of the hitherto unedited and badly edited historical material which still is to be found in the inscriptions of Thebes, notwithstanding the labours of many Egyptologists. In his first volume he published in colour the extant remains of the famous pictures of Minoan Cretan ambassadors in the tomb of Senmut, the prime minister of Queen Hatshepsut, which are so important to the Greek archæologists. These pictures had already been published long ago, in colour, by the French scholar Prisse d'Avennes. The tomb was then lost sight of until re-discovered by Prof. Newberry some years ago. No new publication of the tomb was made, though it is understood that Mr. Howard Carter made a fine coloured drawing for one, until Mr. H. R. Hall published some rough sketches, correcting Prisse's errors, in the "Annual of the British School at Athens" (vol. viii., pp. 172–3), following this up with a photograph of the whole important scene, in the same publication (vol. x., p. 154). Herr Müller then followed with a coloured reproduction on a larger scale in the first volume of "Egyptological Researches." This is very useful, though naturally it is not likely to be so good as Mr. Carter's drawing, which so unaccountably remains unpublished still. Herr Müller's colours were too crude.

In the present volume of "Researches," Herr Müller provides us with similar (and too crudely) coloured reproductions of the scenes painted on the walls of the tomb of Menkheperrā-senb, which also include representations of Minoans. The figures and features of the Cretan ambassadors to the court of Thothmes III. are here represented more clearly than in the tomb of Senmut, though the vases which they carry are not so well or so carefully portrayed. The best of all these representations is probably that in the tomb of Puamra, also at Thebes, which will, we hope, shortly be published with a coloured drawing made on the spot by a most competent artist, Mr. de Garis Davies.

Herr Müller publishes a great many other scenes from tombs and temples at Thebes, with explanations, which are naturally comprehensible only to Egyptological experts, though the subjects of which they treat are of great interest to the general historian, anthropologist, and archæologist. Herr Müller is too technical, is insufficiently explicit, and assumes too much knowledge on the part of his readers, since he is not now writing exclusively for the edification of his *engeren Fachgenossen*. His style also is too notebooky, too much mere jotting down, too *staccato*, though we must congratulate him on his command of English. It is true that he would have done well had he submitted his text for revision to an American colleague before publication, as there remain in it many clumsy phrases and strong Teutonisms. Such forms as "Merenptahtext," "Kahunpapyrus," are German, not English; we always insert a hyphen between the elements of such combinations. We may also quote a very weird phrase on p. 76, "not doest thou look at the mountains" for "thou dost not look at the mountains"; and the quaintly unintelligible sentence, "strange that Duemichen's uncritical credulity toward the plays of the latest time has been revived recently!" (p. 39), needs an Egyptologist with a knowledge of German as interpreter. Herr Müller is not talking about *Schauspiele*, as one might suppose. It is not clear to us what, or rather whom, he is here talking about, or rather, at; this writer seems somewhat given to cryptic "digs" at other men of science, which are apt to fall flat if incomprehensibly phrased!

Though the coloured plates might sometimes be more carefully printed (*e.g.* plate xii. in our copy), the photographic illustrations of the battle-scenes of Rameses II. at Karnak and Luxor are very fine, and the whole book reflects credit on its author and great credit on the Carnegie Institution.

UNPROGRESSIVE PETROLOGY.

Les Roches et leurs Éléments minéralogiques; Descriptions, Analyses Microscopiques, Structures, Gisements. By Ed. Jannettaz. Fourth edition, revised and enlarged. Pp. 704. (Paris: A. Hermann et Fils, 1910.) Price 8 francs.

MOST of those who were students of petrology in the later years of the nineteenth century were familiar with a modest volume, published by the late M. Jannettaz, under the title of "Les Roches." It had a special interest for English readers, as it enabled them to realise the lines on which the teaching of the subject was carried on in France. Amongst other matters, it comprised a readable account of the Haüy system of crystal notation long forgotten in this country, a short section on crystal optics, and a description of the chief rock-forming minerals and rock types.

It was considerably enlarged but hardly improved in the third edition published, after a long interval, in 1900, and still to be found in some of our reference libraries. More than a hundred pages are devoted to the optical characters of crystals, but the treatment is at once ambitious and incomplete, and whatever merits it possesses are obscured by the innumerable misprints and blunders, which are found in its pages, and must render them almost unintelligible to anyone who resorts to them for information. It is difficult, indeed, to believe that the proofs ever passed through the author's hands. We find, for instance, "$E^2/2$" for E^2/a^2, "$\cos^2 \pi t/T$" for $\cos 2\pi t/T$, and are startled to learn that "$\cos r = 2$." The description of the rock-forming minerals is expanded into a treatise on the entire mineral kingdom and little used terms like newjanskite and sysserskite are included, while we look in vain for the refractive indices and birefringence of the commoner rock-forming minerals. The classification and nomenclature of the igneous rocks is open to serious criticism, and is based to a considerable extent on chronological principles, for we are told:—"Les géologues répugneront longtemps à confondre sous le même nom des roches qui sont arrivées au jour à des époques si différentes."

It would have been a work of supererogation to enumerate the defects of a book published ten years ago, if the fourth edition, which bears the date 1910, had not proved on careful examination to be identical with its predecessor. It is not merely that the advances of science in the interval have been ignored, but that every inaccuracy in the third edition, however obvious to the most casual reader, is faithfully reproduced. A hiatus in a reference, represented by a line of points, is left still unfilled, and even the table of errata, which corrected only a fraction of the misprints, and added more of its own, remains word for word the same. Yet we are told that this is a new edition, "revue et augmentée." The revision consists, it would seem, in the substitution of a fresh title-page, with a later date and the name of a different publisher, and the enlargement in the addition of eight reproductions of photographs, some at least of which do not appear for the first time.

Any value the book once possessed has now been greatly diminished by simple lapse of time, and the appearance of this reprint under the false colours of another edition can only be regarded as a breach of faith on the part of those who are responsible for it.

J. W. E.

ELEMENTARY MATHEMATICS.

(1) *The Public School Geometry.* By F. J. W. Whipple. Pp. xii + 154. (London: J. M. Dent and Sons, Ltd., 1910.) Price 2s. 6d. net.

(2) *The Student's Matriculation Geometry.* By S. Gangopádhyáya. Second edition, revised and improved. Pp. xviii + 348. (Calcutta: The Students' Library, n.d.) Price 1.4 rupees.

(3) *First Stage Mathematics.* Edited by W. Briggs. Pp. vii + 194. (London: W. B. Clive, 1910.) Price 2s.

(4) *Second Stage Mathematics (with Modern Geometry).* Edited by W. Briggs. Pp. viii + 128 + 102 + 186 + 14 (answers) + 21 (exam. papers). (London: W. B. Clive, 1910.) Price 3s. 6d.

(5) *Conic Sections.* By S. Gangopádhyáya. Pp. viii + 97. (Calcutta: The Students' Library, 1909.) Price 8 annas.

(6) *Public School Arithmetic.* By W. M. Baker and A. A. Bourne. Pp. xii + 386 + 2. (London: G. Bell and Sons, Ltd., 1910.) Price, with answers, 4s. 6d., without answers, 3s. 6d.

(7) *A School Algebra.* By H. S. Hall. Part I. Pp. xi + 299 + xxxvii. (London: Macmillan and Co., Ltd., 1910.) Price 2s. 6d.

(8) *Elements of Algebra.* By A. Schultze. Pp. xii + 309. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1910.) Price 4s. 6d.

(9) *The Theory of Elementary Trigonometry.* By Prof. D. K. Picken. Pp. vii + 48. (Wellington, N.Z., and London: Whitcombe and Tombs, Ltd., 1910.) Price 2s. 6d. net.

(1) FREE use is made in this volume of inductive methods in establishing the fundamental facts of geometry—the conditions for congruency and parallelism. The opening chapters deal with the measurement of lines and angles and with a few simple constructions. Then follow the elementary properties of the triangle and parallelogram, the usual theorems on inequalities, and a short account of areas. The principles of similar figures are then discussed, and are employed to prove Pythagoras's theorem. And the book closes with the angle and metrical properties of the circle. The author has succeeded in giving in a very concise form a useful summary of the subject-matter of the first six books of Euclid. We regret the introduction of two new terms—new at least so far as elementary text-books are concerned—the use of the word "stretch" for a segment of a straight line, and of the word "cognate" for "corresponding"; while the definition of π on p. 16 is not merely misleading but is incorrect. It is most important that the student should understand that π is a pure number and not an angle. There are a very large number of numerical examples, but most teachers will consider the supply of riders inadequate.

(2) The plan of this book conforms very closely to the syllabus for the matriculation examination at Calcutta, which is practically identical with the Cambridge schedule for the previous examination, the section on proportion being omitted. While due attention is paid to experimental and numerical work, the author has very wisely given chief place to the theoretical developments of the subject. We welcome the presence of a certain number of historical allusions, which might with advantage be increased in a future edition. Those who use this book will find that it answers with uniform success the purpose for which it was written. From its general workmanship it is evident that this volume comes from the hand of an experienced teacher.

(3 and 4) The two parts of this treatise are designed to meet the requirements of the Board of Education examinations in first- and second-stage mathematics. The first part therefore contains the substance of Euclid, book i., and the elementary algebraic processes as far as simultaneous and literal equations. In the second part will be found the substance of Euclid, books ii.-iv., the section on algebra including quadratics, indices, and proportion; the remainder of the volume provides the requisite course of trigonometry up to and including the solution of triangles by logarithms. We have no hesitation in saying that this text-book is admirably suited to the needs of those students who are reading by themselves for this examination, or any other of a similar character. The authors have made good use of their experience in anticipating the nature of the difficulties which the reader is likely to meet with, and in resolving them in a lucid and accurate fashion; and further, what is equally valuable, attention is directed to many points of logical importance which a student is apt to overlook, if working without any supervision. There is a rich supply of well-graded examples and a large number of examination papers, which furnish the student with opportunities for testing his progress.

(5) This book falls into three sections. There is first an introduction containing several preliminary lemmas, together with a few remarks of a general character bearing on geometrical procedure, the second part relates to the parabola, and the concluding chapter to the ellipse. The author has not aimed at giving a complete account of the geometrical properties of conics, but rather a selection of the more useful theorems, his objective being the syllabus for the Calcutta intermediate examination. This leads to some regrettable omissions; there is, for example, no mention of the auxiliary or director circle. Each proposition is followed by a number of simple applications and a few riders of a somewhat harder type are given at the end of each chapter. The book will serve as an admirable introduction to the subject. Among other good features we note the introduction of analysis at several stages, which is calculated to enlarge the outlook of the reader.

(6) There is little that differentiates this from the other numerous text-books on arithmetic which have appeared during the last few years. The supply of examples for oral and written purposes is plentiful, and a large number of test papers are provided. Although it is probable that those who use this book will find it thoroughly satisfactory, yet we do not consider that it marks any real advance on other recent publications of a similar nature.

(7) The present work is far more than a mere revision of Hall and Knight's "Elementary Algebra." Although some of the features of this book, first published twenty-five years ago, have been retained, yet the organic changes in method of late years demand alterations so considerable that the volume before us is to all intents and purposes a new book. It is marked throughout by the same clearness of style and thoroughness of treatment which characterised the author's earlier work. Graphical methods are employed, but it is satisfactory to note that they have been kept within reasonable limits. The tendency to allow it to expand into an elementary course of analytical geometry is a fatal error, for it overlooks the fact that the student is not sufficiently mature at that stage to be able to appreciate the significance of the theoretical aspect of the subject. We hope that this book will be widely used, for it is both sound and comprehensive. Part i. carries the reader as far as simultaneous quadratics. We understand that part ii. is to be published very shortly.

(8) It has often been pointed out that one significant feature of the influence of examining bodies on the educational curriculum is the tendency to standardise into distinct types, and to collect under separate headings, applications of general principles which the student should be so educated as to work out for himself, when required to do so. The old-fashioned text-books on arithmetic bear emphatic witness to this deplorable result; and it is of some importance to consider whether works on algebra are not similarly affected. This is not the place, however, to develop this theme; but in England it is satisfactory to note that the principles which have actuated those educational bodies which are responsible for the leaving certificate and Army qualifying examinations do much to minimise a very real danger. The author of the present volume attempts to meet the sitaution by focussing attention on the central facts and encouraging the reader to make the requisite applications for himself. By avoiding multiplication of detail, he is able to cover a wider range and prepare the student for more advanced work, in a shorter time than would otherwise be possible, without any sacrifice of principle. The explanatory matter is both full and clear, and there are many useful hints, particularly in connection with the solution of problems. We are, however, inclined to regret that the method of undetermined coefficients is omitted, and that the chapter on the binomial theorem is not prefaced by some quite short account of permutations and combinations, treated numerically. There is at the end of the book a useful collection of more than a thousand examples for revision purposes, which are rather harder than those given in the text. The author has done his work well, and his book deserves a good reception.

(9) There is much that is novel in the plan of this book. Broadly speaking, there are two types of text-books. In one the subject is presented in as simple and elementary a fashion as possible, with no attempt at investigating the fundamental axioms and principles on which the theory is based, and in the other a substantial knowledge of the actual analytical results is assumed and attention is concentrated on the formal concepts. Both of these are beneficial, when properly used. In the study of elliptic functions, for example, it is customary to approach the subject by considering such cases of integration which do not lead to any known elementary function; but when the student has acquired a knowledge of the general results, it is very valuable to start again and take as the base the theory of a doubly-periodic function. Prof. Picken has set himself the task of compiling a book for those who are actually starting trigonometry during their university course. His contention is that such students will have attained a maturity of mind which will be fully capable of appreciating the theoretical principles of this subject, and his object is therefore to supplement the ordinary school treatises which refer almost exclusively to numerical applications. We have little doubt that the class of students the author has in view will materially benefit by his work, which, although brief, is both lucid and scholarly.

OUR BOOK SHELF.

Milch und Molkereiprodukte, ihre Eigenschaften, Zusammensetzung und Gewinnung. By Dr. Paul Sommerfeld. Pp. 140. (Leipzig: Quelle and Meyer, 1910.) Price 1.25 marks.

THIS little book forms one of a series entitled "Wissenschaft und Bildung," the object of which is to present the intelligent reader with brief accounts of particular subjects. It is rather more technical than our own popular books of the same size would be, and naturally it lacks the completeness of a monograph. But it would prove distinctly useful for a large class of readers, including students and lecturers at agricultural colleges, and farmers who take more than a commercial interest in their work. It seems, indeed, to be a very useful method of dealing with a complex subject like agriculture.

The first chapter describes the constituents of milk, giving a clear and concise account of the protein, carbohydrates, fats, and mineral matter present, and then follows a section on the characteristics of milk from various animals. In discussing human milk some interesting statistics are given that show how difficult it is to supply any artificial food to infants that shall take the place of the mother's milk. In Berlin during 1905 the total number of infants dying under twelve months of age was 10,170. The method of feeding 7738 of these was known; 7064 had been fed on cow's milk and only 674 on human milk. The figures for other years are similar.

The chapter devoted to the bacteriology of milk is subdivided into three portions, dealing respectively with fermentation organisms, with organisms producing disease in man, and with organisms producing taints or defects in milk, such as ropiness. As all this is compressed into less than twenty pages the treatment is necessarily very brief.

Lastly, there comes a well-illustrated section on milk products and the methods of working them up for market. So important is cleanliness in working that several pictures are given of modern cow-sheds built on the best possible principles; in one, indeed, the cowman is shown cleansing the cow with a special vacuum cleaner! This section will probably prove most interesting to English readers, as it gives fairly full outlines of the German factory methods.

A few misprints are inevitable, but how did this wonderful piece of Greek on p. 12 pass the proof-reader "kohlenhydrate (von λγδορ hydor = griechisch wasser)"? E. J. R.

Theoretical Mechanics. By P. F. Smith and W. R. Longley. (Ginn.) Price 10s. 6d.

UNTIL the student has acquired a certain manipulative dexterity, it is impossible to preserve a proper continuity of thought in the development of the application of infinitesimal theory of mechanics or any other applied science. The authors are therefore justified in assuming that the reader comes to this subject equipped with a thorough working knowledge of the methods of the calculus. In the opening chapter a good account is given of the means for obtaining centres of gravity and moments of inertia of plane and solid figures; no mention is made, however, of the application of orthogonal projection to the theory of the centroid. Chapters ii.–iv. deal with the principles of rectilinear and curvilinear motion in a most attractive fashion; as an example, the motion typified by $x = a \cos kt$ is considered, the equation $d^2x/dt^2 = -k^2x$ is deduced, and the properties of harmonic motion are then obtained in a simple fashion; a similar treatment is applied to damped vibrations. This is followed by an exposition of work, energy, and impulse. Chapters vi.–ix. discuss the motion of a particle under constant forces, central forces, in a harmonic field, and against a resisting medium. The volume closes with a brief account of the equations of rigid dynamics and the principles of equilibrium of a coplanar system of forces with special reference to the catenary.

The examples, which are very numerous, are mainly numerical and practical, and so chosen as to require a minimum of analytical power. This feature renders the book eminently suitable for the senior divisions of secondary schools, where the true understanding of the ideas of mechanics is the chief object. It is to be regretted that practically no English text-book has treated the subject on these lines, a fact which is due mainly to the action of the universities in excluding the simpler applications of particle and rigid dynamics from their entrance scholarship examinations. We hope that the time is not far distant when this restriction will be removed.

The Anatomy of the Honey Bee. By R. E. Snodgrass. (U.S. Department of Agriculture, Bureau of Entomology, Technical Series, No. 18.) Pp. 162. (Washington: 1910.)

IN this modest pamphlet the author has given to entomologists an original, trustworthy, and excellently illustrated account of the structure of the honey bee, and another instance has been furnished of the scientific thoroughness that characterises the publications of the United States Department of Agriculture. Many volumes have been written on the honey bee, yet no surprise can be felt that Mr. Snodgrass has been able to add new points to our knowledge and to correct errors in the work of his predecessors. A feature of value to the serious student is the general survey of the external structure of a typical insect which the author has wisely given as an introduction to his account of the highly specialised modifications to be found in the bee. He expresses scepticism as to certain positive statements that have been made on controverted details of physiology and reproduction; for example, "concerning the origin of the royal jelly or of any of the larval food paste . . . we do not know anything about it." There is a present-day tendency unduly to disparage the results obtained by former workers, and such a statement will strike many readers as extreme. Mr. Snodgrass's scepticism as to the parthenogenetic nature of "drone" eggs seems also unwarranted after the support which Weismann's researches, published ten years ago, afford to the generally accepted view. G. H. C.

Practical Physiological Chemistry: a Book designed for Use in Courses in Practical Physiological Chemistry in Schools of Medicine and of Science. By Philip B. Hawk. Third edition, revised and enlarged. Pp. xviii + 440. (London: J. and A. Churchill, 1910.) Price 16s. net

BOTH the first and second editions of Prof. Hawk's volume have been reviewed in these columns; the former in our issue of July 18, 1907 (vol. lxxvi., p. 268), and the latter in that of July 15, 1909 (vol. lxxxi., p. 67). The present edition has been brought up to date by the insertion of various additions and corrections, as well as by the inclusion of a number of qualitative tests and quantitative methods.

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.]*

Simulium Flies and Pellagra.

IN reference to Mr. Shelford's letter in NATURE of November 10, in which he directs attention to the difficulties in controlling and eradicating the flies of the genus Simulium, known generally as sand flies and black flies, it may be of interest to direct attention to certain experiments carried out in New Hampshire by Dr. C. M. Weed and Prof. E. Dwight Sanderson and their assistants in the control of these insects. The southern buffalo gnat, *Simulium pecuarum*, Riley, which attacks and kills many animals, such as horses, cattle, mules, sheep, poultry, dogs, &c., is well known. In certain parts of the United States, but especially in Canada, "black flies," generally *S. hirtipes*, Fries, and *S. venustum*, Say, make life far more intolerable than mosquitoes, and they are specially annoying when they occur in such resorts as the White Mountains.

In 1903 Dr. Weed and his assistant, Mr. A. F. Conradi, showed that the Simulium larvæ, although they live on the stones in running water, could be killed by the application of Phinotas oil. The destruction was so complete that the flies were practically eradicated in the locality in which the experiments were carried out (see "Experiments in Destroying Black Flies," Bull. No. 112 New Hampshire Agric. Exp. Sta., 1904). A floating oil such as kerosene is manifestly useless for the destruction of larvæ having such habits as Simulium, and the efficacy of Phinotas oil is due to the fact that it has the property of sinking to the bottom in water, thus destroying the larvæ which are stationary on the stones. Further experiments have been carried on more recently in the White Mountains by Prof. E. Dwight Sanderson, and he also found that Phinotas oil applied to the running streams was effectual in the destruction of the Simulium larvæ (see "Controlling the Black Fly in the White Mountains," E. D. Sanderson, *Journal Economic Entomology*, vol. iii., p. 27, 1910). There still remains, however, much experimental work to be done with regard to the effect of the oil upon the fish, the details of the life-histories of the species of Simulium, and the practical methods to be used in applying the oil.

If Dr. Sanbon's results are confirmed, and the Simulium theory is certain to form the basis of a careful and complete series of investigations, not only in Europe, but also in those regions in Africa and America where pellagra also occurs, these experiments and results on the destruction of the Simulium larvæ will be of no little practical importance in the prophylaxis of the disease, whether a definite pathogenic organism is discovered, or the case proves to be analogous to that of Stegomyia or yellow fever.

C. GORDON HEWITT.

Division of Entomology, Ottawa, November 21.

The Song of the Siamang Gibbon.

THE Zoological Society has recently received on loan an almost adult example of the siamang (*Symphalangus syndactylus*); and since I can find no adequate description of the voice of this ape in the books I have consulted, I think the following description may be interesting to readers of NATURE.

The siamang differs from all other gibbons in having a pair of laryngeal vocal sacs visible externally on the throat as an undivided pouch of loose skin. When the animal is in full song the pouch becomes inflated into an immense oblate spheroid much wider from side to side than from above downwards, and comparable in size to the entire head of the gibbon. A feeble imitation can be made of the booming that comes from this pouch by uttering a guttural monosyllabic "*ooo*" with cheeks inflated and lips compressed. It is not unlike the sound produced by a large bubble of air bursting on the surface of water confined in a narrow space like a rain-water pipe. In addition to this there are two very distinct cries apparently quite independent of the vocal sac and uttered with the mouth open. One is a shrill, piercing bark, like the monosyllable "*haow*," cut off sharply by the abrupt closing of the lips. The other is a prolonged, unearthly wailing shriek—"*ahh—o*"—resembling more than any familiar sound to which I can compare it the "*miaou*" of a cat multiplied ten times in volume. It starts on a high pitched note with the mouth widely astretch, and gradually descends the scale as the jaws are closed. There are two variations of this shriek, one being a note or two higher and more piercing than the other.

The song usually begins with a low and gentle booming punctuated by an occasional staccato bark. As the excitement rises the ape starts to move, and swings round the cage barking vigorously and repeatedly, and now and again uttering the wailing shriek, the loud booming from the now fully expanded vocal sac going on all the while like a resonant bass accompaniment. The noise is deafening and terrific, and I shall not easily forget the consternation of the chimpanzees and the look of mild surprise that pervaded the usually expressionless faces of the orang-utans when they heard it for the first time in the apes' house.

The voices of Mammalia have never, I believe, been carefully studied and compared; yet they are worthy of the closest attention as a criterion of specific relationships. The cry of the siamang, for instance, is quite different from that of the Hainan, Hoolock, and Wau-wau gibbons, and each of these species has its characteristic song. I have elsewhere pointed out that the bray of Grévy's zebra betrays pronounced asinine affinities, and equally forcibly attests remoteness of kinship between that species and the quaggine Equidæ; that the likeness between the roar of the lion and the tiger on one hand and of the jaguar and the leopard on the other confirms the conclusion that these species are respectively closely allied, and that these four great cats form, with the probable inclusion of the ounce, a special group of Felis characterised by a roaring voice correlated with a peculiarly modified hyoidean apparatus; that the friendly purr practised by the puma, cheetah, caracal, common cat, and other species which, be it noted, never roar, distinguishes them from lions, tigers, and leopards, which never purr. To the casual observer the Cape hunting dog (Lycaon) is more like a hyæna than a wolf, but the moment he barks and growls it is needless to look at his teeth and skull to detect his cousinship to Canis; and I have recently noticed identity in all essential respects between the raucous growl of a frightened cervine wallaroo (Macropus) and that of a nervous Tasmanian wolf (Thylacinus). In this last instance we have vocal likeness associated with deep-seated ordinal resemblances, and apparently persisting despite great divergences in other structural features and in habits.

Zoological Society.

R. I. POCOCK.

On the Simultaneity of "Abruptly-beginning" Magnetic Storms.

IN the first number of *Terrestrial Magnetism and Atmospheric Electricity* for the present year, Dr. Bauer has written two papers, in which he believes he can prove the following (p. 20):—

"Magnetic storms do not begin at precisely the same instant all over the earth. The abruptly beginning ones, in which the effects are in general small, are propagated over the earth more often eastwardly, though also at times westwardly, at a speed of about 7000 miles per minute, so that a complete circuit of the earth would be made in 3½ or 4 minutes."

Dr. Bauer bases this result upon an investigation of two magnetic storms of Birkeland's "positive equatorial" type, namely, the storms of May 8, 1902, and January 26, 1903. In the latter he makes use of a table in Birkeland's "The Norwegian Aurora Polaris Expedition, 1902-3."

In the following number Dr. Faris made a more thorough investigation of this circumstance, taking fifteen different abruptly beginning storms, recorded at the Coast and Geodetic Survey magnetic observatories, in which he considers that he found Dr. Bauer's result confirmed.

Upon this foundation Bauer then develops the "Ionic Theory of Magnetic Disturbances" (*loc. cit.*, p. 111), of which the principal advantage over Birkeland's corpuscular theory is supposed to consist in the being able to give a natural explanation to time differences such as these, which Birkeland's theory, in his opinion, cannot do.

Notices of these papers appeared in NATURE of August 11.

As it appears that a number of the perturbations described by Dr. Faris are some that I studied last summer when making an investigation of magnetic equatorial storms at the magnetic observatory in Potsdam, a comparison may be of some interest. I determined also the time of the commencement of a number of positive equatorial storms as accurately as possible for another purpose, and without any knowledge of Dr. Faris's work, so that the measuring of the time was entirely independent of it, a circumstance which may be worthy of note.

It may be remarked with regard to the exactness with which the time can be determined by the Potsdam curves that the length of an hour upon the magnetograms is about 20 mm., and that thus one minute answers to about ⅓ mm. If we then take into consideration all the errors that may creep in because the curves, the time-marks, and the points considered are not so sharply defined as might be wished, and further all the errors that may be due to changes in the paper in developing, owing to the fact that the paper has perhaps not laid quite straight on the roller, &c., it will be evident that where there are no exact automatic time-marks upon the curve itself, one minute will at any rate be the *lowest* limit for the accuracy that under favourable conditions can be counted upon.

There might very easily be an uncertainty of several minutes if, for instance, the base-line is not exactly straight, but is slightly curved, if the parallax cannot be determined exactly, and so forth. Unfortunately, neither Dr. Bauer nor Dr. Faris has stated anything as to how the time in the various cases can be given exactly, a point upon which, it would be thought, it was highly important to be clear.

In the equatorial storms that I have studied, and especially those that are also found in Dr. Faris's Table I. (*loc. cit.*, p. 101), the point at which they commenced is especially clear in H. The deflections in D and Z, on the other hand, are very slight, and in consequence the beginning there is far less clearly defined.

It is therefore the beginning in H that is especially suitable for employment in a comparison such as this, and this was what I especially investigated. It will *a priori* be perceived that the results obtained by employing the other two components must be far more uncertain. In the table below I have compared the means of the values found by Faris for the five American stations that he has considered with those I measured out by the aid of the

Potsdam curves. Finally, I have also given the difference (d_r) between the greatest and the smallest time given in Faris's Table I. for the commencement in H at the American stations (Greenwich mean time is employed).

Date	America h. m.	Potsdam h. m.	Diff. m.	d_r m.
1906, July 29	19 56·12	... 19 57	... −0·88	... 3·7
1907, ,, 10	14 22·92	... 14 22·5	... +0·42	... 3·8
,, Oct. 13	7 42·36	... 7 42·5	... −0·14	... 3·9
1908, Sept. 11	7 20·82	... 7 20·3	... +0·52	... 1·3
,, ,, 28	8 42·00	... 8 42	... 0·00	... 2·3
,, ,, 29	1 31·68	... 1 31·8	... −0·12	... 3·4
Mean			−0·03	
Mean of numerical values			0·35	... 3·07

It will be observed that all the differences are considerably below the error-limit which, according to the above, must be reckoned upon, and the difference is as frequently one way as the other.

These figures seem to me to show clearly that in these cases the magnetic impulse occurs, at any rate, very nearly *simultaneously*; in any case there cannot be time-differences of such a magnitude as in Dr. Faris's opinion there are—for July 10, 1907, he even assumes that the storm would take 11·6 minutes to encircle the earth. Further, we see that the *greatest* difference between Potsdam and the mean of the American stations, 0·88m., is only about two-thirds of the *smallest* difference, d_r, between the times at the American stations, 1·3m. This circumstance, and the fact that the relation between the numerical means of these time-differences is as 0·35 : 3·07, would seem distinctly enough to show that the great time-differences observed by Dr. Faris can only be due to inaccuracy in the determination of the time, and that the error-limit must be considerable.

Further, if we consider the foundation that Dr. Bauer has employed for the determination of the rate of propagation in the case of the storm of January 26, 1903, it must, I think, be deemed as weak and uncertain as the above-mentioned, which I was able to control. Birkeland, in speaking of the table employed (*loc. cit.*, p. 63), says:—

"The table shows that the time varies so little with the geographical position that it would be premature to draw conclusions from it. The slight differences may be ascribed to inaccuracies in the determinations of time on the magnetograms; for we see that if a difference in time for a certain point appears between two places, this difference is maintained for all the points, a circumstance which seems best to be explained by an inaccuracy in the statement of the time. We may conclude from this that the serrations appear simultaneously, or rather, the differences in time are less than the amount that can be detected by these registerings. . . . The above question, which is of great importance, cannot be definitely decided until we are in possession of rapid registerings."

Bauer holds, however, that by taking groups of means he can demonstrate, clearly and surely, time-differences that would prove that the cause of the perturbation was transmitted eastwards at a rate of 6400 miles per minute.

I also last summer determined the commencement in H of this perturbation in Potsdam, and found the time to be 8h. 53m. Greenwich mean time. I moreover had the opportunity of going through the curves upon which Birkeland's table was based. From these it appeared that the times for the comparative correctness of which there was some guarantee were from the five following places:—Toronto, Kaafjord, Potsdam, Dehra Dun, and Bombay. As regards the other stations, it may be remarked that from Honolulu, Baldwin, and Cheltenham there were only received Indian-ink copies without hourly or two-hourly automatic time-marks. The parallax there could not be determined accurately, and the uncertainty in the time-determination must be considered to be relatively very great.

In the copy of the curve for San Fernando the base-line was a little curved. In that for Batavia the curve and the base-line were very faint; the parallax could not be determined with sufficient precision, and the time-marks were also rather indistinct. A new determination of the time of beginning which I have just made gives as the result 8h. 52·4m. for San Fernando and 8h. 52·8m. for Batavia. In the table these times are given as 8h. 54·3m. and 8h. 54·9m. respectively, a fact that demonstrates the uncertainty which attaches to these hours. At Christchurch it seems from the D and Z magnetograms as if the clock on that day was about 1·5 minutes too fast, so that the value 8h. 54·8m. given in the table probably should be reduced to about 8h. 53·3m. Further, the beginning of the base-line and the time-marks for the H curve were rather unsharp.

In addition, it may be remarked that the thickness of the curve at Bombay was considerable, about 0·9 mm., thus causing the commencement of the storm to be somewhat less clear; but, on the other hand, there were two-hourly automatic time-marks upon the curve itself, a circumstance which is of great importance in exact determinations of time.

If we now omit those that we already know to be very uncertain, we find the following times of beginning, putting Dehra Dun and Bombay together:—

Toronto	Kaafjord	Potsdam	Dehra Dun and Bombay	Diff.
8 52·6	... 52·6	... 53	... 53·3	... 0·7

Thus the greatest difference is considerably lower than the error-limit, and this would be still less if, as would indeed be best, we attach more weight to Dehra Dun, where the curve is exceedingly clear, than to Bombay. If we attach double the importance to the former, we find 53·1m. instead of 53·3m., and the difference will then be reduced to 0·5m.

It seems to me, also, that this last method, where the conditions are as they are here, must give a far more certain result than that which Bauer has employed.

The remaining characteristic points on the curve seem to me to be too indistinctly defined to allow of being employed in cases where the differences are as small as they are here.

Of the storm of May 8, 1902, I have no special observations that could serve to control Bauer's result. As regards Potsdam, however, I have a determination of its beginning in H, which I also made last summer before reading Bauer's paper. I found the time to be 11h. 58m. Greenwich mean time. Bauer, however, in his table gives it as 12h. 0m. It seems to me that this difference of two minutes is characteristic of the uncertainty that attaches to these statements. When Bauer finds that the weighted mean of all European stations is 11h. 58·24m., it looks as if my determination were the best. When such great differences can be found in the measurement of the same curve, and the Potsdam curves must, I suppose, be considered to be among the most trustworthy of all, how great must be the uncertainty that attaches to the others?

There seems from this, at any rate, to be by no means sufficient data to justify the conclusion that the magnetic storms are generally propagated round the earth in from about 3½ to 4 minutes, and the theory that Bauer mainly bases upon this we must be allowed to regard with corresponding scepticism.

But even if there are no such great time-displacements in these "abruptly beginning storms" as Bauer thinks, there is, of course, a possibility that small time-displacements might exist. This question, which is of such great importance for a full comprehension of the nature of the magnetic storms, can only, however, in my opinion, be solved, as Birkeland has suggested, by rapid registerings. It would be comparatively easy, moreover, to carry some such arrangement into effect by means of a number of stations—at least three—where a short or long period was registered continuously with *very sensitive apparatus* and with frequent and exact *automatic time-marks upon the curve itself*. This was the more easy of accomplishment from the fact that, for the solution of the present question, it was only necessary to register H in this manner. It would then be possible to obtain a sure foundation for reflections of the kind that Bauer makes in his last paper, reflections that, however interesting they may be, must, from what I can understand, be said to be in no small degree premature.

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THE NEGRO IN THE NEW WORLD.[1]

WHEN, more than four centuries ago, the Portuguese obtained the sanction of the Roman Pontiff to engage in the African slave trade, and, some years later (Treaty of Tordesillas in 1494), Pope Alexander VI. assigned to Portugal the west coast of Africa and to Spain the New World (of which Portugal claimed Brazil, in accordance with the terms of the treaty), it could not have been foreseen that these acts were the first steps in the vastest anthropological experiment the world has ever witnessed, the effects of which for many ages to come are likely to confound and confuse the politics of the Americas. In Portugal itself the population has been transformed into Africanised mongrels, who at the present moment are busily engaged in casting out the representatives of the church that permitted them to begin the process of wholesale racial admixture four hundred years ago.

Negro slavery and the breeding of a mulatto population were by no means novel phenomena in 1494, for even then Egypt had been familiar with them for forty-five centuries; and, in less remote times, Arabia and western Asia, Greece, and Rome, Tunis and Morocco were only too familiar with the black slave and the half-caste. But the coincidence of the introduction of negro slaves into Portugal and the opening up of the New World by the two peninsular kingdoms makes the beginning of the sixteenth century—for the experiment of sending negroes to the West Indies began in 1516—a landmark in the history of the world.

Sir Harry Johnston has given a very complete history, without sparing us any of its appalling horrors, of the iniquitous traffic in black slaves, which ultimately led to the transference from one side of the globe to the other, and that a new continent, of a population (whose descendants now number twenty-five millions), which had grown up in the seclusion of the heart of Africa and had there become divergently specialised from the rest of mankind in bodily structure and mental and moral qualities. He has drawn a most graphic picture of how these negro people behaved in their new home, as they came into contact successively with the aboriginal Americans, and also the Iberians and the northern Europeans, who had settled in the New World.

Nothing has surprised the "lay" reviewers of this book in the newspaper press more than the revelation of the gross inhumanity of the representatives of the north European race (the English and the Dutch) towards the negro slave, when contrasted with the more generous behaviour of the Iberian and other Mediterranean peoples. Lamentable and indisputable as is the fact, the explanation is simple enough. The Mediterranean race was evolved and fashioned in an environment similar to, and perhaps in the same continent as, the African negro, and not only developed mental and moral qualities in many respects closely resembling those of the negro, which explains their mutual understanding the one of the other; but also the black and the brunet race had been in contact for many ages, had interbred, and had come to give equal rights to the offspring of mixed unions.

The blond people of the north, the representatives of a more austere civilisation, had nothing in common with the lazy, lascivious negro, and had no knowledge of or sympathy with him. Thus they came to treat him and his offspring, whether pure or mixed, as an inferior being of low intelligence and dirty habits.

When Mr. Roosevelt (at the time President of the United States) invited Sir Harry Johnston to undertake an investigation of the problems of the negro in the New World, he could not have chosen anyone to accomplish this task better fitted by personal knowledge and exceptionally wide experience of the negro in his native haunts.

Others may possibly have had equal opportunities of studying the negro in Africa, but certainly no one has made such excellent use of them as Sir Harry Johnston, who has already written eleven volumes on the subject.

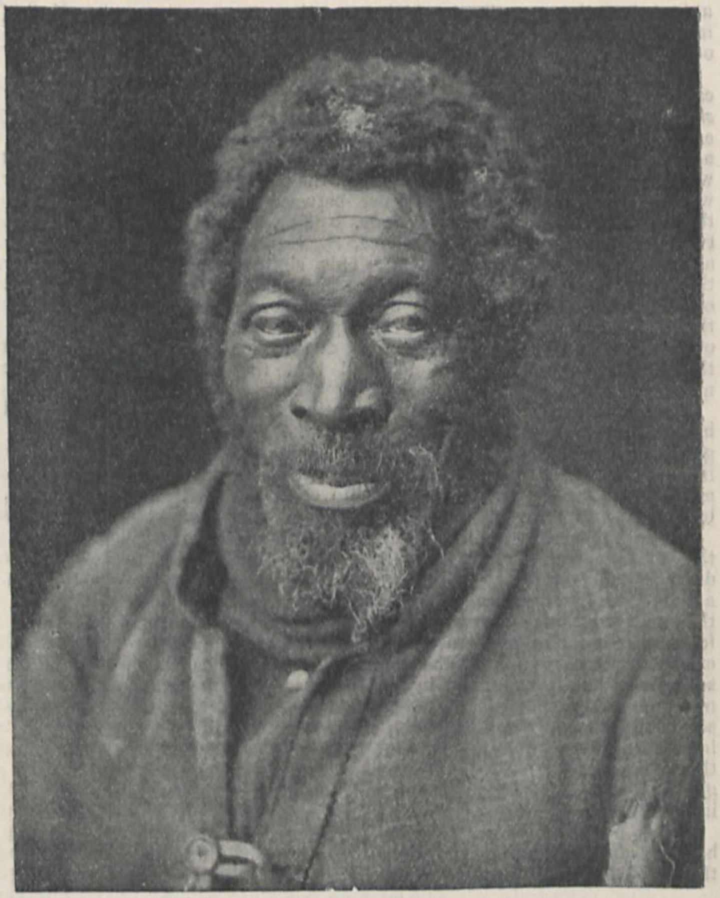

FIG. 1.—Type of the Virginian Negro of Slavery Days. From "The Negro in the New World."

With such an intimate knowledge of the essential negro, Sir Harry Johnston was well equipped for the examination of his behaviour under the influence of his altered surroundings in the New World.

In this book he has given us a detailed account, illustrated by maps and hundreds of excellent photographs, of the nature of each territory in the New World occupied by negroes or negroids, its commercial resources and social conditions, the place occupied in it by the black man, and especially the half-caste, and the degree of success and the possibilities for the

[1] "The Negro in the New World." By Sir Harry H. Johnston, G.C.M.G., K.C.B. Pp. xxix+499. (London: Methuen and Co., Ltd., 1910.) Price 21s. net.

future in ameliorating the lot and uplifting the coloured people, socially and morally.

Although no one is more fully aware than Sir Harry Johnston of the failings and moral weaknesses of the negro, he takes a very hopeful view—which many persons with a less intimate knowledge of the black man may think unreasonably sanguine—of his future, and especially of the hybrid's prospects, in the New World, provided only that he follows the example and teaching of his great and wise leader, Dr. Booker Washington, who "wants the negro to become the most industrious race in the United States" (p. 407), because only work will exhaust his energies and keep him out of mischief.

The book starts with a statement of Sir Harry Johnston's views on the negro's place in nature, which for the most part are well known to readers of his other books.

It is unfortunate, however, that on the very slender basis of the evidence afforded by the skeletons in the Grimaldi caves (see p. 26) he extends the habitat of

FIG. 2.—Type of Modern Negro; an electrical engineer trained at Tuskegee. From "The Negro in the New World."

the negro over half the continent of Europe and the whole of the British Isles!

It is not as a work of science, however, that this work, with its introductory *vulgarisation* of anthropology, is to be judged, but as a book of exceptional interest, and as the reasoned judgment of a man of wide experience on one of the most difficult sociological problems of the present time.

G. ELLIOT SMITH.

GEOLOGICAL CHRONOLOGY.[1]

THE vexed question of the age of the earth has passed through several distinct phases. Lyell and his contemporaries, accustomed to dwell on the extreme slowness of geological processes, considered themselves free to make unlimited "drafts on the bank of time"; but, since 1862, this position has been seriously challenged from the physical side. The chief argument brought against it was that, granting the globe to have cooled from a molten state, it would attain its assumed present thermal condition in a few scores of millions of years, only a fraction of which time would be available for the stratigraphical record. If the general body of geologists, influenced by the high authority of Lord Kelvin, have tried to adapt themselves to this narrow limitation, it has not been without reluctance, and some sturdy dissentients have refused any such coercion. To these, during the last few years, welcome support has come from unexpected quarters. The nebular hypothesis of the earth's origin, upon which the estimates of Kelvin and King were tacitly based, has been shaken by Moulton's calculations and other arguments put forward by Chamberlin. Moreover, the remarkable discoveries in the domain of radio-activity have compelled a reconsideration of the thermal state of the globe. Estimates of the earth's age deduced from its supposed rate of cooling clearly become futile if we have no good reason for believing that the earth is a cooling body. On the other hand, from the radio-active properties of various minerals Strutt has deduced geological ages liberal enough for the most extreme uniformitarian.

The debate concerning the age of the earth is thus no longer an issue between geologists and physicists, since the newer school of physics has declared on the side of the ampler chronology. Meanwhile, there has arisen within the body of geologists a formidable minority who contend, on geological grounds, for an estimate of geological time no more elastic than that imposed by the old argument from refrigeration. The discussion has followed two distinct lines, starting on one hand from the rate of accumulation of sediments, and on the other from the rate at which sodium is carried down by rivers into the sea. The interesting memoirs by Mr. Clarke and Dr. Becker, recently published by the Smithsonian Institution, deal mainly with the second mode of approaching the problem, but Becker offers also a revised estimate of the earth's age as calculated from the rate of cooling.

In 1899 Prof. Joly made estimates, first, of the total amount of sodium contained in the ocean, and, secondly, of the amount annually carried down by rivers, and, dividing the one by the other, obtained the quotient 97,600,000 years as the age of the ocean, supposed to be initially of fresh water. If the sea contained some salt from the beginning, this figure must be reduced accordingly. The choice of sodium is dictated by the consideration that this constituent is less removed from sea-water than any other. A relatively small correction is made for salt carried inland by the wind, and it is assumed that there is no other process of importance by which sodium is being continually removed from the oceanic waters. We may note in passing that certain observed facts, such as the evident chemical action of sea-water upon potash-granites, throw some doubt upon this assumption.

The data at Joly's command were very defective, and the main object of Clarke's memoir is to revise the calculation in the light of more recent information. In particular he has drawn upon the large mass of observations relative to the discharge, drainage-areas, and salinity of American rivers contained in the Water-Supply Papers of the United States Geological Survey. He has brought together the available information on the same points for other parts of the world, and indicated where additional observations are especially desirable. The "denudation factor," *i.e.* the number of metric tons annually removed in solution from each square mile of a drainage-basin, varies from 105 for the St. Lawrence to 16 for the Nile, and the

[1] "A Preliminary Study of Chemical Denudation." By F. W. Clarke. Pp. 19. Smithsonian Miscellaneous Collections, vol. lvi., No. 5. (Washington, 1910.)
"The Age of the Earth.' By G. F. Becker. Pp. 28. *Ibid.*, vol. lvi., No. 6. (Washington, 1910.)

relative amounts of the different dissolved salts also vary widely, these variations being related to climatic and lithological differences. Clarke computes the amount of sodium annually carried down by rivers to be 175,040,000 metric tons, and the total amount of sodium in the sea $14,130 \times 10^{12}$ tons, which gives as a quotient 80,726,000 years. He apparently considers possible corrections to be unimportant, or to balance one another, for he believes this crude quotient to be "as probable as any other value that might be chosen." As representing the age of the ocean, he considers this figure, for reasons set forth in Becker's memoir, to be "certainly a maximum."

The fundamental weakness of all such calculations, whether based on sedimentation or on solvent erosion, lies in the assumption that the present annual rate represents with sufficient approximation the mean rate throughout geological time. To the present writer this consideration deprives the conclusions of even a remote relevance to the actual problem. We know, for instance, that, even during the accumulation of a single formation at a given spot, the rate of deposition may vary widely, and in a shallow-water formation may be at one time positive and at another negative. To accept the thickness of a formation as a measure of its time of accumulation, with whatever qualifications and allowances, must inevitably lead to error, and probably to a greatly exaggerated estimate of the rate of sedimentation. Like reasoning applies to all processes of chemical as well as mechanical erosion and deposition, which are necessarily controlled by varying conditions. Even if we could eliminate the effects of relatively rapid and local variations, we have still to consider probable secular changes and others of a broadly periodic kind.

A partial recognition of this side of the problem has led Dr. Becker to discard Joly's assumption of a constant rate of increment of sodium in the sea, and to adopt instead a secular change of rate. He lays stress on the fact that at present the felspathic rocks are, over great areas, covered with a blanket of rotten rock in place, which contains only a negligible amount of sodium; and he pictures a distant future, when all massive rocks may be decayed down to sea-level, and addition of sodium to the ocean will practically cease. He thus reaches the remarkable conclusion that the rate of increment of sodium in the sea is progressively *declining*, and he accordingly represents it by a descending exponential expression. The age of the ocean is calculated, according to different hypotheses, as from 74·4 millions of years. The argument is not one which is likely to convince geologists. A decayed crust covering large continental areas must certainly have existed at many past epochs, and, indeed, the present time seems to be peculiarly favoured, in that extensive tracts have been recently scoured by ice. Further, stratified deposits yield more sodium, per square mile, than crystalline rocks, and, throughout geological time as a whole, the sediments have certainly made an increasing proportion of the whole land-surface. Most geologists believe, moreover, that the total area of land-surface has, on the whole, been growing. It would be possible, therefore, to make out a strong case for a secular *acceleration* of the rate of addition of sodium to the sea. There is another consideration of even more weight. The larger vicissitudes of the earth's history indicate a certain rough periodicity, and there is good reason to believe that we are living in a time of geological activity above the average. The author himself remarks that the continents stand at present above their average level, which, of course, greatly promotes erosion; and he also recognises that the recently glaciated regions of the globe are contributing soduim to the ocean at a rate which must raise the average. Unfortunately, he is content to leave these important considerations without discussion, assuming that they are sufficiently offset by an increased marine erosion.

The second part of Dr. Becker's paper, in which he revises Kelvin's refrigeration argument, we must pass over very briefly. It is ingenious in treatment, but involves too many precarious hypotheses to carry much weight. The special feature is that no assumption is made relative to the present superficial temperature-gradient. This is eliminated by making use of Hayford's "level of isostatic compensation," which is computed to lie at a depth (71 miles) beyond any disturbance from radio-activity. Of several special cases considered, the author prefers one which gives sixty million years since the *consistentior status*, and leads to a present temperature-gradient of 1° F. in 77 feet. We may take this latter value as a crux of the whole argument. Dr. Becker remarks that it is low as compared with observation, but he fails to see that, for the gradient *due to refrigeration*, it must certainly be far too high. Here at least radio-activity cannot be left out of consideration, and, indeed, Strutt has maintained that the observed gradient can be wholly accounted for by heat generated in the outer crust of the earth. If we allow some fraction of the annual loss of heat to represent secular cooling, it still appears that the age of the earth must be enormously greater than any estimate included in Becker's supposititious cases.

A. H.

PROF. ANGELO MOSSO.

THE School of Physiology in Leipzig was the Mecca that attracted young men from all quarters of the globe to study physiology under that great master, teacher, and experimenter, Carl Ludwig. A steady stream of young, ardent, able, and talented students crossed the Alps from Italy to prosecute research and acquire a knowledge of the methods in use in the Leipzig School. Amongst the earliest of these Transalpine scholars was L. Luciani—happily still amongst us—and a little later came Angelo Mosso, one of the most illustrious of Italian physiologists, whose death at the age of sixty-four the whole physiological world to-day deplores. He was born on May 31, 1846, in Turin. After studying at his native university—with no advantages of wealth, fortune, or high social position—he, by the exercise of his own high intellectual and brilliant gifts, soon became distinguished amongst his compeers, and he was selected by Moleschott to be his assistant in the university. He also acted as assistant to Prof. M. Schiff in Florence.

Before coming to study under Ludwig in the early 'seventies of last century, Mosso had already published his well-known researches on the movements of the Œsophagus, and determined in the dog the weight that could be lifted in the process of swallowing an olive-shaped ball (1872). In fact, the study of movements of all kinds always proved to him a fascinating and fertile subject of study. At an early period of his career he made observations on the movements of the Iris, and he attributed part of the change in size of the pupil to the filling of the blood-vessels of the membrane itself. Ludwig set him the problem to study the peculiarities of the movements of the vascular wall as they can be inferred from the results of the perfusion of blood through an excised organ, such as the kidney, a method which already had yielded such brilliant results in other organs. His results were published in 1874.

Another subject of study was plethysmography. A. Fick previously had used a plethysmograph to study variations in the volume of an organ. Mosso, under Ludwig's direction, modified this apparatus, and made an elaborate study on the alterations of the volume of the human limbs under various conditions, mental and physical, or with intellectual work, for the volume of a limb does vary with mental work, as Mosso conclusively showed. Later on, years after his return to Italy, in 1884, he published his famous paper on application of the balance to the study of the circulation in man. He constructed a balance so subtle that when a person was extended on it and delicately poised, mental work caused the head end to descend from an afflux of blood towards the brain.

In 1876, after his return to Italy, Mosso became professor of pharmacology in Turin. In 1880, when Moleschott was called to fill the chair of physiology in Rome, Mosso succeeded his old teacher as professor of physiology in Turin, a post he held with the highest distinction until his death. During the last few years illness incapacitated him from working in his laboratory, a matter of the acutest mental anguish to one whose untiring brain had ever new problems to investigate and solve.

The fact that in search after health he was able to devote his enforced leisure to the study of the result of excavations made in Sicily, and, above all, in Crete, was some compensation. He has left behind him a standard work on prehistoric anthropology in his "Palaces of Crete," published in English in 1907. His first laboratory was in a convent, but his boundless activity, productiveness, and the increase in the number of scholars, as well as the growing importance of his subject, led the Government to provide him with a palatial laboratory, one of the finest, most artistic, and æsthetic and best equipped in Europe. In 1882, along with Prof. Emery, he founded the well-known "Archives italiennes de Biologie," in which many of his now classical investigations were published. The first volume contains, Bizzozero's article on the blood platelets, and that of Mosso and Pellacani on the movements of the bladder. His unrivalled activity found vent in many directions in physiology; nor was this all. He was elected a senator, and often travelled to Rome to Monte Citorio to attend to his parliamentary duties, returning at night to undertake his more academic duties in Turin next morning.

The physiology of respiration early, and indeed constantly, occupied his attention. He studied the relations between abdominal and thoracic movements in 1878, periodic respiration, Cheyne-Stokes breathing in 1886. He had a special laboratory in the Regina Margherita hut on the top of Monte Rosa, 4560 metres above sea level, for the study of life at high altitudes, and the results of his prolonged and arduous labours he published in his "Life of Man on the High Alps," which was translated into English in 1898. As human beings cannot live much more than two months at a time in these altitudes, he had a fully-equipped laboratory erected on Cold'olen at 3000 metres, where much physiological, physical, and biological work was done.

In his "Diagnostik des Pulses" (1879) he made a careful study of the pulse, and in 1895 he invented his sphygmo-manometer for the study of the blood pressure in man. Amongst the most interesting of his studies on the circulation are those on that of the brain. The temperature and psychical activities of this organ he studied in 1894, and the researches formed part of the subject of his Croonian lectures in 1892.

Perhaps his work best known in this country is that on fatigue—translated into French, German, and English—as studied by the use of his ergograph, a most valuable contribution, written with a charm of diction that one rarely finds in physiological memoirs. Mosso was a master of style, happy in his phraseology, wide and catholic in his literal tastes, a keen and loyal admirer of the poets of his beloved Italy. The bust of Dante was always present on his laboratory writing-table. His interesting work on "La Paura" ("Fear") was also translated into English. Amongst his other popular writings are "L'Education physique de la jeunesse," "Les Exercises physiques et le développement intellectuel," and "Materialismo et Misticismo."

Amongst his chemical investigations the best known are those on ptomaines (with Guaresche, in 1882), and the discovery of the fluorescent serum and the powerful toxic venin—which he called ichthyotoxin—which occurs in the blood of the Murinideæ, such as the conger eel.

In Angelo Mosso the world loses a great and distinguished physiologist, who was beloved by all who knew him, was venerated by his pupils, and by his work, both in its theoretical and its practical applications, secured for himself a reputation as an investigator and expositor such as to place him alongside that illustrious galaxy of his countrymen who have added so much to the domain of natural knowledge.

JULES TANNERY.

THE unexpected death of M. Jules Tannery on November 11, at the age of seventy-two, will be sincerely regretted by a much larger circle of admirers than he would have anticipated. He belonged to a type of mathematician which is not too common, because he was at the same time an original thinker, a successful teacher, and a writer endowed with an unusually clear, brilliant, and attractive style.

In England, at any rate, he is probably best known by his mathematical text-books. Of these, the "Leçons sur l'Arithmétique" is a masterpiece in its way, combining rigour of method with a charming lucidity and ease; the "Traité sur la théorie des fonctions elliptiques" (written in conjunction with M. Molk), is one of the best works on the subject suited for a beginner; while the value of his "Introduction à la théorie des fonctions" is shown by the fact that a second and revised edition has recently appeared. Tannery was essentially an arithmetician, and one main object of his work on function-theory is to show that (as Dirichht asserted) all its results are deducible from the notion of a whole number. A more philosophical work, dealing with the same class of ideas, is his "Rôle du nombre dans les sciences," which he appears to have regarded as his greatest work. As might be expected, he took a part in the controversies aroused by Cantor's invention of transfinite numbers.

M. Picard, in announcing the death of their colleague to the Academy of Sciences, referred in appreciative terms to the notices of mathematical works and memoirs contributed by Tannery to the *Bulletin des Sciences mathématiques.* He said:—"Elles ne sont pas toutes signées, mais on ne peut s'y tromper, car elles portent sa marque si personnelle. En les réunissant, on aurait un tableau fidèle d'une partie importante du mouvement mathématique dans ces vingt-cinq dernières années."

Tannery's last official post was that of vice-principal of the Higher Normal School, and he was elected an Academician in 1907. M. Picard bears witness to his amiable, witty, and engaging character in private life.

G. B. M.

NOTES.

SIR J. J. THOMSON, F.R.S., has been elected a corresponding member of the Berlin Academy of Sciences.

THE principal trustees of the British Museum have appointed Mr. Walter Campbell Smith, of Corpus Christi College, Cambridge, to an assistantship in the mineral department.

PROF. E. P. DI SESSA (Rome), Prof. E. G. Warburg (Charlottenburg), Prof. J. H. Poincaré (Paris), Prof. Alexander Graham Bell (Washington), and Prof. P. N. Lebedew (Moscow), have been elected honorary members of the Royal Institution.

THE sixth annual exhibition of electrical, optical, and other physical apparatus, arranged by the Physical Society, will be held at the Imperial College of Science, Imperial Institute Road, South Kensington, on Tuesday, December 20.

AT the request of the council of the Royal Society of Arts, Sir Edward Grey, Secretary of State for Foreign Affairs, authorised the transmission of the society's Albert medal to his Majesty's Ambassador at Paris for its presentation to Madame Curie. Sir Francis Bertie received Madame Curie at the British Embassy on November 25, and handed to her the Albert medal, telling her that he had been instructed by the Secretary of State to present it to her on the part of the Royal Society of Arts in recognition of the services rendered to the world by her discovery of radium, and adding that it gave him great pleasure to be the medium of carrying out the wishes of the society.

IN view of the candidature of Madame Curie for membership of the Paris Academy of Sciences, great interest attaches to the discussion at the last monthly meeting of the central administrative committee of the five French academies, on the admission of women as members of the Institut de France. According to the Paris correspondent of the *Times*, the committee was unable to agree, and it was decided, finally, that the question should be remitted to the administrative committees of the various academies, that their decisions should be considered at the next sitting on December 28, and that the whole question should be then transferred to the plenary trimestral united sitting of all the academies on January 4. It may be mentioned here that Madame Curie has just been elected an honorary foreign member of the Stockholm Academy of Sciences.

THE Vienna correspondent of the *Times* states that Mr. Alton, of the Radium Institute in London, has bought from the Austrian Ministry of Works, on behalf of Sir Ernest Cassel, 1 gram of radium for the sum of nearly 15,000*l*. The radium is a gift by Sir Ernest Cassel to the institute, and is intended for use in cancer research. One half of the gram is now being tested at the Vienna Radium Institute, and will be sent to England next month. The other half is being extracted from the pitchblende at Joachimsthal, and will be available in three or four months. Mr. J. W. Gifford, of Chard, Somerset, has announced to Prince Alexander of Teck, chairman of the Weekly Board of the Middlesex Hospital, his intention of presenting 40 milligrams of radium to the cancer research laboratories of that institution for the prosecution of their investigations. At current rates this quantity of radium, weighing approximately one seven-hundredth of an ounce, is worth about 600*l*.

THE following are among the lecture arrangements at the Royal Institution before Easter:—Prof. Silvanus P. Thompson, a Christmas course of six illustrated lectures on sound, musical and non-musical, a course of experimental acoustics, adapted to a juvenile auditory; Prof. F. W. Mott, six lectures on heredity; Dr. A. E. H. Tutton, three lectures on crystalline structure: mineral, chemical, and liquid; Dr. M. Aurel Stein, three lectures on explorations of desert sites in Central Asia; the Astronomer Royal, Mr. F. W. Dyson, three lectures on recent progress in astronomy; Dr. P. Chalmers Mitchell, three lectures on problems of animals in captivity; Prof. Arthur Keith, two lectures on giants and pygmies; Prof. W. A. Bone, two lectures on surface combustion and its industrial applications; Sir J. J. Thomson, six lectures on radiant energy and matter. The Friday evening meetings will commence on January 20, when Sir James Dewar will deliver a discourse on chemical change at low temperatures. Succeeding discourses will probably be given by Prof. W. H. Bragg, Mr. A. E. Shipley, Prof. H. E. Armstrong, Prof. Jean Perrin, Prof. Karl Pearson, Mr. J. H. Balfour-Browne, Sir David Gill, Prof. H. S. Hele-Shaw, Sir J. J. Thomson, and other gentlemen.

AN important question with regard to the distribution and occurrence of the various species of tsetse-flies in Africa is to what extent the areas infested by them remain constant. It has long been known that in a given tract of country certain parts harbour tsetse-flies, while from other parts they are absent; but of late years an impression has grown up that these areas are liable to change, and that the fly is spreading. Sir Alfred Sharpe, in a memoir on the habits of *Glossina morsitans* in Nyasaland (Bulletin of Entomological Research, vol. i., part iii.), is of opinion that fly-areas do not alter their limits to any appreciable extent. He states, however, that within the area, fly may sometimes be found in one part, sometimes in another, and in very variable quantity at different times. He believes that the numbers of the fly depend largely on the season of the year, but also on other causes impossible as yet to define. On the other hand, Mr. P. E. Hall communicates to the same journal some notes on the movements of *G. morsitans* in N.E. Rhodesia, and indicates on a map a number of areas which, to the best of his knowledge, were clear of fly up to 1906, but are now fly-infested. This conflict of opinion (perhaps more apparent than real) shows how urgent is the need of systematic investigations by expert entomologists upon these and other questions relating to the bionomics of tsetse-flies.

IN the *Philippine Journal of Science* for June Dr. R. B. Bean, of the Anatomical Laboratory, Manila, reports the discovery of a living specimen in the island of Luzon which he believes to bear close relationship to the Palæolithic type represented by the Neanderthal skull. The massive lower jaw with its square ramus and receding chin, the low cephalic index (73·68), heavy brow ridges, rounded orbits, large nasal apertures and high nasal index (102·2), combined with small stature (156·8 cm.), muscular frame and short femur, all approximate to a form similar to that of the antediluvian man of Europe, *Homo heidelbergensis*. Dr. Bean in the same issue of the Journal continues his study of the racial anatomy of the people of Taytay, dealing here with the women, whom he finds to be more primitive than the men, and closely resembling the women of Siberia. The Blend type is largely primitive in character, and the Austroloid variety comes between the Iberian and the primitive.

IN the first part of the Journal of the Royal Anthropological Institute Mr. W. Crooke discusses the origin of the Rajputs and Mahrattas, the warrior tribes of India. He identifies among the former a considerable intermixture of Central Asian blood derived from the Hun invasions, and he holds that they constitute a status group developed from a stock of which the lower grades are now represented by the Jats and Gujars of the Punjab. The Mahrattas he also considers to be a status group developed from the Kunbi tribe, and now claiming affinity with the Rajputs. He questions the validity of the suggestion that the brachycephalic element in southern India is the result of emigration of Huns or Scythians under pressure from the Aryans. It may be more reasonably accounted for by a prehistoric movement of races from the west either by the land route or in the course of commerce which existed with the Euphrates valley from a very early period.

OUR note in NATURE of November 24 (p. 114) upon the suggested inversion of the expression "thunder and lightning" leads another correspondent to point out that the phrase "animals and birds," inadvertently used on the same page, is open to the objection that it suggests that birds are not animals. He proposes the term "beasts, birds and fishes" as comprehensive and sufficiently distinctive.

DR. R. HORST has favoured us with a copy of an account of a new species of peripatus (*Paraperipatus lorentzi*) from Dutch New Guinea, published in vol. xxxii. (pp. 217–8) of Notes from the Leyden Museum. The species, which is fortunately represented by a male and a female, is of interest as filling a gap in the distribution of the group. The two specimens were discovered in moss on Mount Wichmann, at a height of between 9000 and 10,000 feet. In colour the new species is dark greenish-blue, becoming somewhat paler on the under side, and with a median central row of small whitish spots.

WHEN Dr. J. Huber succeeded Prof. E. A. Goeldi as director of the Museu Goeldi (Museu Paraense) in March, 1907, the opportunity was taken of reorganising the staff of that institution on a new and improved footing. These changes, as well as the general progress of the museum, are recorded in the reports for 1907 and 1908, which form the first portion of vol. vi. of the *Boletim do Museu Goeldi*, which, although relating to the year 1909, has only just been published. The zoological gardens attached to the museum, which are largely devoted to the exhibition of the animals of the country, appear to be in a thriving condition, having received a large number of accessions during the period under review.

THE pharyngeal teeth of fishes form the subject of an article, by Colonel C. E. Shepherd, in the November number of the *Zoologist*. These organs, except in the case of the wrasse and carp groups, have, according to the author, received but scant attention at the hands of naturalists. After referring to their different structural types, Colonel Shepherd expresses the opinion that pharyngeal teeth are probably the chief masticating organs, as they are undoubtedly in carp and wrasse. Fish-eating species, which swallow their prey whole, would have the action of the gastric juice facilitated if the bodies of the fishes swallowed had the scaly coat broken by means of the pharyngeal teeth. These teeth also assist in working the food down into the œsophagus.

THE local pearl and pearl-shell fishery forms the subject of an article by Mr. A. Scale in the July number (vol. v., No. 2) of the *Philippine Journal of Science*. Two species of pearl-oyster are found in Philippine waters, the valuable gold-lip, *Margaritifera maxima*, and the less precious black-lip, *M. margaritifera*. With the exception of those used in a factory at Manila, which is capable of turning out about 6000 gross of buttons per month, and consumes about 300 tons per annum, all the shells are exported to Singapore or Europe. Although almost the whole area from Sibutu Passage to Basilan Strait and the south shore of Mendanao is a potential pearl-bank; most of the banks have been over-fished, and it is now difficult to find productive ones. One bank was recently found in which all the shells were dead, and so corroded as to be valueless. The fisheries afford a fair yield of pearls, although much less than the Ceylon output, which comes from a smaller species, with shells of little value. On the other hand, some of the finest known pearls are the product of the Sulu fishery. The Japanese are producing pearls, although not of good shape, by introducing foreign objects into the oysters, and the author states that within the next few years it will be possible to produce perfectly spherical pearls of good lustre.

To the Proceedings of the U.S. National Museum, No. 1778, Messrs. Everman and Latimer communicate the first complete list of the fishes of the Lake of the Woods and neighbouring waters, so far as at present known. Although the Lake of the Woods, which forms the receptacle for the waters of Rainy River, lies mainly in Ontario, its southern border is situated on the northern frontier of Minnesota, and therefore belongs to the United States. On account of the recent treaty between Great Britain and the United States, which provides for the federal control of the fisheries in these waters, an account of their fish-fauna is a matter of some importance at the present time. The fisheries in the Lake of the Woods, which are carried on by means of nets, are of very large economical value, having yielded in 1909 a total sum of 42,193 dollars, of which 28,051 pertained to the United States and 14,142 to Canada. In 1894 the total value was, however, as much as 81,337 dollars. The most valuable product is the great lakes sturgeon (*Acipenser rubicundus*), which formerly swarmed in Lake of the Woods, and in 1893 yielded no fewer than 26,000 dollars, although of late, like that of the rest of the fishery, the yield has been much less. During the last few years a slight increase in the catch is, however, reported, but this may be due to closer fishing.

IN connection with the preservation of localities where rare plants or special plant associations are found, attention is directed to a paper, by Mr. A. R. Horwood, on the extinction of cryptogamic plants, published in the Transactions of the South-Eastern Union of Scientific Societies (1910). The author discusses the numerous factors that lead to the extinction of plants, and presents the results of special inquiry with regard to Ireland, where perhaps the most destructive factor is the collector, who in the south-west counties raids the ferns *Trichomanes radicans* and *Osmunda regalis*.

IN the *Victorian Naturalist* (vol. xxvii., No. 6) is published a report by Mr. J. W. Audas on a botanical expedition in the Victorian Alps, and a list of plants recorded from the district that has been compiled by Dr. A. J. Ewart. Out of 334 species, one-third belong to the three families Compositæ, Leguminosæ, and Myrtaceæ, while the families Saxifragaceæ and Ericaceæ are only represented by *Bauera rubiginosa* and *Gaultheria hispida*; a single gentian, *Gentiana saxosa*, is found. The one endemic plant is a bushy labiate, *Westringia senifolia*.

Among the plants observed by Mr. Audas about an altitude of 5000 feet were the shrubs *Eriostemon myoporoides*, *Helichrysum rosmarinifolium*, and *Kunzea Muelleri*; near the summit of Mt. Hotham he found the grass-like umbellifer, *Aciphylla glacialis*, and a tufted carophyll, *Scleranthus biflorus*.

MR. E. P. STEBBING presents in Forest Pamphlet No. 15, published by the Government of India, a note on the preservation of bamboos from the attacks of the bamboo beetle or "shot-borer." The destructiveness of this insect, *Dinoderus minutus*, may be gauged from the fact that bamboos generally last in India only for a year or eighteen months. Cooperation between the author and the Indian Telegraph Department has resulted in the evolution of an effectual method of treatment, which consists in soaking the bamboos for five days in water, when they exude a gelatinous substance, and then immersing in Rangoon oil for forty-eight hours. The object of the bulletin is to record the experiments undertaken and the results, showing that the oil has effectually preserved bamboos treated in 1904 up to the time of writing in 1909.

THE *Agricultural Journal of British East Africa*, recently to hand (vol. iii., part i.), contains a short article by Dr. Bodeker on native methods of fishing in relation to the incidence and dissemination of sleeping sickness. Fishing is attended with grave danger to all natives in the vicinity wherever *Glossina palpalis* is found. Several districts where formerly a large population of fishermen dwelt are now uninhabited as a result of the disease. Among remedial measures, the destruction of the thin strip of bamboo canes along the whole coast-line is recommended. In another article Mr. MacDonald urges the advantages of maize as a crop for export. It can be grown readily and at comparatively low cost over a large area of the country, and, so far, it has not been infested by any seriously destructive pest. Railway rates to the coast being now much reduced, it becomes possible to send the maize to Great Britain or to the Continent, where the demand is practically unlimited.

A TABLE is given in a recent issue of the *Journal of Agriculture of South Australia* (vol. xiv., No. 1) showing how the use of fertilisers for cereals has increased during the past thirteen years. From 1898, the first year given in the table, to the current year the increase has been continuous; some of the figures are as follows:—

Year	Quantity of manure used Tons	Area of cereal crop manured Acres
1898	12,500	250,000
1899	16,500	350,000
1907	61,000	1 366,400
1908	65,000	1,456,000
1909	76,500	2,100.000
1910	87,000	2,320,000

A few soil analyses are recorded in another article, from which it appears that the soils are very different from our own. The nitrogen varied from 0·026 to 0·091 per cent., the phosphoric acid from 0·010 to 0·045 per cent., and the potash from 0·044 to 0·82 per cent. All these values are much lower than in ordinary English arable soils.

THE Natal Museum has issued a catalogue of a collection of rocks and minerals from Natal and Zululand arranged stratigraphically by Dr. F. H. Hatch. The specimens were collected by Dr. Hatch during the winter months of 1909. Beginning with the oldest rocks, the order of arrangement is:—(1) metamorphic rocks, Swaziland system; (2) granites intrusive in the metamorphic rocks of the Swaziland system; (3) Waterberg or Table Mountain sandstone; (4) rocks of the Karroo system; (5) surface deposits. The collection of specimens is a duplicate of one which Dr. Hatch proposes to present to a London museum.

IN a paragraph upon the recently discovered ice-cave near Obertraun, Upper Austria, which appeared in NATURE of October 13 (p. 469), Prof. E. Fugger was described as one of the explorers of the cave. Prof. Fugger asks us to state that he has not yet personally examined the cave, and that the information he kindly sent at our request was provided by Herr Alexander von Mörk, who took part in the exploration of it. The discoverers and first explorers of the cave were, according to reports in the Linz newspapers, Herren J. Lahner and Kling (Linz), J. Pollak (Wels), I. Bock (Graz), A. v. Mörk (Salzburg), and L. Kranl (Budapest).

MESSRS. OUTES AND BÜCKING have added notably to the discussion of the *tierras cocidas* of the Pampas beds of Argentina by publishing photographs of thin sections of the debatable materials ("Sur la structure des scories et 'terres cuites,'" *Revista del Museo de la Plata*, vol. xvii., p. 78, September). Scoriæ are figured from Monte Hermoso which are undoubtedly of volcanic origin. These are contrasted with the fragmental earths, which contain, however, volcanic particles. When these earths are subjected to the action of fire, they show fluidal structures and a glassy ground between the surviving fragments, and certainly do not resemble the alleged "terres cuites" selected for comparison. True burnt earths are formed during agricultural operations near La Plata when the settlers wish to clear their ground by burning the surface-vegetation, and these are of the glassy type. It is urged, therefore, that the andesitic scoriæ which occur in the earths of the Pampas beds cannot be regarded as products of superficial burning. The petrographic argument is immensely strengthened by the illustrations, and their production, if we may judge from a quotation made by the authors, seems due to certain remarks published in NATURE in 1909 (vol. lxxxi., p. 535).

IN the September Bulletin of the American Geographical Society, under the title of "Notes on the Description of Land Forms.—I.," Prof. W. M. Davis returns to his attack on the "empirical" method of description in a criticism of three recent geographical papers (German, Italian, and English). He urges that it is "ultra-conservative" to adhere to the empirical method when "the whole trend of modern physical geography is toward the use of explanatory description." It may be replied, however, that while the new "terms of origin" can be sometimes used with good effect by a physiographer of Prof. Davis's experience and confidence, they might be more misleading than any empirical description if employed wrongly or applied without sufficient warrant. It is not every traveller who could be trusted with the use of "mature insequent ravines," &c., as desired by Prof. Davis in his "Notes."

THE November issue of the *National Geographic Magazine* contains thirty-nine photographs in colour, which is the largest number of coloured pictures ever published in a single number of the magazine. These illustrations all deal with life and scenes in Korea and China, and together provide an excellent means of picturing the habits and customs of these Eastern peoples. The article which is illustrated by these pictures is by Mr. William W. Chaplin, who shows an intimate acquaintance with the countries he describes, and he also took the photographs from which the pictures were made. Mr. Guy E. Mitchell contributes a well-illustrated paper on a "New Source of Power," in which he deals with the extensive beds of lignite in the United States. The State geologists have estimated that the lignite deposits in the United States, exclusive of Alaska, amount to 740×10^9 tons, of which fully one-third belongs to the public lands. The total area underlain by lignite and sub-bituminous coal—coal mostly of little, if any, value in steam plants, but of great efficiency in gas producers—is 246,245 square miles. The U.S. Geological Survey fuel tests have showed that when coal is made into producer gas and then used in a gas engine, it has from two to three times the efficiency that it has when burned under a steam boiler in the ordinary way. Moreover, the experiments showed that lignite, which is useless for steaming purposes, can be used most successfully in the gas producer. Other articles in this issue of the magazine are "Kboo, a Liberian Game," by Mr. G. N. Collins; the "Pest of English Sparrows," by Mr. N. Dearborn; and "The Mistletoe," by Mr. W. L. Bray.

THE remarkable series of earthquakes that occurred in Alaska in September, 1899, is described in a valuable paper by Mr. Lawrence Martin (Bulletin of the Geol. Soc. of America, vol. xxi., 1910, pp. 339–406). The first known shock occurred on September 3, the last on September 29. In these four weeks there were four, possibly five, world-shaking earthquakes, and several hundred minor shocks. The strongest of all was the second great shock of September 10. It disturbed an area of probably not fewer than 432,000 square miles, and produced water-waves in Lake Chelan, Washington, which is nearly 1200 miles from the origin. Shore-lines were raised as much as 47½ feet, and depressed 5 feet or more in Yakutat Bay, and new reefs were uplifted. Sea-waves 20 or 30 feet high swept the shores. The Muir Glacier subsequently retreated eight miles in as many years, while other glaciers were subject to brief spasmodic advances. But, though the earthquake ranks among the greatest that have visited the American continent, there was no recorded loss of life among the twenty thousand inhabitants of the disturbed area, while the destruction of property was insignificant. This immunity was, no doubt, due to the fact that the people lived in tents, log cabins, or low frame buildings.

IN *Bergens Museums Skrifter. Ny Raekke.*, Bd. i., No. 1, Dr. A. Appellöf, of the Bergen Museum, describes the investigations on the life-history of the common lobster, upon which he has for a number of years been engaged. The monograph ("Untersuchungen über den Hummer") contains also a summary of previous work on the subject, and, as a whole, gives the best account of our knowledge of the natural history of the lobster which is at present available. With regard to the migrations of the animal, Dr. Appellöf, basing his opinion chiefly on the results of marking experiments, concludes that the lobster is a stationary animal, and remains in a very restricted area for many years, undertaking only short migrations, a conclusion which is of great importance when possible schemes for stocking a fishery by means of artificial rearing of lobster larvæ are under consideration. The author considers that the probability of increasing the supply of lobsters on the fishing grounds by means of artificial hatching, combined with the rearing of the larvæ until they reach the bottom-haunting stages, is very great, and refers to the successful rearing experiments carried out by Mead in the United States. The monograph is illustrated by a series of plates showing the various stages of development of lobster larvæ.

WE have received from Mr. A. Ghose a letter with reference to the review in NATURE of September 29 (p. 406) of his paper on "Manganese-ore Deposits of the Sandur State." Mr. Ghose points out that the Indian outputs of manganese ore were quoted incorrectly; our reviewer regrets the error, and supplies the correct figures as follows:—Production of manganese ore in the State of Sandur during 1908, 23,413 tons; during the quinquennial period 1904–8 (four years), 50,872 tons. Production of manganese ore in the Presidency of Madras during 1908, 118,089 tons; in the quinquennial period 1904–8, 513,845 tons. Production of manganese ore in the whole of India during 1908, 685,135 tons; in the quinquennial period 1904–8, 2,545,718 tons. The production of Sandur is therefore a little more than 3 per cent. of the whole output of India.

THE meteorological chart of the North Atlantic for December (first issue), published by the Meteorological Committee, has some interesting details of the two West India hurricanes experienced during October last. A cablegram from Havana on October 13 stated that the barometer was then falling, and later on a destructive cyclone passed over the south of Cuba, and was central between there and Cay West on October 15. On October 17 another storm of greater intensity (referred to in London newspapers on October 19) passed over Havana, and the island of Cuba is reported to have sustained the greatest material damage in its history. Several steamships were driven ashore by one or other of these hurricanes. Interesting synoptic weather charts are also given for the period November 10–16. These and the useful explanatory text indicate the existence of three high-pressure areas, one over the western American States, another to the north of Iceland, and a third which was gradually transferred from Europe to the region of the Azores. Over Europe as a whole the weather was dominated by depressions developed over the upper portion of the Atlantic, between the Icelandic and Azores high-pressure systems.

WE have received from the Abbé T. Moreux, director of the Bourges Observatory (Cher), a revised edition of his pamphlet entitled "Introduction to the Meteorology of the Future: the Sun and the Prediction of Weather." The Abbé is dissatisfied with the present method of forecasting weather for a day or two in advance. He points to the changes in the sun, which seem to have some connection with those on the earth, and asks whether this is not something more than a simple coincidence. He quotes step by step the progress made in tracing this connection from the time that Sir W. Herschel discussed the question of sun-spots (Phil. Trans., 1801, p. 265), and rapidly passes in review the labours of Schwabe, Wolf, and subsequent investigators down to the present day, and many references are given to the discussions which have appeared in our columns and elsewhere. The spectroscopic researches and discoveries of Sir Norman Lockyer and M. Janssen, and the establishment of the Solar Physics Observatory at South Kensington, are referred to as of prime importance; the former marked the epoch of extended observations on the simultaneity of solar and terrestrial changes, and the latter formed a base for similar inquiries in other parts of the world. The author observes that we have now an important groundwork of operations, and it must be maintained at any price.

IN two notes published in the *Bulletin International* of the Academy of Sciences of Cracow (March and April) Dr. Const. Zakrzewski communicates the results of measurements made by him on the dispersion of metallic bodies in the visible spectrum. Two experimental methods were used:—(1) The author's "elliptic analyser," described by Dr. Zakrzewski in 1907, and used since with success by Herr Volke; as shown in the paper, this arrangement provides a comparatively exact way for the determination of the refractive index ν and of the index of extinction κ for a metallic body. (2) A new scheme depending on the use, for the observation of ellipticity, of a convergent pencil of light; the results thus obtained are estimated to be correct within 5 per cent. of their values. Illustrative results for platinum, cobalt, and graphite are adduced. Maxwell's simple equation $\nu^2 - \kappa^2 = \text{const.}$, now given up on theoretical grounds, is found to hold true for graphite. The second correlative equation, however, asserting the proportionality of the product $\nu\kappa$ with the period of vibration in the incident beam of light, does not agree with the observations.

AN interesting address on "Comets and Electrons" was delivered by Prof. Augusto Righi to the Bologna Academy on June 22, and is published as No. 13 of *Attualità scientifiche* (Bologna: Nicola Zanichelli, 1910, price 2.50 lire). In the paper Prof. Righi traces the growth and development of ideas regarding radiation-pressure, the successive proofs, disproofs, and reproofs of its existence for finite bodies, for minute solid particles such as are believed to exist in comets' tails, and for gaseous molecules, the theory of formation of the tails themselves, the electrical phenomena accompanying them, the escape of gases from planetary atmospheres, the nature of sun-spots and allied astrophysical phenomena. Prof. Righi, in conclusion, refers to the experiments conducted during the passage of the earth through Halley's comet, a large proportion of which gave rise to no definite conclusions. The following suggestive remark occurs in the paper:—"In this connection of the action of radiations on the individual molecules of a gas, and hence on the presence of gases in comets' tails, there has been once more verified the not uncommon fact that conclusions which are just, or regarded as such, are reached only by an asymptotic method, that is, after a series of successive corrections, and often, as in the present case, after having completed a series of successive oscillations, fortunately of decreasing amplitude, from one side to the other of the truth."

A COMMITTEE was appointed about two years ago by the Institution of Civil Engineers to investigate and report on questions connected with the use of reinforced concrete. A preliminary and interim report has now been issued giving information regarding the conditions under which reinforced concrete has been employed in engineering work in various countries, and the views of engineers having special experience in its use. The committee does not accept any responsibility for any of the statements contained in the report, and reserves its own views and recommendations until later. Hence the designer will still have to depend largely on the excellent report presented some time ago by the Royal Institution of British Architects, more especially as he will find difficulty in extracting definite information from the present report. The reader is expected to compare for himself the various statements of opinions contained in 262 pages of letterpress. The committee is now engaged upon tests and investigations in order to enlarge the knowledge at present available, and no doubt more definite information and conclusions will appear in a subsequent report.

MESSRS. NEWTON AND CO. have been granted a warrant of appointment as opticians to the King. They have held Royal warrants for more than sixty years.

OUR ASTRONOMICAL COLUMN.

EPHEMERIS FOR FAYE'S COMET, 1910*e*.—Dr. Ebell publishes a continuation of the ephemeris for Faye's comet in No. 4457 of the *Astronomische Nachrichten*; the following is an extract:—

Ephemeris 12h. (Berlin M.T.).

1910	α (true) h. m.	δ (true) ° ′	log r	log Δ	mag.
Dec. 6	3 37·1	+3 44·0	0·2270	9·8717	10·3
,, 10	3 37·6	+3 25·0	0·2292	9·8845	10·3
,, 14	3 38·5	+3 12·8	0·2316	9·8985	10·4
,, 18	3 39·8	+3 7·1	0·2342	9·9134	10·5
,, 22	3 41·6	+3 7·5	0·2371	9·9290	10·6
,, 26	3 43·7	+3 13·3	0·2401	9·9453	10·7
,, 30	3 46·3	+3 24·1	0·2433	9·9621	10·8

This ephemeris is calculated from Prof. Strömgren's elements with a correction ΔM., and the time of perihelion is brought forward by about +8·91 days, to November 1·647 (Berlin M.T.); an observation at Teramo on November 23·4 gave a correction of −9s., −2·1′, to the ephemeris position.

RECENT HELWAN PHOTOGRAPHS OF HALLEY'S COMET.—Halley's comet was again photographed with the Reynold's reflector at the Helwan Observatory on November 7, 9, and 11, and the plates indicate a correction of +0·2m., 0′, to the ephemeris published in No. 4450 of the *Astronomische Nachrichten*; the magnitude is estimated at about 14·5.

A telegram from Prof. Frost announces that Prof. Barnard observed the comet (presumably with the 40-inch refractor) at the Yerkes Observatory on November 11 at 17h. 17·8m. (M.T. Yerkes), and found its magnitude to be about 11·0; the observed position was

R.A. = 12h. 4m. 21·3s., dec. = −14° 54′ 15″.

From these observations it would appear that there is a marked difference between the photographic and visual magnitudes, and, curiously enough, it seems that the visual brightness is the greater (*Astronomische Nachrichten*, No. 4457).

THE TOTAL ECLIPSE OF THE MOON ON NOVEMBER 16.—Some interesting notes dealing with observations made during the recent eclipse of the moon appear in No. 21 of the *Comptes rendus* (November 21). MM. Luizet, Guillaume and Merlin, at the Lyons Observatory, observed the occultations of several stars, and found that in some cases the disappearances were not instantaneous. In two cases the star appeared to be projected on the disc before disappearing, and in one case contact with the limb preceded disappearance by three seconds. On the other hand several well-observed occultations and reappearances were quite sudden.

M. Montangerand, Toulouse Observatory, noted that in one case the extinction took an appreciable time, but in two others it was instantaneous; he also directs attention to the apparent unevenness of the shaded disc. M. Lebeuf, at Besançon, also noted this phenomenon, and describes the apparent rotation of the deeper coloration as the eclipse proceeded. The general transparency of the shadow, as compared with earlier eclipses, notably that of April 11, 1903, also attracted his attention.

M. Jonckheere, at the Hem Observatory, was able to see the penumbral shadow, with the naked eye, at 10h. 32m., and observed first contact with the shadow at 10h. 57m. 5s. (M.T. Hem). He also records that the meteorological observations, presumably delicate, indicated a sensible lowering of temperature during totality.

THE PROBABLE ERRORS OF RADIAL-VELOCITY DETERMINATIONS.—The radial velocities of stars are now being measured by many observers, not always with concordant results, and it becomes important that the probable errors of such observations should be investigated and defined with every care. In a paper in No. 3, vol. xxxii., of the *Astrophysical Journal* (p. 230), Mr. Plaskett deals with this subject, basing his discussion on exhaustive experiments he has made at the Ottawa Observatory. Many factors enter the problem, and one of the most important is the effect of dispersion. Mr. Plaskett finds that, contrary to expectation, the accuracy is not inversely proportional to the dispersion of the spectrograph used, only a small increase of probable error, say 40 per cent., appearing when the dispersion is divided by three.

In the early-type stars the diffuseness of the available lines in the spectrum increases the probable error very rapidly, and Mr. Plaskett is convinced that physical causes in the star's atmosphere are contributory to this increase.

For solar-type stars it would appear that the average probable error of a good three-prism determination need not exceed ± 0.5 km. per sec., while with one prism ± 0.70 km. might be expected in good work. If stars of an earlier-type spectrum are dealt with, ± 2 to ± 11 km. per sec. is a moderate estimate of the probable error. Finally, Mr. Plaskett suggests that with solar stars the greater part of the error accrues from instrumental causes, the errors of measurement only accounting for about one-third or less.

THE PHOTOGRAPHIC MAGNITUDES OF STARS.—In Circular No. 160 of the Harvard College Observatory Prof. E. C. Pickering discusses the progress made, to July, in the establishment of a method for determining photographic magnitudes and of a scale for recording them.

Three methods have been found to give satisfactory results. The first depends upon the law that stars of the same spectral class have the same colour and has been tested with concordant results; the following values are interesting as giving the constants necessary to reduce photometric to photographic magnitudes according to spectral class:—

B	A	F	G	K	M
−0·31	0·00	+0·32	+0·71	+1·17	+1·68

Thus if the visual magnitude of a star is 5·00 and the spectrum is of type B, the photographic magnitude is 4·69, but if the spectrum is of the G type the photographic magnitude is 5·71.

The second method, in which a standard "polar sequence" of stars is photographed on the same plate and under similar conditions as the stars to be measured, has been already described in these columns, but it is interesting to note that the work has been extended to stars so faint as the twentieth magnitude, and it is hoped, ere long, to publish definitive magnitudes for a great number of stars in both hemispheres. About 11,000 measures of 200 photographs have already been made; for stars fainter than magnitude 14, for which long exposures are necessary, it has been found that this method is not so suitable. For such stars it has been found that the third method, in which a small circular prism of very small angle is attached to the centre of the objective, is better; the small prism diverts a known proportion of the light from each image into a secondary image, and so provides a ratio scale. Prof. Pickering discusses the difficulties presented by the problem, and states that although the results already attained are very hopeful, much remains yet to be done.

The same problem is also attacked by Herr E. Hertzsprung in No. 4452 of the *Astronomische Nachrichten*, who proposes a tried method in which the density of a direct image is compared with an image, on the same plate, produced when a grating is placed before the objective.

PROPER MOTION OF THE STAR B.D. $+33°$ 99.—Whilst making observations of the minor planet 1910 KU, Dr. Abetti was led to suspect that one of his comparison stars, B.D. $+33°$ 99 (AG. Lei. 226), has a large proper motion. Subsequent investigation and calculations show that this proper motion amounts to $-0·027 \pm 0·004$s. and $-0·34 \pm 0·00''$. The magnitude of this star is 8·5 (*Astronomische Nachrichten*, No. 4453).

THE NEW METEOROLOGICAL OFFICE.

ON Thursday, December 1, a large party assembled at the new Meteorological Office at the corner of Exhibition Road and Imperial Institute Road on the invitation of the Meteorological Committee.

The committee was originally appointed by H.M. Treasury in 1905 to control the administration of the Parliamentary grant for meteorology. Its inexpressive title gives little indication of its responsibility to the country and, indirectly, to the world at large. It consists of the director of the office, Dr. W. N. Shaw, who is *ex officio* chairman; the hydrographer of the Navy, Rear-Admiral H. E. Purey Cust; Mr. G. L. Barstow, of the Treasury; Captain J. M. Harvey, of the Board of Trade; Mr. T. H. Middleton, of the Board of Agriculture and Fisheries; with Sir G. H. Darwin, F.R.S., and Prof. Arthur Schuster, F.R.S., the nominees of the Royal Society.

The work of the office goes back, in continuity, to the original establishment of a Meteorological Department of the Board of Trade for the joint service of the Navy and the mercantile marine under the superintendence of Admiral FitzRoy, the naval officer who, as captain of the *Beagle*, had carried Charles Darwin round the world. The motive power for the establishment of a special department for meteorology came from a maritime conference held in Brussels in 1853, in which Lieut. Maury, of the United States Navy, a well-known geographer and meteorologist, took a leading part. The primary object of the office was the collection and discussion on an organised plan of meteorological observations made at sea; but when Leverrier began collecting daily observations by telegraph in France, FitzRoy associated himself with the idea, and in 1860 he introduced a system of weather telegraphy with storm warnings and forecasts which in 1861 were published in the newspapers.

This line of action evoked a great deal of criticism on the part of scientific authorities, and it is doubtful whether meteorology, at that time a bashful *débutante* among the sciences, has ever been forgiven for so shocking a *faux pas*. It is true that the system of warnings was continued after FitzRoy's death at the instance of the Board of Trade, influenced by several memorials to Parliament, and that in 1879, after the issue of forecasts had been dutifully suppressed for twelve years, in a report of the council then in control of the office, appointed by the Royal Society and made up of the great names of Henry J. S. Smith, Warren De la Rue, Frederic J. O. Evans, Francis Galton, George Gabriel Stokes, and Richard Strachey, the following paragraph appears:—"For several years forecasts not intended for publication had been daily prepared in the office, and the experience thus gained by the staff has emboldened the council to announce their readiness to commence in April, 1879, the issue to the public of forecasts for the different parts of the United Kingdom," and that the issue has been continued ever since; but the natural hesitation which men of science feel about publishing their conclusions before they have had an opportunity of verifying them has always overshadowed that side of the office work. To that circumstance, combined with the frigidity with which the young science has been treated by her elder sisters, it is probably due that, while prolonged effort has been devoted to the preparation of forecasts twice, or even three times a day, for a whole generation, and while the rule that no forecast shall be formulated without first setting out the data and the grounds for the inference has been rigorously enforced, yet the issue of the forecasts has been left practically to the newspapers. It seems otherwise inexplicable that no general system of distribution of forecasts by telegraph should have been adopted in this country.

FitzRoy died in 1865, and the office became the subject of inquiry by a Government committee, with the result that in 1867 the control of the Parliamentary grant was handed over to a committee of the Royal Society, with Sir E. Sabine, the president of the Royal Society, as chairman. At the same time provision was made for marine meteorology and weather telegraphy to be associated with the work of fully equipped meteorological observatories of the first order, six of which were forthwith established, namely, Falmouth, Stonyhurst, Aberdeen, Glasgow, Armagh, and Valencia, in addition to Kew, which had become the central observatory of the system.

Continuity between FitzRoy's department and the Meteorological Office was maintained by the transfer of all the duties of the department and a number of members of the staff to the new committee. Mr. T. H. Babington, however, who took over the management of the department on FitzRoy's death, was not transferred; Mr. R. H. Scott was appointed director of the new establishment with

Captain H. Toynbee as marine superintendent. The office occupied the quarters at 1 and 2 Parliament Street, belonging to the Board of Trade, which accommodated FitzRoy's department; but to its chagrin it was dispossessed in 1869, and the ejected committee hired accommodation for itself in the form of a residential flat over a shop at 116 Victoria Street.

In 1875 another Government committee of inquiry was constituted, with the result that in 1877 the direction of the office became vested in a council appointed by the Royal Society. This constitution lasted until 1905, when, as the result of a third committee of inquiry, the present system was adopted, under which the office is managed by a director with an advisory committee appointed by the Treasury. Throughout the period of the council the office occupied the premises at 116 Victoria Street, which during its tenure was renumbered 63.

It cannot be said that the council regarded the suite of offices which they occupied as ideal accommodation for the Office; but it was generally hampered for want of funds, and, as a matter of practical politics, the idea of new accommodation may be attributed to Sir H. Maxwell's committee of 1903, which pronounced the accommodation at Victoria Street to be unsuitable. The advantage of housing the office under the same roof as a post office had long been recognised, and the wish of the Post Office to have a permanent structure at South Kensington on land which formed part of the estate of the Commission for the Exhibition of 1851 led, at the suggestion of a member of the Meteorological Committee, to an arrangement by the Treasury for the committee to rent from H.M. Office of Works more spacious accommodation than they had at Victoria Street at practically the same rent. The arrangement was concluded in May, 1907, and the transfer of the work to the new premises was completed on November 15, 1910. The party on December 1 was intended to give those interested in the work of the office an opportunity of seeing the new premises newly equipped.

This long introduction is necessary, because the office has now fifty-six years of history behind it, passed in a habitation chosen with a view to the collection and discussion of observations from sea and land. During that time it has been responsible for supplying meteorological instruments to the Navy, the mercantile marine, its own stations, and recently to colonial Governments, and it has become the controlling centre of more than 500 stations of various kinds in these islands and in various colonies, while it has instruments on more than 200 ships afloat, and is in direct communication with nearly all liners crossing the Atlantic. It has made a vast collection of observations from ships in the form of log books which fill 500 feet of shelving. It deals with about 50,000 telegrams a year in its telegraphic branch. The independent existence of the British Rainfall Organisation, founded as a private enterprise by Mr. G. J. Symons, a member of FitzRoy's staff, exonerates it from dealing fully with the statistics of rainfall, but for more than forty years it has aided the meteorological societies of London and Edinburgh in the collection of climatological data for the British Isles, and has gradually become itself a centre for the compilation of returns from volunteer observers all over the country and from some of the colonies. To this collection is added the published meteorological data of all the countries of the world, forming a library almost unique of its kind. It has issued publications to the number of about 250 volumes, which, being in the form of Blue-books or of unwieldy atlases or charts, are little read. So far as the general public is concerned, it appeals to them only through the forecasts which the newspapers are kind enough to issue for it, through the storm signals which are occasionally visible on the coasts, and through certain fishery barometers supplied to coast stations, which are, however, mostly marked with the initials B.T., because the official in charge was unwilling to recognise as *de jure* the dissociation *de facto* of the office from the Board of Trade.

Until quite recently, partly on account of the apathetic attitude of the universities, partly because meteorology deals with British units and other sciences use metric units, the education of the people in the new science had not ever been begun. The meteorology of Daniell and Herschel had been, in fact, allowed to fall out of the educational curriculum, and its place was taken by sciences with which the teachers were themselves acquainted.

In moving their home from Victoria Street to South Kensington the Meteorological Committee has set itself to change all this. They have sought to secure, with what success the public may now judge, space in which their collection of books and records can be reasonably well housed, and which at the same time affords an opportunity to display, for the information of the public, a series of exhibits which show what the work of the Meteorological Office has been in the last fifty years, what its work is now, how it does it, and what its purpose is in doing it. Those who have visited the office will agree that the idea of combining a library with a museum has elicited very generous sympathy from the Office of Works, and that the architect of the new building, Sir H. Tanner, has dealt with the problem, which is not without difficulty, in a manner for which admiration is not too strong a term to use. The space is perhaps a little over full, as the library has even now to accommodate part of the working staff of the office in addition to its other requirements; but when it is remembered that rent is still a consideration to be reckoned with by the committee, there is, after all, little to complain of.

The office premises are mainly on the first and second floors of the new building at the corner of Exhibition Road and Imperial Institute Road. These two floors provide, besides the library and its ante-room, a room for the director and rooms for the four superintendents and for the director's secretary, a large room for the clerical staff and another for the forecast staff, three rooms for the marine staff, and two for the instruments staff. To judge by external appearances, the whole building might be regarded as a post office, but it is not so. The ground floor and the greater part of the basement is assigned to the post office, but in the basement the Meteorological Office has space which it is hoped may provide for a printing office as well as a workshop. A small physical laboratory is provided on the third floor, the remainder of which is temporarily occupied by the staff of the Science Museum. Access is given thereby to a large flat roof, which provides invaluable opportunity for the exposure of instruments for the purposes of trial and investigation.

The manner in which the committee have utilised the space at their disposal and have kept in view the educational purposes which have been indicated will be evident from the list of exhibits prepared for the party on December 1.

In a case outside the doorway is exhibited the most recent information about the current weather, based on the telegrams received. In the outer lobby, opposite the door of the post office, is a case containing a barograph, the recording apparatus of a Callendar thermograph, and of a Dines pressure-tube anemograph, exhibiting the continuous record of pressure, temperature, and wind velocity. On the walls of the inner lobby and the staircase leading to the first floor are a series of frames showing the course of the seasons in the British Isles as determined by the weekly averages since 1878. The relation thereto of the weekly values of the current season for four divisions of the country is shown upon transparent paper, which covers the diagrams of average variation. These diagrams lead up to one which shows how the meteorological elements at the several stations in the same district may vary under similar types of weather. Four frames show the monthly meteorological charts of the Atlantic and Indian Oceans, and further on is a diagram showing the variation of temperature in the upper air on various occasions in 1908 up to 15 miles or more, in juxtaposition with a series of photographs of clouds presented to the office by Dr. W. J. S. Lockyer.

The catalogue of exhibits makes reference to a series of three cases on the first-floor hall intended to illustrate the work of the office under FitzRoy at the Board of Trade, under Sabine and Scott, of the Meteorological Committee of the Royal Society, and under the Meteorological Council, with Smith and Strachey, successively, as chairman, but for reasons not given in the programme the cases are not yet there; some of the exhibits are to be found compressed into a single case in the upper corridor.

The hall accommodates, however, a radiation recorder by Callendar and a hyetograph or rain recorder of Negretti and Zambra's most recent pattern.

From the hall we pass to an ante-room provided with a counter for the supply of information of various kinds, and leading to the library and museum on the one side and to the headquarters of the clerical and inquiry staff on the other. This room, with the library and the staircase, are finished throughout with ornamental woodwork in Austrian oak. Round the ante-room are glass cases for the display of barograms from ships and land stations, anemograms and other records of importance to aëronauts, and also cases devoted for the present to diagrams prepared in the office to show results deduced from data for the whole globe or for British observatories or stations, including the relationships of meteorology and agriculture. A diagram, newly prepared, showing the distribution of rainfall throughout the day for the several months of the year at Kew and Valencia, is specially noticeable. In the same room is the Kelvin harmonic analyser constructed for the council to be used for the analysis of barograms and thermograms. A relief map of the British Isles on the scale of one-millionth, intended for the central space, being unfinished, was represented by a cast of the English section.

On either side of the entrance to the library and museum are square kiosks for envelopes, the faces of which are framed in glass and used for displaying the weekly sets of records from observatories, the records of sunshine at ninety-two stations for a single day of last summer, and the winter sunshine records of 1909–10 in London, Cambridge, and Eastbourne. Within the library, in four cases, are displayed a series of exhibits in connection with marine meteorology, the daily service of forecasts and storm-warnings, climatological statistics, and the investigation of the upper air. Another and larger case is devoted to the observatories at Kew and Eskdalemuir. Four small cases show a new method of representing data for the whole world on what is called a developable globe. The current daily weather charts of all countries and the latest climatological reports from the British Dominions are collected together in special cabinets. Two glass cases face one as one enters the museum: one contains specimens of the normal instruments adopted by the office, the other such examples as the office possesses of the corresponding instruments of other countries.

The library is divided into six compartments by bookcases extending from the side walls. In four of the compartments the books of published data are grouped according to countries, the remainder being occupied by periodicals, text-books, &c. The recesses of three of the bays are used by the working staff of the statistical and library division of the office; two are furnished with tables for students, and on the book-cabinets near by the latest additions to the library are displayed. A few educational exhibits, lantern-slides, photographs, &c., including some valuable stereophotographs of clouds from a long base, by Mr. J. Tennant, were set on Thursday on one of the tables.

The library is not large enough to contain all the books and documents belonging to the office. Accordingly, the manuscript records of observations at stations of various kinds find a place in the room of the superintendent of statistics. The original working charts of the Daily Weather Service are housed with the files of daily synchronous charts of all kinds in the forecast room, a spacious room on the second floor in direct connection by means of pneumatic tube with the instrument room of the post office. The series of meteorological logs from ships, now exceeding 13,000 in number, is housed in the working rooms of the marine staff; the books of data extracted from them are in the marine superintendent's room or in the passage near by. The stock of instruments is housed in the rooms of the instruments staff, while separate store rooms are set apart for publications and for observatory records. These latter are already too numerous for the accommodation provided. The bound volumes of anemograms are therefore stored on shelves elsewhere, and for the time being the sunshine cards are in the basement, where it is proposed to construct with them a 13-inch wall 50 feet in length and 10 feet high.

One of the main difficulties connected with the removal has been the housing of the enormous collection of records and documents, the accumulation of upwards of fifty-six years. The problem of the ultimate fate of these accumulations is one which has now to be faced.

The new arrangement of the office, which is open to the public, has chiefly in view the educational advantages which a library and museum can afford; but it has another object. One often hears a distinction drawn between routine and research, sometimes to the disparagement of the work of an office. Routine work in meteorology is really and truly cooperative research; if not it ought to be discontinued, for it has ceased to have any object. Research in the more restricted sense means personal research upon a subject selected by the individual taste. In cooperative research one cannot choose one's subject; it has been chosen for us by international agreement, by conferences and congresses, by committees perhaps, or by other circumstances over which we have no immediate control. What is still left to our free choice is whether the cooperative research shall be manifestly our research or other people's research. Routine becomes sterile when it is a listless contribution to other people's research. To keep cooperative research alive we need to keep very close up to the working face of the bore into the unknown. It may take a generation or more to carry the whole work through, and premature publication may be worse than routine. To put the record of our progress in a shape in which it can be seen by those who appreciate it, as well as those who do not, gives us a place in the ranks of conscious workers for a definite, even if a distant, object.

W. N. SHAW.

THE CLAIMS OF SCIENTIFIC RESEARCH.

THE anniversary dinner of the Royal Society was held as we went to press last week. Lord Robson proposed the toast of "The Royal Society," and it was replied to by Sir Archibald Geikie, K.C.B., president of the society. In the course of his remarks, Lord Robson pointed out that in nearly every direction the labour and research of science, however remote they may sometimes seem from the affairs of the workshop or the office, are opening up new and almost illimitable sources of wealth and new avenues of profitable employment. It is the man of science who is to decide the fate of the tropics; not the soldier, or the statesman with his programmes and perorations, but the quiet entomologist. He is the man of science who of all others strikes popular imagination the least, and gets less of popular prestige; but he has begun a fascinating campaign for the sanitary conquest of those enormous tracts of the earth, and before long he will have added their intensely fertile soil, almost as a free gift, to the productive resources of the human race. The report in the *Times* states that Lord Robson continued as follows:—"Not long ago it was my duty to consider legislation in reference to the most complicated problems of overcrowding in cities. That is essentially a problem for statesmen, but not for statesmen alone. Perhaps the most hopeful attack on overcrowding is being unconsciously made by those men of science who have lately done so much to improve the transmission of electric power. They are on the way to make it possible and profitable for factories to establish themselves away from cities and coal-pits, and yet have the exact amount of power they want each day for their machinery sent down to them every morning by wire at a trivial cost. Some day manufacturers will begin to go back to the land, and we shall regard engine-building or soap-boiling as rural occupations. We look to you, the men of science, and almost to you alone, to ensure, not only that our centres of population shall not be congested, but also that our cities, now smoke-laden and devitalised, shall not be polluted. I have spoken of a sanitary conquest of the tropics. Give us also a sanitary conquest of the air of England. What a programme of social reform the Royal Society has got! Yet I have not heard that you are making any claims on the Development Fund. In all seriousness and earnestness, I contend that you ought to be the most favoured, as you would certainly be the most meritorious, of all claimants on that reservoir of national generosity. The various sections and interests who are on the way to absorb it all are seeking, I believe, without exception, to advance the material interests of those whom they represent. The claims which you put forward on behalf of experimental research would be wholly unselfish. They would be for work in the common interest, in the interest of mankind. In the report for the year there is a very long list of work done in different departments of scientific research with small sums like 10*l.* or so given out of your small Government grant to meet expenses. It is a list capable of indefinite expansion, and indicates work that might be done on a larger and more fruitful scale. Undertakings like the Research Commission to Uganda may well return their cost a hundred-fold, and I venture to suggest that an appeal should be made to those in charge of the Development Fund to give a wider scope to your disinterested and most beneficent activities."

COTTON GROWING WITHIN THE BRITISH EMPIRE.

THE British Cotton Growing Association was inaugurated in 1902 with the object of extending the cultivation of cotton throughout parts of the British Empire where conditions should prove suitable. During the eight years that have elapsed, valuable information has been acquired by means of pioneering expeditions and experimental cultivation in more remote parts of the Empire and from the results yielded by private undertakings that have been liberally assisted with technical advice and financial means. As it was announced a year ago, the inquiry stage is practically completed, and it has been decided to concentrate the main efforts of the association on the work in Nigeria, Uganda, Nyasaland, and the West Indies. The present state and future outlook of the cotton industry are therefore opportunely summarised in the address delivered by Mr. J. H. Reed before the Royal Geographical Society on Monday, December 5.

The principal supply of raw material from the United States of America has increased during the last quarter of a century from seven to thirteen million bales per annum; the output of India may reach a total of five million bales, but most of it is short-stapled, and Egypt supplies somewhat more than a million bales. Against this has to be placed the demand for cotton, which in this country has remained nearly stationary, at a total of three million bales, while the United States of America now require nearly five million bales, and the countries of Europe absorb six million bales. With regard to other sources of supply, the class of cotton grown in the West Indies is of good quality, but owing to the limited area the amount produced can never be large, so that the most hopeful fields for the labours of the association lie in West and Central Africa. The colony of Lagos bids fair to produce an appreciable quantity of cotton; the extension of the industry in Nyasaland, where a superior type of upland is a prominent variety, is distinctly encouraging, and the late High Commissioner of Uganda has reported upon the favourable climate and conditions, as well as the eagerness of the natives in that Protectorate for taking up cotton cultivation. In the Sudan there are large areas of suitable land near the junctions of the Atbara and the Blue Nile with the main stream, in the province of Berber, and on the plains between the converging courses of the Blue and White Nile. Of the prospects in Rhodesia it is too early to pronounce a definite opinion, but the experimental work gives promise of the possibility of a native industry being developed under European guidance.

PESTS OF FRUIT TREES.

A FRUIT-GROWERS' conference was held, in conjunction with the National Fruit-growers' Federation, at Wye College, Kent, on December 2. Nearly six hundred persons, mostly fruit-growers in Kent, attended. The papers of scientific interest were read by Mr. F. V. Theobald, vice-principal and entomologist at the college, and by Mr. E. S. Salmon, mycologist.

Mr. Theobald dealt with the damage done to fruit trees by Thrips. At least three species of Thrips damage fruit trees and bushes, the commonest, apparently, being *Euthrips pyri*, Daniel. This species is found on apple, pear, plum, raspberry, loganberry, and strawberry. The winged adult females first enter the opening buds, and then by means of their conical mouths so lacerate the young tissue that the buds die soon after opening. Leaves and blossoms are also attacked. The ova are laid in slits cut by the female in the young leaves and strigs. The pale, wingless larvæ attack the young fruitlets, which either crack and drop off prematurely, or, if less injury is done on somewhat larger fruitlets, the abrasions lead to the formation of areas or scars, which disfigure or even entirely ruin the fruit. The larvæ when mature enter the soil, and there produce a pupal stage with long wing buds, and the winged Thrips appear again. The winter is passed in the larval stage in the earth. Treatment with soil fungicides appears to be the only practicable method of dealing with this fruit pest.

Mr. E. S. Salmon dealt with the epidemic outbreak of *Eutypella prunastri*, which during the past few years has destroyed thousands of young fruit trees in certain districts in Kent, Herefordshire, and Worcestershire. In one case near Canterbury 1200 "Victoria" plums, 300 "Czars," and 50 "Monarchs" were attacked and killed. The variety of plum called "Rivers Early Prolific" appears to possess powers of resistance to Eutypella. Young apple and cherry trees have also been destroyed by this disease.

The life-history of the apple "scab" fungus (*Venturia inaequalis*) was dealt with, and instances were given which showed that this disease can be successfully prevented by the use of the fungicide known as "Bordeaux mixture." The statement sometimes made by growers that the "scab" fungus can infect and spread on stored apples is due to an error of identification. Recent investigations made by Mr. Salmon show that we have in this country a species of Leptothyrium, not hitherto reported, which attacks apples both on the tree and in the fruit-room, and forms sooty-looking spots on them. It is probably the species *L. pomi*, well known in America as the cause of the "sooty blotch" and "fly speck" diseases.

Evidence was adduced as to the different degrees of susceptibility to injury from Bordeaux mixture shown by different varieties of English apples.

THE DISCOVERY OF NEPTUNE. LEVERRIER'S LETTER TO GALLE.

WHILE so much has been written about the dramatic discovery of the outermost known planet, it is strange that until quite recently the full text of the letter in which Leverrier announced to Galle the results of his wonderful investigations appears not to have been published.

A copy of this historic document was communicated by its recipient to Dr. See about five years ago, for use in a work on the planetary system which the latter was then preparing. But the death of Galle in July last has prompted Dr. See to anticipate the issue of his work by publishing the letter by itself in No. 8, vol. xviii., of *Popular Astronomy* (October, p. 475). The ostensible reason for writing to Galle was to acknowledge the receipt of the memoir which the latter had prepared, and in which he had reduced and critically discussed Roemer's synopsis of three days' work, which alone escaped the conflagration of 1728, under the title "O. Roemer's Triduum Observatorium Astronomicarum a. 1706 Institutorum" (Berlin, 1845). The letter runs as follows:—

"*Paris, le* 18 *septembre* 1846.

"MONSIEUR

"J'ai lu avec beaucoup d'intérêt et d'attention la réduction des observations de Roemer, dont Vous avez bien voulu m'envoyer un exemplaire. La parfaite lucidité de Vos explications, la complète rigueur des résultats que Vous nous donnez, sont au niveau de ce que nous devions attendre d'un aussi habile astronome. Plus tard, Monsieur, je Vous demanderai la permission de revenir sur plusieurs points qui m'ont intéressé, et en particulier sur les observations de Mercure qui y sont renfermées. Aujourd'hui, je voudrais obtenir de l'infatigable observateur qu'il voulût bien consacrer quelques instants à l'examen d'une région du Ciel, où il peut rester une Planète à découvrir. C'est la théorie d'Uranus qui m'a conduit à ce résultat. Il va paraître un extrait de mes recherches dans les *Ast. Nach.* J'aurais donc pu, Monsieur, me dispenser de Vous en écrire, si je n'avais eu à remplir le devoir de Vous remercier pour l'intéressant ouvrage que Vous m'avez adressé.

"Vous verrez, Monsieur, que je démontre qu'on ne peut satisfaire aux observations d'Uranus qu'en introduisant l'action d'une nouvelle Planète, jusqu'ici inconnue: et ce qui est remarquable, il n'y a dans l'écliptique qu'une seule position qui puisse être attribuée à cette Planète perturbatrice. Voici les éléments de l'orbite que j'assigne à cet astre:

Demi-grand axe de l'orbite	36,154
Durée de la révolution sidérale	217 ans,387
Excentricité	0,10761
Longitude du périhélie	284° 45′
Longitude moyenne: 1er janvier 1847	318° 47′
Masse	$\frac{1}{9300}$
Longitude héliocentrique vraie au 1er janvier 1847	326° 32′
Distance au Soleil	33,06

"La position actuelle de cet astre montre que nous sommes actuellement, et que nous serons encore, pendant plusieurs mois, dans des conditions favorables pour le découvrir.

"D'ailleurs, la grandeur de sa masse permet de conclure que la grandeur de son diamètre apparent est de plus de 3″ sexagésimales. Ce diamètre est tout-à-fait de nature à être distingué, dans les bonnes lunettes, du diamètre fictif que diverses aberrations donnent aux étoiles.

"Recevez, Monsieur, l'assurance de la haute considération de Votre dévoué serviteur

"U.-J. LE VERRIER.

"Veuillez faire agréer à Mr. Encke, bien que je n'aye pas l'honneur d'être connu de lui, l'hommage de mon profond respect.

"A Monsieur J. GALLE,
"Astronome à l'Observatoire Royal de
"Berlin, à Berlin."

THE NEW ZEALAND SURVEY.

IN a report which has recently been published, the Surveyor-General of New Zealand describes the work of his department during the year 1909–10. A large area of country has been surveyed, but the urgency for pushing forward the topographical and settlement surveys, and the survey of native lands, leaves little opportunity for dealing with the major triangulation of the country. It is satisfactory, however, to see that besides some 320 square miles of minor triangulation, a commencement of a secondary triangulation has been made, and a base-line some eight miles in length has been measured. There is said to be a pressing need for this form of control, which may "bring into harmony different groups of practically uncontrolled minor work with their different standards of length, &c." The experience of many other regions goes to show that not only is such control indispensable, but adequate expenditure on it is the best economy, and very soon repays itself.

As the report is arranged by districts, it is difficult to appreciate fully the character of work done; but the demand for land surveys on large scales is very large, and the want of ample and accurate triangulation of second- as well as the present third-order series is no doubt a real one.

The measurement of a base of the secondary triangulation at Wairarapa was carried out with two five-chain invar tapes; a third of greater width, a quarter of an inch instead of an eighth, was also used for the first two sections only. The tension was determined by a Salter spring balance, and not by weights, as is now the more usual method. The tapes were supported at intervals of fifty links by special stands. Four measurements were made of all sections, two with each tape, and of the first four two additional measurements were made; the probable error of the final value adopted for the base is given as 1 part in 2,962,000. The standard of length for controlling the invar tapes was a steel 100-link tape, of which the true length was known at 62° F. and under a tension of 15 lb., but not its coefficient of expansion and modulus of elasticity. A second base is now in hand, and with the increase of this important high-grade work greater facilities for comparison and verification of base apparatus will doubtless be introduced. The work of the department also includes the harmonic analysis of the tidal observations of the Dominion for the New Zealand Nautical Almanac, and arrangements have been made to furnish advance proofs to the Admiralty.

The work of the magnetic observatory has provided an unbroken series of magnetograms from the Adie instruments, and also a large number of seismograms from the Milne seismographs.

THE JAPAN MAGAZINE.[1]

THE great development of Western education in Japan has naturally led to the extensive publication of newspapers and magazines of a very varied kind, and many of them are of a high literary, scientific, or philosophical quality. *The Japan Magazine* is one of the most recent additions, and although its editor seems to be a European, almost all the writers are Japanese. The issue for October, which has just come to hand, is a very good combination of readable matter, which at the same time is of great interest to all who know Japan.

The first article is on "Torii," the characteristic and picturesque gateways to be found at the entrance to every Shinto shrine. It is one of the best which we have seen, and is illustrated by some of the most striking examples in the country. Mr. Seiichi Tejima, the director of the Higher Technological School in Tokyo, gives an interesting description of the organisation and work of his school which will be read with advantage by those engaged in similar work in this country. In addition to the technical part of the curriculum, the importance which is given to the training of character should be specially noted. Mr. Tejima points out that a person engaged in any occupation may be tempted to bargain his honour for venal purposes if the basis of his morals is not sound, and thereby lose the credit of an expert, and it is therefore the school's principal line of policy in education to give moral training on one hand and engineering practice on the other. Mr. Tejima was recently in London in connection with the Japan-British Exhibition, and no doubt some of our readers made his acquaintance and admired the exhibit shown by his school and other educational institutions in Japan. Viscount Taneko, the well-known statesman and writer, gives some readable reminiscences of American statesmen which throw interesting sidelights on some of the problems arising between America and the Far East.

The chief city engineer of Tokyo, Mr. Benjiro Kusakabe, has a descriptive article on "The New Tokyo," which gives a good idea of the transformation which has taken place and almost made the city unrecognisable by those who knew it in former times. Of course this magic transformation is, after all, not so marvellous as it appears, for the reconstruction of a city of wood cannot be regarded as so colossal a task as would be the rebuilding of a stone city like London or Berlin. But the story of the modernisation of Tokyo is none the less interesting as an indication of the tact, skill, and expedition with which the Japanese attempt and achieve great things, and Mr. Kusakabe thinks that when all the new buildings now either in course of construction or contemplated in the near future are completed, and the city's plan of public improvements carried out, Tokyo will be, both in appearance and reality, one of the finest capitals in the world.

Mr. Yaichi Haga tells "How Western Civilisation came to Japan," and Mr. Yoso Kubo, of the Investigation Bureau, has an important article on "The Remaking of Manchuria," which explains Japanese policy and methods in that part of the world. There are very good articles on "The Art of Judo," or of physical training, with special relation to its ethical aspects, on the "Silk Indus-

[1] Published by the Japan Magazine Co., Tokyo. Subscription, in Japanese Empire, per year in advance, 4.50 yen, in foreign countries 6.100 yen.

try," on "Fruit Culture in Japan," and on "The Art of Flower Arrangement," as well as others of special interest to all who study things Japanese. Altogether, the magazine makes very good reading, and if it maintains the standard of the issue which we have been considering it will take a high place among publications on the Far East.

H. D.

RADIATION FROM HEATED GASES.[1]

On the Radiation from Gases.

In the first and second reports of the committee reference was made to the part played by radiation in the cooling of the products of an explosion, and to its bearing on the measurements of volumetric and specific heat with which those reports were principally concerned. The general question of radiation from heated gases has, however, from the point of view of the committee, an interest and importance of its own which are sufficient to justify a detailed study of it in its wider aspects. Radiation plays a part comparable with that of conduction in determining the heat-flow from the gas to the cylinder walls in the gas engine, and it is this flow of heat which is the most important peculiarity of the gas engine, and to which are chiefly due the leading characteristics of its design. Even to the uninstructed eye the most obvious features about large internal-combustion engines are the arrangements for cooling, and the great size and weight for a given power which is necessitated mainly by those arrangements. The difficulties which the designer has to meet are due in the main to the stresses set up by the temperature gradients which are necessary to sustain the flow of heat. In the present state of the art it is probable that the most important service which science could render to the gas-engine constructor would be to establish definitely the principles upon which depends the heat-flow from hot gases into cold metal with which they are in contact, and thus to enable him to predict the effect upon heat-flow of changes in the temperature, density, or composition of the charge, and in the state of the cylinder walls.

The committee does not propose in this report to deal with the whole of this large question, but will confine its attention to one important factor in heat-flow, namely, radiation. The subject is a wide one, which has excited much attention among physicists and chemists, and on several important points agreement has not yet been reached. No attempt will therefore be made to do more than state shortly the experimental facts, and to define the issues which have been raised in regard to the explanation of these facts.

Practical Effects of Radiation.

It is believed that the first instance in which radiation from a flame was used in an industrial process, with knowledge of its importance, was the regenerative glass furnace of Frederick Siemens, which he described at the Iron and Steel Institute in 1884. Here the combustible gas was burnt in a separate chamber, and the hot products of combustion were led into the furnace. The objects to be heated were placed on the floor of the furnace out of contact with the stream of flame which flowed above them. They would therefore receive heat only by radiation, and it was supposed that this radiation came in a large measure from the flame. Siemens, however, was of opinion (in 1884) that the radiation was due to incandescent particles of carbon, and that there was little radiation from a non-luminous flame.[2]

In 1890 Robert von Helmholtz measured the radiation from a non-luminous coal-gas flame 6 mm. diameter, and found it to be about 5 per cent. of the heat of combustion.[3] The radiation from a luminous flame was greater, but not very much greater—rising to a maximum of 11½ per cent. for an ethylene flame. Discussing the Siemens furnace in the light of these results, R. von Helmholtz calculated that radiation from the flame in the furnace could only account for a small fraction of the actual heat transmission. He pointed out, however, that a large flame would probably radiate energy at a greater rate than a small one. But while admitting that for this reason gaseous radiation might play a part in the heat transmission, he suggested that a more important agent was radiation from the roof of the furnace, which received heat by direct contact with the hot gas, and so reached a very high temperature. He showed by calculation that a comparatively small excess of temperature in the roof over that of the floor would cause a sufficient flow of heat.

But though the discussions on the Siemens furnace and the work of Helmholtz show that the idea that a flame, even if non-luminous, might radiate large amounts of heat, was a familiar one to many people twenty years ago, its possible importance in causing loss of heat during and after a gaseous explosion, and in determining the heat-flow in a gas engine, does not appear to have been appreciated until quite recently. Prof. Callendar was probably the first to direct attention to its significance in this connection. In the discussion on a paper about explosions, read before the Royal Society in 1906, he said that he had found a non-luminous Bunsen flame to radiate 15 to 20 per cent. of its heat of combustion, and expressed the opinion that the loss from this cause in a closed-vessel explosion would be of the same order.[1]

There are, in fact, several points about the behaviour of gas engines which suggest the importance of radiation as a cooling agent. The particular matter which attracted Callendar's attention was the effect of speed on thermal efficiency. His experiments showed that a part of the loss of efficiency in an internal-combustion motor, as compared with the corresponding air-cycle, was independent of the speed at which the engine was run. The loss of heat per cycle could, to a first approximation, be represented by an expression of the type $A+B/n$, where n is the number of revolutions per minute and A and B are constants. The term A represents a constant loss of heat per explosion, and among the many causes contributing to this constant loss of heat, radiation from the flame is probably important.[2]

Another phenomenon which is difficult to explain, except as the result of radiation, is the effect of strength of mixture on heat-loss. The following table shows some results which were obtained by Hopkinson upon a 40 horse-power gas engine[3]:—

Percentage of gas in cylinder contents	8·5	11·0 per cent.
Total heat-loss per minute	1510	2300 B.Th.U.
Total heat-loss as percentage of total heat-supply	29	34 per cent.
Temperature of piston	300° C.	430° C.

It will be observed that the proportion of heat-loss to the walls increases very materially as the strength of mixture is increased. If the transfer of heat were wholly due to conduction it might be expected, apart from the disturbing influence of speed of ignition, which in this case was not very important, that the percentage of heat-loss would rather diminish with increase of charge, because the temperature with the stronger mixture should be relatively less on account of the increase of volumetric heat. The increased temperature of piston and valves would work in the same direction. The existence of radiation, however, which increases more rapidly in proportion to the temperature, would account for the increased heat-flow. The practical importance of questions of this kind is illustrated by these figures, from which it appears that the piston is 50 per cent. hotter, though the charge of gas is only increased 30 per cent.

More direct evidence of the importance of radiation is furnished by experiments on the effect of the surface of the walls. In the second report of the committee reference was made to the belief, which is widely spread among those who are concerned with the practical design and operation of gas engines that polishing the interior of the

[1] From the Third Report of the British Association Committee, consisting of Sir W. H. Preece (Chairman), Mr. Dugald Clerk and Prof. Bertram Hopkinson (Joint Secretaries), Profs. Bone, Burstall, Callendar, Coker, Dalby, and Dixon, Dr. Glazebrook, Profs. Petavel, Smithells, and Watson, Dr. Harker, Lieut.-Col. Holden, Capt. Sankey and Mr. D. L. Chapman, appointed for the Investigation of Gaseous Explosions, with special reference to Temperature. Presented at the Sheffield meeting of the Association, 1910.

[2] Capt. Sankey has prepared an abstract of papers relating to the Siemens furnace.

[3] "Die Licht- und Wärmestrahlung verbrennender Gase," Robert von Helmholtz. (Berlin, 1890.)

[1] Hopkinson, Proc. Roy. Soc., A. vol. lxxvii., p. 400.

[2] Proc. Inst. Automobile Eng., June, 1907.

[3] Proc. Inst. C.E., vol. clxxvii. (1909).

combustion chamber tends to increase efficiency. Some experiments were also quoted in which it was found that lining an explosion vessel with bright tinfoil perceptibly retarded the cooling of the products. More recently an explosion vessel has been plated with silver on the inner surface, and the results have been compared after exploding identical mixtures, first when the lining was highly polished, and secondly when it was blackened over with lamp-black. It was found that by highly polishing the interior of the vessel the maximum pressure reached could be increased 3 per cent., and the subsequent rate of cooling during its earlier stages reduced by about one-third. These experiments leave no doubt of the reality and of the practical importance of radiation as a factor in determining the heat-loss in the gas engine.[1]

Reference may also be made to the part played by radiation in determining the heat-flow in a boiler. Attention was directed to this by Dalby in a recent report to the Institution of Mechanical Engineers.[2] The circumstances in this case are widely different from those usually obtaining in the gas engine, but the instance serves to emphasise the importance to the engineer of the questions which will be discussed in this report.

Amount of the Radiation from Flame.

R. von Helmholtz appears to have been the first to attempt the accurate measurement of the radiation emitted by a flame. He found that a "solid" flame 6 mm. diameter, burning coal-gas, radiated about 5 per cent. of the total heat of combustion. A carbon monoxide flame radiated about 8 per cent., and a hydrogen flame about 3 per cent. On account of the smallness of the flame his experiments have not much application to the problem of the gas engine. The size of the flame affects the matter in two ways. In the first place, a large flame radiates more per unit of area than a small one, because a flame is to a great extent transparent even to its own radiation, so that radiation is received, not only from molecules at the surface of the flame, but also from those at a depth within it. This matter will be further dealt with in another section of the report. The second point is that the cooling of the gas is slower in a large flame than in a small one. The radiation originates in the vibration of the CO_2 and steam molecules, and the life of one of these molecules as a radiating body extends from the moment of its formation to the time when its vibrational energy has been destroyed by radiation and by collision with colder molecules, such as those of the air surrounding the flame. The smaller the flame the more rapid will be the extinction of the vibrations, and the less, therefore, the total amount of radiation per molecule. The products of explosion in a closed vessel or in a gas engine differ considerably in this respect from any open flame, however large, which it is possible to produce, for they are not subject to cooling by mixture with the outside air. Moreover, the density of the gas is very much greater.

Callendar has repeated some of Helmholtz's experiments on a larger scale, and has found that the radiation in a non-luminous coal-gas flame 30 mm. in diameter may amount to 15 per cent. of the whole heat of combustion. Further reference will be made to Callendar's work under the heading of "transparency."

Hopkinson has recently made measurements of the radiation emitted in the course of an explosion in a closed vessel and subsequent cooling. A bolometer made of blackened platinum strip was placed outside a window of fluorite in the walls of the explosion vessel. The electrical resistance of this bolometer was recorded by means of a reflecting galvanometer throwing a spot of light on a revolving drum, and an optical indicator traced simultaneously a record of the pressure on the same drum. He found that the total heat radiated during an explosion of a 15 per cent. mixture of coal-gas and air, and the subsequent cooling, amounted to more than 22 per cent. of the whole heat of combustion. The radiation which had been received at the moment of maximum pressure amounted to 3 per cent., and it continued, though at a diminishing rate, for a long period. Radiation was still perceptible half a second after maximum pressure, when the gas-temperature had fallen to 1000° C.[1]

[1] Hopkinson, Proc. Roy. Soc., A., vol. lxxxiv. (1910), p. 155.
[2] Proc. Inst. Mech. Eng., October (1909).

Nature and Origin of the Radiation from Flames.

In the gas-engine cylinder and in explosion experiments we are usually concerned with flames in which there is some excess of air. A mixture of similar composition burnt at atmospheric pressure would give an almost non-luminous flame; in the gas engine there is more luminosity on account of the greater density. There is, however, no reason to suppose that the radiation in the gas-engine cylinder differs materially as regards its quality or origin from that emitted by an open flame.

A very complete analysis of the radiation from different kinds of flame was made by Julius, and his experiments leave no doubt that the radiation is almost wholly due to the CO_2 and steam molecules. He examined the spectrum of the flame by means of a rock-salt prism, and he found that in all flames producing both CO_2 and steam most of the radiation was concentrated into two bands, the wave-lengths of which are, respectively, 4·4 μ and 2·8 μ. In a pure hydrogen flame the 4·4 band disappears completely, but the other remains; and in the pure CO flame the 2·8 band disappears, the other remaining. These results are independent of the nature of the combustible gas, the spectrum depending solely on the products of combustion.[2]

A confirmation of the statement that the radiation from these flames originates in the CO_2 and H_2O molecules only was furnished in the course of the work by R. von Helmholtz, to which reference has been made above. He measured the amount of radiation per litre of gas consumed, emitted by flames of given size burning, respectively, hydrogen, carbon monoxide, and certain compound gases, such as methane, giving both CO_2 and steam. The supply of air was adjusted in each case so that the flame was just non-luminous. His results are best given in his own words, but it should be stated that he worked with a small flame about 6 mm. diameter and measured the radiation with a bolometer, taking the steady change of its resistance as a measure of the amount of radiation falling upon it:—

"According to the experiments of Julius described in the first chapter, the *quality* of the radiation of flames depends only on the nature of the burnt and not on that of the burning gases. It is relevant to inquire whether the *quantity* of radiation is also dependent on the mass of the products of combustion. I have calculated in the second and third columns below how many litres of H_2O and CO_2, respectively, arise theoretically from each litre of combustible gas. I then assume that for every litre of water produced as much radiation is sent out as corresponds to the radiating power of a hydrogen flame—for this gas yields one litre of H_2O per litre of combustile—and that in a corresponding way the radiation from one litre of carbonic acid would be determined by the radiating power of the carbonic oxide flame, and I can then calculate the radiation from the non-luminous flames of methane, ethylene, and coal-gas.

	Litres		F	
	H_2O	CO_2	Observed	Calculated
Hydrogen	1	0	74	—
Carbon monoxide ...	0	1	177	—
Marsh gas	2	1	327	325
Ethylene	2	2	510	502
Coal gas...	1·2	0·5	181	179

"The correspondence between the calculated numbers with the radiation from a flame which has just been rendered non-luminous surprised me the more since the latter is conditioned, in some measure, by the volume of air mixed with the gas, and this is very different for the three non-luminous flames. On this account it cannot be asserted that this agreement is not accidental. Moreover, the number of observations is much too small. Nevertheless, the experiment seems worthy of record and will be followed up further."

[1] Proc. Roy. Soc., A., vol. lxxxiv. (1910), p. 155.
[2] "Die Licht- und Wärmestrahlung verbrannter Gase," Dr. W. H. Julius. (Berlin, 1890.)

With regard to the last remarks, it is to be noted that the fact that the flame was just rendered non-luminous shows that the air was in each case in approximately the proportion required for complete combustion. The heating value of such a mixture is much the same for all the gases in the above table, and the temperatures of the flames would be still more nearly the same, the higher heating value of a CO mixture being partly neutralised by the high specific heat of the products. The agreement is certainly more than a coincidence. W. T. David, from a comparison of the radiation emitted in the steam and CO bands, respectively, in a coal-gas and air explosion, infers that CO_2 radiates about 2½ times as much as steam per unit of volume. This result, which was obtained in ignorance of Helmholtz's estimate, agrees with it almost exactly.

Cold CO_2 shows a strong absorption band at the same point of the spectrum as the emission band given by a flame in which CO_2 is produced, and water vapour powerfully absorbs the radiation from a hydrogen flame.

As stated above, it is most probable that the radiation in an explosion also consists almost entirely of the same two bands as are emitted by the Bunsen flame. A complete analysis of the radiation from an explosion has not been made, but Hopkinson and David found, using a recording bolometer, that the radiation is almost completely stopped by a water-cell, and that it is largely stopped by a glass plate. It follows that the luminosity of the flame in an explosion or in a gas engine accounts for but little of the energy which it radiates.

Molecular Theory of Radiation from Gases.

Much difference of opinion exists as to the physical interpretation of the facts described in the preceding sections. The issues in this controversy can conveniently be stated in terms of the molecular theory, and it is therefore desirable to give a short account of this theory. But it will be apparent that the issues are not merely of theoretical interest, but are in large measure issues of fact capable of being tested by experiment, and that the answers to important practical questions may depend on the manner in which they are settled.

According to the kinetic theory, the energy of a gas must be referred partly to translational motion of the molecules as a whole and partly to motions of some sort internal to the molecules. The translational motion is that which causes the pressure of the gas, and in the case of gases for which pv/θ is constant (with which alone we are concerned in this discussion), the translational energy per unit of volume is equal in absolute measure to 1½ times the pressure. This part of the energy may conveniently be called "pressure energy." It amounts to nearly 3 calories per gram molecule, or to 12 feet lb. per cubic foot per degree centigrade.

The other part of the energy produces no external physical effect except radiation, and at ordinary temperatures, when there is no radiation, its existence and amount are inferred from the fact that when work is done or heat put into the gas the corresponding increase in pressure energy amounts to only a fraction of the whole. The internal motions to which this suppressed energy corresponds may be pictured as of a mechanical nature, such as the vibrations of spring-connected masses or as rotation about the centre of gravity of the molecule, but there is not the same reason as exists in the case of the transitional energy for supposing that they are really of this character. They may be, and indeed probably are, electrical phenomena, at any rate in part. Any radiation from the gas must take its origin in this internal motion, and so much of that motion as gives rise to radiation must be of a periodic character and have a frequency equal to that of the radiation emitted. It will be convenient to call the whole energy which is internal to the molecule "atomic energy," and that part of it which gives rise to radiation may be called "vibrational energy." The vibrational energy may be imagined as due to high-frequency vibrations within the molecule, and the rest of the atomic energy as due to slower movements—perhaps rotations of the molecule as a whole—which do not produce any disturbance in the æther. This remaining energy may conveniently be called "rotational," it being understood that the motion to which it corresponds is not necessarily a physical rotation, but is some internal motion which gives no external physical effects.

When the gas is in a steady state the various kinds of energy will bear definite ratios to one another, dependent on the temperature and pressure. It may be expected, however, that after any sudden change of temperature or pressure the gas will not at once reach the steady state of equilibrium corresponding to the new conditions. For instance, it may be that in the rapid compression of a gas the work done goes at first mainly to increasing the translational energy. If in such case the compression be arrested, and if there be no loss of heat, this form of energy will be found in excess; and a certain time, though possibly a very short time, will elapse before the excess is transformed by collisions into atomic energy and the state of equilibrium attained. This change would be manifest as a fall of temperature or of pressure without any change of energy.

If, on the other hand, the gas be heated by combustion, the first effect is undoubtedly an increase in the energy of those molecules, and of those only which have been formed as the result of the combustion; and it is probable that in the first instance the energy of the newly formed molecules is mainly in the atomic form. Before equilibrium can be attained there must be a process of adjustment, in the course of which the energy of the new molecules will be shared in part, with inert molecules, *e.g.* the nitrogen in an air-gas explosion, while the translational form of energy will increase at the expense of the atomic energy. The final state of equilibrium reached will be the same at the same temperature, whether the gas was heated in the first instance by combustion or by compression; the assumption that this is the case is involved in any statement of volumetric heat as a definite physical quantity. The pressure energy in the final state of equilibrium is certainly shared equally between the different kinds of molecules, but the atomic energy is not necessarily equally shared. It is known, for example, that the steam molecules, after an explosion of hydrogen and air, carry, on the average, more energy than the nitrogen molecules, though the pressure energy is the same.

The process of attaining equilibrium after an explosion, which has just been described, would (if heat loss were arrested) result in a rise of temperature, and in the ordinary case of rapid cooling it would retard the cooling. It would, therefore, be indistinguishable as regards pressure or temperature effects from continued combustion or after-burning.

Stated in terms of the molecular theory, the first question as to which there is difference of opinion is whether the radiation from a flame arises from gas which is in equilibrium or whether it comes from molecules which still possess a larger share than they will ultimately (in the equilibrium state) be entitled to of the atomic energy which resulted from their formation. If the products of combustion of a non-luminous Bunsen flame were heated, say, by passing through a hot tube—to the average temperature of the flame (taken to be equal to that of a solid body of moderate extent immersed in it), would they emit substantially the same amount of radiation? In order to clear the ground for the discussion of this question it will be convenient, first, to state two or three points about which there will probably be general agreement. First, there is here no question of the origin of luminosity, for the luminous part of the radiation from the flame possesses practically no energy. Secondly, the radiation, whether in the heated gas or in the flame, arises almost entirely from the compound constituents CO_2 and H_2O; in neither case does any come from the molecules of nitrogen or of excess oxygen. And, thirdly, the powerful absorption of cold CO_2 for the radiation from a CO flame, and of water vapour for that from a hydrogen flame, will probably lead all to admit that these gases when heated will emit *some* radiation of the same type. The only question is, how much?

R. von Helmholtz was of opinion that the radiation in a flame comes mainly from molecules which have just been formed, and which are, therefore, still in a state of vigorous vibration. Pringsheim, Smithells, and others take the same view. This is practically equivalent to saying that this radiation, like the radiation of higher frequency which gives luminosity, is due to chemical action and not to purely thermal causes. On the other hand, Paschen and some others have maintained that the radiation from a flame is purely thermal, or that it arises from gas which has attained the normal or equilibrium state, and is substantially the same as that which would be emitted if the products of combustion were heated.

It will readily be seen that the difference between the two opinions really turns on the question of the time taken by a gas which is not initially in, or has been disturbed from, the equilibrium state to attain that state. All will concede that the CO_2 or steam molecule will radiate more powerfully just after its formation than at any other time. If, as R. von Helmholtz contended, the greater part of the radiation which it gives out in the course of its life is to be ascribed to this early period of its history, we must suppose that that period is sufficiently extended to give time for the emission of a considerable amount of energy with a rate of radiation which, though greater than that of the gas in its ultimate equilibrium state, is at least of the same order of magnitude. In other words, we must suppose that the process, which may indifferently be called attainment of equilibrium or continued chemical action, must go on in the gases as they pass through the flame for a time of the order perhaps of one-tenth of a second. For if it be supposed that equilibrium is reached in an excessively short time, say in 1·1000 second or less, then the radiation, if ascribed to that short period, must be supposed to be of corresponding intensity—there must be a sudden and violent flow of energy by radiation just while combustion is going on, and very little radiation after it is complete. This is, however, negatived by the bolometer measurements made during an explosion, which show that radiation goes on for something like half a second after maximum pressure. Those who hold that the radiation emitted by CO_2 and steam is mainly due to continued combustion must be prepared to admit that such combustion goes on for a long period after the attainment of maximum pressure in an explosion. The issue involved here is, in fact, the same as that in the controversy about "after-burning."

The principal argument advanced by R. von Helmholtz in support of his view is the experimental fact discovered by him that the radiation of a flame is diminished by heating the gas and air before they enter the burner, in spite of the fact that the temperature of the flame must be raised. This he explains by the acceleration of the approach to the state of equilibrium which would be brought about by the more frequent collisions between the newly formed compound molecules and their neighbours.

The question of the velocity with which a gas approaches its normal state after a disturbance has been much discussed in connection with the kinetic theory. Immediately after an explosion we have an extreme case of such a disturbance, the atomic energy being, at any point which the flame has just reached, in considerable excess. The transformation of this energy into the pressure form will proceed at a rate diminishing with the amount remaining to be transformed and, in the final stages of the process at all events, proportional thereto. The slowness of approach to the state of equilibrium may be measured by the time required for the reduction of the untransformed energy in any specified ratio. It is usual to take $1/e$ as this ratio, and, following Maxwell, the corresponding time may be called the "time of relaxation." Estimates of this time, based on the kinetic theory of gases, may be made in various ways, but they all involve hypotheses as to the nature of the action between the molecules, and must be regarded as little more than speculation. It will be well, however, to indicate the general character of the arguments on which they are based. By methods which need not be considered in detail here, it is possible to calculate the number of collisions with its neighbours which the average molecule undergoes per second. This calculation can be approached in various ways, based on different kinds of data, but they all lead to the same result, at any rate as regards order of magnitude, namely, that a molecule of air at normal temperature and pressure collides, on the average, 3×10 times per second with other molecules. At every collision the energy distribution in the colliding molecules is modified, both as regards the manner in which it is shared between the two and the relative proportions due to vibration and translation in either. It is argued that after every molecule has suffered a few thousand collisions, which will happen in a millionth of a second, the gas must have reached a steady average state. This argument would, however, be upset if the interchange of energy as between vibration and translation at each collision were sufficiently small. It is only necessary to suppose that a vibrating molecule loses less than one-thousand millionth part of its vibratory energy at each collision to raise the time of relaxation to something of the order of a second. Any objection to this supposition must be founded on some hypothesis, which cannot be other than entirely speculative, as to the mechanism of a collision. The kinetic theory, therefore, can give no information about the absolute value of the time of relaxation, though it provides valuable suggestions as to the way in which that time is affected by the temperature and density of the gas.

There is plenty of physical evidence, however, that in ordinary circumstances the time of relaxation is excessively short. The phenomena of the propagation of sound shows that compressions and rarefactions of atmospheric air may take place many thousands of times in a second without the gas departing appreciably at any instant from the state of equilibrium. The experiments of Tyndall, in which an intermittent beam of radiant energy directed through the gas caused variations of pressure sufficiently rapid to give sounds, show that the transformation of vibrational into pressure energy under the conditions of his experiments is a process far more rapid than any with which we are accustomed to deal in the gas engine or in the study of gaseous explosions. The departure from equilibrium which follows combustion is, however, of a special kind, and it may be that the gas is slower in recovering from it than when the disturbance is that produced by the propagation of sound at ordinary temperatures.

Transparency.

The radiation from hot gas is complicated by the fact that the gas is to a considerable extent transparent to its own radiation. The radiation emitted, therefore, depends upon the thickness of the layer of gas, instead of being purely a surface phenomenon, as in the case of a solid body. This property, besides being of great physical interest, is important from the point of view of the committee because upon it depends, or may depend, the relative magnitude of radiation losses in engines or explosion vessels of different sizes.

The transparency of flames is well illustrated by some experiments which Prof. Callendar has been making, and which he showed to the committee. The radiation from a Mêker burner (which gives a "solid" flame without inner cone) was measured by means of a Fery pyrometer, the reading of which gives a measure of the radiation transmitted through a small cone intersecting the flame and having its vertex at this point of observation (see Fig. 1). Callendar proposes to give the name "intrinsic radiance" to the radiation of a flame measured in this way, divided by the solid angle of the cone. When a second similar flame was placed behind the first in the line of sight, it was found that the reading recorded by the pyrometer was considerably increased, but not doubled; the first flame appeared to be partly, but not completely, transparent to the radiation emitted by the second. A third flame placed behind the first two contributed a further but smaller addition to the radiation, and as the number of flames in the row was increased the radiation received from each fell off according to an exponential law. The total radiation from the whole row (which is that recorded on the pyrometer) tends to a finite limit as the number of flames is increased. The radiation from a depth of 12 cm. is about half, and that from a depth of 100 cm. is within half per cent. of that emitted by an infinitely great depth.

The general result of Callendar's experiments is to show that flames of a diameter of 3 centimetres or less burning at atmospheric pressure emit radiation approximately in proportion to the volume. If the diameter be increased beyond that figure the radiation will also increase, but not in proportion to the volume of the flame. The radiation from very large flames would tend to become proportional to the surface, but no certain inference as to the diameter of flame for which this would be substantially true can be drawn from Callendar's experiments, because he was looking along a thin row of flames in which there was but little lateral extension.

The flames met with in a gas-engine cylinder or in explosion vessels differ from open flames such as can readily be produced in the laboratory, both in respect of the lateral extension which has just been mentioned and also in respect of density. In both these particulars the difference is rather great, the least dimension of the mass of flame in a gas-engine cylinder being only in the smallest sizes comparable with the diameter of the Mêker burner flame, while the density of the gas just after firing in the gas engine is from twenty to thirty times that of the burner flame gases. It does not seem possible from theoretical considerations to determine the effect of these two factors with sufficient accuracy to enable any quantitative inference as to radiation in the gas engine to be drawn from laboratory experiments on flames, but it is useful to discuss their probable qualitative effects.

In Fig. 1, P is the point of observation at which the pyrometer is placed, as in Callendar's experiments, and the portion of the flame from which the radiation is measured is that intercepted by the small cone. If a second similar flame B is placed behind A at a considerable distance, but so that it is intersected by the cone, then the radiation recorded by the pyrometer will be increased, say, by 50 per cent., showing that of the radiation emitted by B and falling on A 50 per cent. is absorbed and the remainder is transmitted to the pyrometer. The absorbed energy is, of course, not lost, but must result

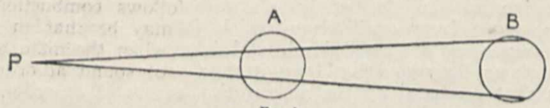

FIG. 1.

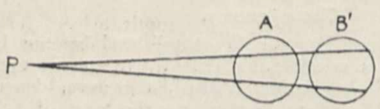

FIG. 2.

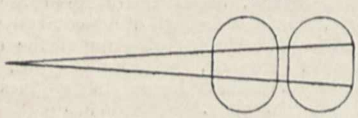

FIG. 3.

in slightly increased radiation from A in all directions. The flame A appears to be a little hotter because of the proximity of B. Thus the increase of radiation absorbed at the pyrometer is due, not only to the radiation transmitted from B, but also to an increase in the intrinsic radiance of A. If the two flames are a considerable distance apart, the latter part is negligibly small, since the flame A does not then receive much radiation from B, and what it does receive is dissipated in every direction. But when flame B is pushed close up to A into the position of B^1 (Fig. 2) this effect may be considerable, and it is obvious that it will be greatly enhanced if the two flames are extended laterally as in Fig. 3. For in such case flame A must get rid of the energy which it is receiving by radiation from B^1, mainly by an enhanced radiation in the direction of P. It may therefore be expected that the effect of lateral extension will be to make the flame apparently more transparent.

To a first approximation it may be expected that the radiating and absorptive powers of a gas at a given temperature will be proportional to its density. That is to say, two geometrically similar masses of flame, in which the temperatures at corresponding points are the same, and the densities in inverse proportion to the volumes (so that the total masses are the same), will radiate in the same way and to the same total amount. It would seem that this must be so, so long as the vibrations of the radiating molecules are the same in character and amplitude in the two cases. For there will then be the same number of molecules vibrating in exactly the same way and arranged in the same way in the two cases. The only difference is in the scale of the arrangement, and this can only affect the matter if the distance between molecules is comparable with the wave-lengths of the radiation emitted, which is not the case. It is only, however, within moderate limits that the molecular vibrations are independent of density. Angström found that the absorption of the radiation from a given source in a tube of CO_2 at ordinary temperature and atmospheric pressure was reduced by increasing the length and diminishing the pressure [1] in the same proportion so as to keep the mass of gas constant. Schäfer found that on increasing the pressure the absorption bands of this gas were widened, so that the curve connecting intensity of radiation and wave-length did not remain of the same shape.[2] These experiments were made at low temperatures, and at the higher temperatures, in which the committee are more particularly interested, there has been but little work. There is no reason to doubt, however, that the character and amount of the radiation from CO_2 and steam at high temperatures will change with the density.

From the point of view of the molecular theory, such a change might be anticipated from either of two causes. An increase of density implies a proportionate increase in the frequency of molecular collisions, and this would result in greater facility of interchange between the translational and atomic types of energy. It is possible that the equilibrium proportion of the two types might be different in consequence. The denser gas may conceivably possess, with a given amount of translational energy, more atomic energy, and therefore radiate more strongly at a given temperature. It is certain that there would be a more rapid attainment of equilibrium in the gas after an explosion or a rapid expansion. Another possible cause is a direct interaction between the molecules, apart from collisions. Two molecules at a sufficient distance apart will vibrate practically independently, each behaving as though the other was not there, except that there will be a tendency for them to vibrate in the same phase. But if the two are close together they react on one another so that the natural period or periods of the two together will not be the same as those which each would have if it were isolated.

Such direct measurements as have been made of the radiation after a closed-vessel explosion suggest that the flame is more transparent than might be inferred from the experiments on open flames. According to information given to the committee by Prof. Hopkinson, W. T. David has found that the radiation received by a bolometer placed outside a fluorite window in the cover of a cylindrical explosion vessel 30 cm. × 30 cm. is greatly increased by highly polishing that portion of the opposite cover which can be "seen" by the bolometer. This implies that a thickness of 30 cm. of flame in these circumstances can transmit much of the radiation which it emits. The density of the gas in this case was atmospheric, and the 30 cm. thickness in the explosion vessel would be equivalent to perhaps 150 cm. of open flame if absorption were simply proportional to density. According to Callendar's experiment, such a thickness would be almost completely opaque. It is possible that the lateral extension is sufficient to account for this result. The open flame should be a cylindrical mass of dimensions 150 cm. × 150 cm., instead of a long strip with a cross-section of 3 cm., in order to make the two cases strictly comparable. It will be remembered that in the discussion above it appeared that the laterally extended flame would seem to be more transparent.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Walsingham medal for 1910 has been awarded to A. V. Hill, of Trinity College. A second medal has been awarded to J. C. F. Fryer, of Gonville and Caius College.

The following have been elected to the Clerk Maxwell scholarship:—R. D. Kleeman and R. T. Beatty, both of Emmanuel College.

At a meeting of the Fitzwilliam Museums syndicate, held

[1] Ark. for Mat. Astron. och Fysik, Stockholm, vol. iv., No. 30, p. 1.
[2] Ann. der Physik, vol. xvi. (1905), p. 93.

on November 29, F. W. Green, of Jesus College, was appointed honorary keeper of the Egyptian antiquities.

OXFORD.—At a Convocation held on December 6, the Vice-Chancellor (Dr. Heberden, Principal of Brasenose) presiding, the honorary degree of doctor of science was conferred on Prof. Meldola, F.R.S., professor of chemistry in the Finsbury Technical College (City and Guilds of London Institute), in anticipation of the Herbert Spencer lecture to be delivered by him on December 8. In making the presentation, the Sedelian professor natural philosophy, Prof. A. E. H. Lowe, F.R.S., delivered the following oration :—

"Adest vir quem omnes, qui scientiae et imprimis Chemiae et Biologiae student, ornare gaudent, Societatis Regalis Sodalis, Societatum Entomologiae, Chemiae, Chemicorum industriae, operam dantium Praeses emeritus, Raphael Meldola. Qui vir cum prima aetate Carolo Darwin coniunctissimus esset, ita de Natura formarum novarum creatrice quaesivit ut plurimis eodem studio incensis illud Biologiae genus quod ipse excoluerat nostratium fere proprium fieret. Posteriora eius studia partim in Physice, partim in Chemia versata sunt, quo e numero si pauca quaedam momenti maximi commemorare liceat, et eligerem quae de Chemia Photographiae inserviente, de chemicis carbonis elementis, de chemica umorum corporalium compositione commentus est. Multos iam annos in hoc Chemiae genere principem habitum atque latissimo in campo evagatum nescio an nemo hunc virum laude superavit."

THE annual prize distribution and students' conversazione of the Northampton Polytechnic Institute, Clerkenwell, E.C., is to be held this evening, December 8. The Right Hon. Lord Alverstone, G.C.M.G., P.C., Lord Chief Justice of England, will distribute the prizes and certificates. Lecturettes will be given by Mr. F. M. Denton on commercial uses of electro-magnets, and Mr. F. Handley Page on how to fly.

DR. EDGAR F. SMITH has been appointed to succeed Dr. C. C. Harrison as provost of the University of Pennsylvania, in which institution he has held a chair of chemistry since 1888. His chief work has been done in electrochemistry, as a list of his principal publications would show. He is a past-president of the American Chemical Society and of the American Philosophical Society. He has also been a member of the U.S. Assay Commission and adviser in chemistry to the Carnegie Institution.

THE annual conversazione of the Royal College of Science and Royal School of Mines will be held on Wednesday, December 21. Both the new and old buildings will be open in Imperial Institute and Exhibition Roads, South Kensington, S.W., and many interesting exhibits will be shown in chemistry, physics, mechanics, metallurgy, mining, botany, and zoology, arranged by the respective scientific societies. During the evening Dr. C. Gilbert Cullis will give a lecture on "Coral Islands."

IT is announced, says *Science*, that Mr. Andrew Carnegie has given a further sum of 300,000*l*. for the construction of buildings of the Carnegie Technical Schools at Pittsburgh. From the same source we learn that by the will of Prof. A. Marshall Elliott the Johns Hopkins University receives his library, and the sum of 400*l*. for the establishment of a scholarship for graduate students; and that the American Museum of Natural History receives 5000*l*. by the will of the late Mr. Charles E. Tilford, of New York City.

STEPS are being taken to inaugurate a Students' Union in connection with Sheffield University. An influential committee, representative of all faculties, has been elected from amongst the members of the Students' Representative Council to proceed with the formation of the union. Sheffield University stands alone amongst the universities of the United Kingdom in not possessing such an institution, and we feel sure that the committee's appeal to members of the University and their friends for contributions to the fund to provide premises where students may be united in the bonds of social intercourse will meet with a generous response. Cheques may be made payable to Mr. H. Khalifa, honorary secretary and treasurer to the Students' Union Committee, The University, Sheffield.

THE Royal Agricultural College, Cirencester, founded in 1845 and reorganised in 1908, is now definitely associated with the University of Bristol for the purpose of instruction in agriculture, forestry, estate management, land surveying, veterinary science, natural history, agricultural chemistry, botany, zoology, and geology, to which other allied subjects may subsequently be added. Instruction given at the college in these subjects to undergraduates will be deemed to be instruction given in and by the University for the purpose of degrees and diplomas in agriculture and forestry. The present principal, Mr. Ainsworth-Davis, is recognised as professor of natural history in the University, and Mr. Drysdale Turner as professor of agriculture, this recognition carrying with it membership of the University Senate. While the association will in no way interfere with the primary work of the Royal Agricultural College, which will still retain its distinctive and time-honoured diploma, a new class of students will come into existence, and an important advance be made in the correlation of agricultural education in the west of England.

UNDER the auspices of the London County Council, another conference of teachers will be held on three days, Thursday, Friday, and Saturday, January 5, 6, and 7, 1911, at Birkbeck College, Bream's Buildings, Chancery Lane, E.C. The programme includes the following subjects, among others:—Thursday, January 5, *Specialisation in Schools*: Addresses by Mrs. Sophie Bryant on the value of specialisation in secondary schools, and F. Bulley on an experiment in specialisation in elementary schools. *Memory*: Addresses by Dr. C. Spearman on the relation of the memory to the will, Dr. E. O. Lewis on some interesting investigations on memory, and Dr. F. H. Hayward on the cultivation of memory. Friday, January 6, *The Teaching of Geography*: Addresses by B. C. Wallis on the teaching of geography in secondary schools, J. Fairgrieve on a practical room for the teaching of geography, and C. J. Rose on open air teaching in geography. Saturday January 7, *Education Experiments in Schools*: Addresses by B. Lewis on a combined scheme of history and geography teaching, E. Thomas on pictorial aids for the teaching of geography and history, A. G. Gawler on how to secure individual work in large classes, J. Greer on an experiment in number teaching, A. E. D. Lowden on stencilling—a valuable form of handwork, and Mrs. Sandford on animals in infants' schools. No charge will be made for admission to the conference. Application for tickets of admission should be made to the Chief Inspector, London County Council, Education Offices, Victoria Embankment, W.C.

BY the passing of the Education (Choice of Employment) Bill into law on the day of dissolution of Parliament, the English and Welsh local education authorities have after a keen controversy been accorded statutory powers to "give boys and girls information, advice, and assistance with respect to the choice of employment." The School Boards of Scotland were put in possession of these powers by the Education (Scotland) Act, 1908, and the School Board of Edinburgh took the lead in making the powers operative. The originator of the conception of a national system of school information and employment bureaux was Mrs. Ogilvie Gordon, D.Sc., who first placed her scheme before the public at the annual meeting of the Glasgow Union of Women Workers, held in March, 1904. The full draft of her scheme was submitted to the President of the Board of Education and to the Secretary for Scotland, and was supported by numerous resolutions passed in its favour at public meetings. It was afterwards published in Mrs. Ogilvie Gordon's "Handbook of Employments" (Aberdeen: Rosemount Press). The aim of the scheme is to bring the teachers' knowledge of the individual boy and girl effectively to bear upon their choice of a future career, and it is based upon the sound economic principle that work on such lines ought to be nationally organised in order to make sure that it should reach every child, and that the work ought to cover all the openings and occupations for our youth—skilled or unskilled, mercantile or personal. By the measure which has at last become law, there is now a prospect of an effective advisory service being organised throughout the country, administered by committees formed under the education authorities, and there should be no difficulty in arrangements being made locally between the labour exchanges and the education authority, so that no actual overlapping of work shall take place, but each be helpful to the other.

THE annual prize distribution of the Sir John Cass Technical Institute was held on Tuesday, November 29, when Sir William Tilden distributed the prizes and delivered an address; the chair was taken by Sir Owen Roberts, chairman of the governing body. Sir William Tilden, after contrasting the conditions available for obtaining scientific instruction now, in such institutions as that of the Sir John Cass, as compared with his own student days, referred especially to the improved character of the teaching, but pointed out that the responsibility for gaining the full benefit of these advantages rested still, as it did in former years, far more with the students than with the teachers. Whilst the business of the teachers was to be regarded as being concerned with the selection of the subjects to be studied rather than their exposition, the real responsibility for progress must always rest with the student. The assimilation of knowledge is the business of the student, and the greatest inducement and stimulus for such assimilation is the desire for knowledge, a desire which is most advantageously associated with a conviction of ignorance. Sir William Tilden further urged the necessity of the thorough understanding of the subjects taught at each stage of progress, and pointed out that students should not look to their teachers for recipes for doing things, but to their own efforts, as the means of acquiring a full understanding of their work, and that they should not omit becoming fully conversant with the history and meaning of the expressions and words employed in their studies. In conclusion, it was pointed out that with every student there are times when the mind should be allowed to relax a little from the pages of their text-books, and that of the many forms of relaxation it was most desirable that all young English men and women should devote some attention and interest to the history of their own country. The exceptional advantages of London, and especially of the City of London, as a stimulant to such study was particularly referred to, for there is nothing more interesting, more absorbing, or more enchanting than the study of the history of mankind, especially that particular variety of mankind which is represented by the Anglo-Saxon race. Sir William Tilden subsequently opened the new chemistry laboratory which has recently been equipped by the governors of the institute.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 24.—Sir Archibald Geikie, K.C.B., president, followed by Mr. A. B. Kempe, vice-president, in the chair.—Sir Norman **Lockyer**: The sequence of chemical forms in stellar spectra.—A. **Mallock**: Influence of viscosity on the stability of the flow of fluids. The effect of this paper is to direct attention to an observation made by the late Mr. W. Froude, F.R.S., with regard to an experiment on fluid jets, and to its application in explaining some of the phenomena presented by the flow of viscous fluids. The experiment referred to was shown by Froude at the British meeting of the British Association in 1875, and one of the deductions drawn from it was that in a viscous flow the character of the stream differed according as to whether the flow was towards decreasing or increasing pressure.—Horace **Lamb**: Atmospheric oscillations. The paper treats of the free oscillations of an atmosphere, the temperature being a function of the altitude, and the adiabatic laws of expansion being assumed. In particular, the case of a uniform temperature gradient is discussed in some detail. The possible oscillations are of various types, of which the most important is of the character of a longitudinal wave. The results are simplest when the equilibrium state is one of convective equilibrium, and the velocity of the longitudinal wave is then equal to the Newtonian velocity of sound, $\sqrt{(gH)}$, corresponding to the temperature of the lowest stratum. The bearing of the results on Kelvin's theory of the semi-diurnal barometric oscillation is examined, and it appears that the existence of a free period of the earth's atmosphere, of somewhat less than twelve mean solar hours, is highly probable. Other types of oscillation depend for their frequency on the degree of stability of the atmosphere, and may in circumstances be comparatively slow. It is possible that these may account for some of the minor fluctuations of the barometer. The paper includes also an examination of the theory of waves at a surface of discontinuity.—P. J. **Kirkby**: A theory of the chemical action of the electric discharge in electrolytic gas and other gases. The complicated results attending the passage of an electric discharge through electrolytic gas, described in previous papers, and in particular the chemical effects observed in the positive columns of long discharges, were explained by the theory that the chemical action is due to molecular dissociation effected by the collisions of gaseous ions constituting the current with the molecules of the gas, the atoms of which are thus set free to enter into new combinations. In this paper an account is given of experiments designed to determine both the number of molecules of water (w) formed by the passage of the atomic charge through 1 cm. of the positive columns of various discharges passed through electrolytic gas ($2H_2+O_2$), and also the electric force (Y) within these columns, the results providing data for testing and developing the theory. The chemical effects of the positive column are attributed to the motion of the electrons alone. The number of atoms of oxygen set free by the collisions of an electron moving through 1 cm. in electrolytic gas at p mm. pressure under the electric force Y is of the form $cpe^{-bp/Y}$, where c, b are certain constants. Hence, if an atom of oxygen can unite directly with a *molecule* of hydrogen, w is proportional to $cpe^{-bp/Y}$. All the experimental results satisfy this condition within error-limits in the particular form $w/p=7\cdot9\,e^{-42\cdot7p/Y}$, and thus support the above theory as well as the hypothesis that water-vapour is formed by the collision of an atom of oxygen with a molecule of hydrogen. This equation involves that the energy of formation of an oxygen molecule is less than, and probably nearly equal to, $6\cdot\times 10^{-12}$ ergs; and experiments of Berthelot upon the heat of transformation of ozone into oxygen are shown to be in fair agreement. An estimate, 7×10^{-12} ergs, is also given for the energy of formation of a molecule of water vapour. These experiments also prove, independently of theory, that dissociated atoms of oxygen are not charged electrically. Similar experiments were made with the gaseous mixture $CO+H_2$. The chemical effects observed in the positive column reproduce the main features observed with electrolytic gas, and are explainable by a similar theory.—G. W. **Walker**: An electrostatic voltmeter for photographic recording of the atmospheric potential. The paper describes some experiments made at Eskdalemuir Observatory with the object of obtaining a simple and efficient voltmeter for continuous photographic registration of the electrical potential at a fixed point in the atmosphere. Experience has shown that occasionally the instrument would require to register up to fully 1000 volts + or −. Satisfactory results have been obtained by means of a Dolezalek electrometer. The usual sensitiveness was greatly reduced by using a phosphor-bronze suspension, while the needle was loaded to prevent tilting. A fixed difference of potential is applied between the quadrants by means of one or two standard cadmium cells, while the potential to be measured is applied to the needle. The needle can now carry 1100 volts with perfect safety and stability, while the scale value on the paper is constant to within a few per cent. over a range from −900 to +900 volts. Trial has been made of a voltmeter (made in the workshop) similar in general design to the Dolezalek, but in which the fixed difference of potential between the quadrants is provided by making the quadrants alternately of copper and zinc soldered together and not insulated. Uniformity of scale value has been obtained from about −500 to +500 volts, but for higher potentials only approximate uniformity was secured. This defect arises from want of mechanical perfection of the quadrants and needle, and should disappear in an instrument made with the same accuracy as the Dolezalek. At present, also, the damping of the needle during very rapid changes of potential is insufficient. Reference is made to certain points in the manipulation of sulphur for insulating, which have been found essential to secure good results.—Dr. T. H. **Havelock**: Optical dispersion: an analysis of its actual dependence upon physical conditions. The paper is based upon a generalised dispersion formula

$$\frac{1}{\sigma + 1/(n^2 - 1)} \cdot \frac{1}{P} = \Sigma \frac{c_s}{\lambda^2 - \lambda^2_s}$$

where P is the density of the medium. The quantities c_s and λ_s refer to natural vibrations inherent in the molecule, and it is assumed that these are not changed by varying physical conditions, such as temperature, pressure, or density; thus an attempt is made to express these conditions in their optical effect by two variables, P and σ, The scheme is tested first by a relation deduced from the above formula, namely, the difference in value of $P/(n^2 - 1)$ for any two physical conditions of the same substance is constant in regard to wave-length. From an examination of available data this appears to be satisfied approximately for gases and liquids and for changes from gas to liquid. Numerical values of σ for various substances in different conditions are obtained by assigning it zero value for the gaseous condition at normal pressure and temperature. Artificial double refraction is included in the same formal scheme by allowing anisotropic changes of the quantity σ. Finally, for dispersion formulæ of the above type an observed maximum of absorption (or of selective reflection) is identified, not with λ_s, but with a wave-length λ'_s, differing from λ_s by a term involving P and σ; numerical examples are given for rock-salt and fluorite. The wave-lengths λ'_s are calculated under various conditions for certain substances; experimental data are analysed to show the pressure-displacement for air and the temperature-displacement of absorption maxima for water and carbon disulphide.—C. P. **Butler**: The spectrum of Halley's comet. Provision was made for photographing the comet and its spectrum from the beginning of May at Fosterdown, Caterham. Exceptionally bad weather prevented observations until the end of the month, when photographs and visual observations of the spectrum were obtained on May 23 and 26. The photographs of the comet taken with a Dallmeyer lens, 6 inches aperture, 50 inches focus, show that the nucleus was at times multiple. Visual observations of the nucleus showed strong continuous spectrum with three bands in the yellow-green, green, and greenish-blue, having approximate wave-lengths 5635 (int. 7), 5165 (int. 10), 4737 (int. 7). The spectrum of the coma surrounding the nucleus consisted of these same three bands, without any indication of continuous radiation. The photographic spectra show only the brightest spectra features of the spectrum of the nucleus, the relative intensities differing widely from the visual intensities owing to the selective sensitiveness of the plates. The two most conspicuous bands are near λ 4737 (int. 10) and 3884 (int. 6), with fainter bands near $\lambda\lambda$ 4050, 4360, 5165, and 5635. Photographs obtained elsewhere at different times show differences in the relative intensities of the component bands. This has been ascribed to variations of atmospheric absorption. It may be noted, however, that before and after the transit of May 19 the aspect of the head would vary quickly; at one time the hotter side facing the sun would be best seen, at others the cooler portions away from the sun would be more prominent. Preliminary experiments show that by varying conditions of vaporisation the relative intensities of the carbon or hydrogen bands may be considerably modified, and it would appear that the changes observed in the cometary spectrum might be produced by some such difference of condition.—Dr. H. F. **Baker**: A geometrical proof of the theorem of a double six of straight lines.

EDINBURGH.

Royal Society, November 7.—Prof. Crum Brown, vice-president, in the chair.—J. D. Hamilton **Dickson**: A thermoelectric diagram from $-200°$ to $+100°$ C., based on the experiments of Sir James Dewar and Prof. Fleming. The platinum temperatures were first reduced to absolute scale. The observations of the electromotive force of each metal-lead couple were plotted against temperature, and the curves were drawn freehand with the greatest care through them. By finding the locus of the middle points of parallel chords, Mr. Dickson proved that the curves were all, with one exception, parabolas. The exception was in the case of antimony-lead, for which the curve was a hyperbola. In the majority of cases the parabolas differed from those obtained by Tait through the more limited range of temperature used by him and his students in the main fact that their axes were not perpendicular to the temperature axis. The "Tait lines," as it was convenient to name the lines of thermoelectric power, were not in these straight, although limited portions of them might be very nearly so. As was easily proved from the geometry of the parabola with inclined axis, each Tait line was a curve with two asymptotes perpendicular to one another. Of the metals investigated, gold, silver, zinc, and German silver followed Tait's rule, the thermoelectric powers referred to the lead line giving straight lines; but platinum, copper, cadmium, nickel, manganese, palladium, and aluminium gave for their electromotive-force curves parabolas with inclined axes. Similar results were obtained from recent observations published by Holborn and Wien, Barus, and from early observations by J. Murray and J. C. Young, working under Tait's directions.—Profs. Alex. **Smith** and A. W. C. **Menzies**: A dynamic method for measuring vapour pressures, with its application to benzene and ammonium chloride. A modified form of the isoteniscope, previously described, was used in determining the vapour pressures of these substances. The advantages of the new form of apparatus were that it could be used for high pressures, that the confining fluid could be reduced in amount, and that the thermometer was inserted directly in the bath with its bulb no longer in a region of varying pressure.—Profs. Alex. **Smith** and W. C. **Menzies**: A quantitative study of the constitution of calomel vapour. The object of the investigation was to find to what extent the vapour of calomel was dissociated, and the method was to measure the vapour pressures by means of the isoteniscope at various temperatures from 360° C. to 400° C. The results showed (1) that the vapour of calomel was composed wholly of mercury and corrosive sublimate, HgCl and HgCl being alike absent; (2) that calomel dissolves in mercury with a molecular weight corresponding to the formula HgCl; (3) that the isoteniscope may be used in the quantitative investigation of chemical problems.—Dr. R. A. **Houston**: The efficiency of metallic filament lamps. The results were obtained by means of a new method involving the examination with a thermopile and very sensitive galvanometer of the spectrum of the radiation transmitted by a water filter. The values obtained for the efficiencies of carbon, osmium, tantalum, and tungsten lamps as energy transformers were respectively 2·9, 5·2, 6·5, and 7·5 per cent.

PARIS.

Academy of Sciences, November 21.—M. Émile Picard in the chair.—H. Lorentz was elected a foreign associate in the place of the late Prof. Schiaparelli.—Lord Avebury was elected a correspondant for the section of anatomy and zoology, in the place of Sir Ray Lankester, elected foreign associate.—G. **Fayet**: The identity of the Cerulli comet with the Faye comet. The elements calculated for the two comets are nearly identical, the slight difference noted being probably due to the fact that the considerable disturbance of the orbit of the Faye comet caused by Jupiter in 1899 was only approximately allowed for.—C. **Popovici**: Observation of the Cerulli-Faye comet. Data are given for November 22.—G. **Tzitzéica**: A theorem of M. Darboux.—W. **Stekloff**: A new application of the method of development of fundamental functions.—Paul **Lévy**: The integrability of the equations defining line functions.—G. **Eiffel**: The resistance of rectangular planes struck obliquely by the wind. Experiments were carried out with a suction fan, using a 70 horse-power motor, giving an air current of 10 to 20 metres per second in a tube of 1·5 metres diameter. The results are given graphically in a series of curves.—Jean **Becquerel**: The reversal of the phosphorescence bands. Rubies and an emerald were used for these experiments at the temperature of liquid air. The reversal establishes a qualitative relation between the emission and absorption, and some quantitative relations are worked out.—R. **Jouaust**: The magnetic properties of iron at high frequencies. The iron was used in sheet form, the alternating current, produced by a Poulsen arc, having a frequency of 150,000 per second. The losses observed are 20 per cent. higher than those calculated from J. J. Thomson's formula.—Frédéric **Reverdin** and Armand **de Luc**: The comparative nitration of mono- and dialkylated amines.—L. H. **Philippe**: The glucodeconic acids. The author has extended E. Fischer's synthesis of gluconose to the next higher homologue, glucodecose. In the present paper the preparation and properties of the glucodeconic acids are described.—G. **Friedel** and F. **Grandjean**: Anisotropic liquids. A discussion of the meaning of some experiments recently described by M. Mauguin on the optical properties of azoxyphenetol. The authors regard the term *anisotropic liquids* as being preferable to *liquid crystals*. Marin **Molliard**: The mode of action of the intensity of illumination in the formation of cleistomamic flowers.—P. A. **Dangeard**: A marine alga from the Concarneau Laboratory.—M. **Ringelmann**: Experiments on the yield of juice from the cider press.—Armand **Dehorne**: The coexistence of division and a subdivision of chromosomes in a quiescent state.—Paul **de Beauchamp**: A new gregarian of the genus Porospora.—A. **Gruvel**: The lampreys of the western coast of Africa and their commercial possibilities.—J. **Chatanay**: A remarkable anomaly of *Zonabris variabilis v. Sturmi*.—A. **Fernbach**: The biological degradation of the carbohydrates. Macerations of *Tyrothrix tenuis* act upon starch, maltose, dextrose, or saccharine, and dioxyacetone, glyceric aldehyde, and methylglyoxal have been recognised among the products of the reaction. Formaldehyde and acetaldehyde are also produced by this organism.—J. **Effront**: The action of the Bulgarian ferment upon proteid and amido substances. The Bulgarian ferment rapidly destroys albuminoid material, removing the nitrogen in the form of ammonia, and it is possible that the favourable action of the ferment in gastro-intestinal affections is due to this action instead of to the production of lactic acid.—P. **Chaussée**: The production of primitive thoracic tuberculosis in cattle by the inhalation of infinitesimal amounts of bovine tuberculous material. These experiments prove the possibility of direct infection of the lungs by the inhalation of minute proportions of tuberculous material. In all the cases the mesenteric and cervical ganglia were examined for tubercular infection with negative results.—Jacques **Deprat**: Seismic activity in southern Yun-nan in 1909.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 8.

ROYAL SOCIETY, at 4.30.—Colour-blindness and the Trichromatic Theory. Part II. Incomplete Red or Green Blindness: Sir W. de W. Abney, K.C.B., F.R.S.—On the Sensibility of the Eye to Variations of Wavelength in the Yellow Region of the Spectrum: Lord Rayleigh, O.M., F.R.S.—(1) Trypanosome Diseases of Domestic Animals in Uganda. IV. *Trypanosoma uniforme*, sp. nov.; (2) Trypanosome Diseases of Domestic Animals in Uganda. V. *Trypanosoma nanum*. (Laveran): Colonel Sir D. Bruce, C.B., F.R.S., and others.—Some Enumerative Studies on Malarial Fever: Major R. Ross, C.B., F.R.S., and D. Thomson.—On Hæmoglobin Metabolism in Malarial Fever: G. C. E. Simpson.—A Case of Sleeping Sickness studied by precise Enumerative Methods. Further Observations: Major R. Ross, C.B., F.R.S., and D. Thomson.—Enumerative Studies on *Trypanosoma gambiense* and *Trypanosoma rhodiense* in Rats, Guinea-pigs, and Rabbits; Periodic Variations disclosed: Dr. H. B. Fantham and J. G. Thomson.—The Life History of *Trypanosoma gambiense* and *Trypanosoma rhodiense* as seen in Rats and Guinea-pigs: Dr. H. B. Fantham.—Experiments on the Treatment of Animals infected with Trypanosomes, by means of Atoxyl, Vaccines, Cold, X-rays, and Leucocytic Extract; Enumerative Methods employed: Major R. Ross, C.B., F.R.S., and J. G. Thomson.

MATHEMATICAL SOCIETY, at 5.30.—(1) Properties of Logarithmico-exponential Functions; (2) Some Results concerning the Increase of Functions defined by an Algebraic Differential Equation of the First Degree: G. H. Hardy.—Optical Geometry of Motion: A. A. Robb.—(1) Note on the Pellian Equation; (2) A Property of the Number 7: T. C. Lewis.—On the Arithmetical Theory of Binary Cubic Forms: G. B. Mathews.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Magnetic Properties of Iron and its Alloys in Intense Fields: Sir R. Hadfield, F.R.S., and Prof. B. Hopkinson, F.R.S.

FRIDAY, DECEMBER 9.

ROYAL ASTRONOMICAL SOCIETY, at 5.—The Determination of Selenographic Positions and the Measurement of Lunar Photographs. Fifth Paper: Results of the Measurement of Two Yerkes Negatives: S. A. Saunders.—Note on an Erroneous Formula employed in the Tables of the Four Great Satellites of Jupiter: R. A. Sampson.—On the Accuracy of the Positions of the Star Images in the "Harvard Sky": H. H. Turner.—On Multiple Solutions in the Determination of Orbits from Three Observations: C. V. L. Charlier.—Occultations of Stars observed during the Eclipse of the Moon, Nov. 16, 1910: Cambridge Observatory.—The Equatorial Current of Jupiter in 1886: A. Stanley Williams.—(1) Photographic and Visual Observations of Halley's Comet (1909*c*), Daniel's Comet (1909*e*), and Comet 1910*a*, made at the Radcliffe Observatory, Oxford; (2) Observations of Stars Occulted by the Moon during the Eclipse of Nov. 16, 1910, at the Radcliffe Observatory, Oxford: A. A. Rambant.

ILLUMINATING ENGINEERING SOCIETY, at 8.—Recent Progress in Electric Lighting: Prof. E. W. Marchant.

MONDAY, DECEMBER 12.

ROYAL SOCIETY OF ARTS, at 8.—Industrial Pyrometry: C. R. Darling.

TUESDAY, DECEMBER 13.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Some Unexplored Routes between Angora and Eregli: R. Campbell Thompson.

ZOOLOGICAL SOCIETY, at 8.30.—Report of the International Commission on Zoological Nomenclature presented to the Graz Meeting of the International Zoological Congress, 1910: Dr. W. E. Hoyle.—On the Segmentation of the Occipital Region of the Head in the Batrachia Urodela: E. S. Goodrich, F.R.S.—On the Structure and Function of the Gas-glands and Retia Mirabilia associated with the Gas-bladder of some Teleostean Fishes, with notes on the Teleost Pancreas: Dr. W. N. F. Woodland.—The Mammals of the Tenth Edition of Linnæus: an attempt to fix the Types of the Genera and the exact Bases and Localities of the Species: Oldfield Thomas, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further discussion*: Portland Cement, and the Question of its Aëration: H. K. G. Bamber.

FARADAY SOCIETY, at 8.—Separation of Oxygen by Cold: J. Swinburne, F.R.S.—New Apparatus for the Rapid Electro-analytical Determination of Metals: Dr. H. J. S. Sand and W. M. Smalley.

WEDNESDAY, DECEMBER 14.

ROYAL SOCIETY OF ARTS, at 8.—A New View of Roman London: Reginald A. Smith.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Some Recent Developments in Condensing Plant: G. L. Kothny.

THURSDAY, DECEMBER 15.

LINNEAN SOCIETY, at 8.—Reports on the International Botanical Congress at Brussels, 1910: Dr. Otto Stapf, F.R.S., and others.—Non-calcareous Sponges from the Red Sea, collected by Mr. Cyril Crossland: R. W. H. Row.—Comparative Anatomy of Leaves of Veronica: R. S. Adamson.

ROYAL SOCIETY OF ARTS, at 4.30.—The Taj Mahal and its Relation to Indian Architecture: R. F. Chisholm.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Submarine Cables for Long Distance Telephone Circuits: Major W. A. J. O'Meara, C.M.G.

FRIDAY, DECEMBER 16.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Production of Castings to withstand High Pressures: Prof. H. C. H. Carpenter and C. A. Edwards.—The Constitution of Troostite and the Tempering of Steel: Andrew McCance.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Mathematical Deduction of the most Economical Ratio of Reinforcement for Reinforced-concrete Structures: R. N. Mirza.

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