THURSDAY, FEBRUARY 15, 1912.

THE PHILOSOPHY OF SCIENCE.

(1) *Natural Philosophy.* By W. Ostwald. Translated by T. Seltzer. Pp. ix+193. (New York: Henry Holt and Co.; London: Williams and Norgate, 1910.) Price 1 dollar net.

(2) *Prolegomena zur Naturphilosophie.* By Hermann Graf Keyserling. Pp. xii+159. (München: J. F. Lehmann's Verlag, 1910.) Price 5 marks.

(1) READERS of German will remember that Prof. Ostwald published as the first volume of Reclam's series, "Bücher der Naturwissenschaft," a book which is practically a popular summary of his larger "Vorlesungen über Naturphilosophie." This little work, after special revision by the author, now appears in an American edition. Mr. Seltzer's translation is generally satisfactory, though he has left, here and there, an obscurity of diction which it is difficult to charge to the account of so clear a writer as his original.

A book in which an investigator of Ostwald's eminence gives in systematic outline his views on the aims, nature, and general methods of science is bound to exercise considerable authority over the opinions of young students and inquiring laymen. It is, therefore, a matter of considerable importance to determine whether his guidance in these subjects may be recommended with confidence. In spite of great admiration for the genius of the distinguished chemist, the reviewer is bound to record on this point an unfavourable opinion. It would be absurd to deny that the book has value. The practical wisdom and inspiration of a successful man of science inform many of its pages, and may gladly be accepted in lieu of a good deal of correctitude in logic and philosophy. Moreover, Prof. Ostwald's characteristic doctrine of "energetics" leads him in a very direct way to results —such as the limited validity of the concept of mechanism—which, though unpopular among physicists and chemists, are regarded as of great importance by all students of the philosophy of science. But outside the thirty-six pages given to the general principles of the physical sciences, the treatment of his topics seems frequently unsatisfactory. His logical and psychological analyses lack precision and thoroughness, and often suggest that on some questions of fundamental importance he accepts the views of the Mill and Spencer epoch as finally authoritative.

The pragmatism which made Prof. Ostwald's work so interesting to the late William James appears very early in the book. Strictly speaking, science is, he holds, concerned only with the prediction of future events. The "retrospective prophecy" to which Huxley attached equal importance "must take its place with other aimless activities called *play*" (p. 13). Moreover (as the last phrase indicates) even predictions of the future are not properly to be called science unless they bear directly or remotely upon the practical management of human life. At first sight this dictum would seem to confine the legitimate development of some sciences within severely narrow limits. For example, must the palæontologist prove that his studies have a bearing (say) upon eugenics before he can be admitted into the company of men of science? In anticipation of such questions, the author is obliged to argue that since we can never know completely "what kind of knowledge we shall next need . . . therefore it is one of the most important functions of science to achieve as *perfect* an elaboration as possible of *all* the relations conceivable." Thus, judged by the pragmatic test of "alikeness" upon which Prof. Ostwald lays so much stress (p. 52), his definition of the aim and scope of scientific inquiry turns out after all to be identical with the intellectualist view upon which he is so severe (p. 13).

Prof. Ostwald's preoccupation with the practical value of science—though a fault which leans to virtue's side—makes him cling to an empiricism which is, to say the least, *démodé*. In spite of an (apparently) wider definition on p. 62, the word "experience" is constantly used as synonymous with "perceive" or "perception." Concepts are simply the "coinciding or repeated parts of similar experiences"—a view which seems identical with Huxley's "composite photograph" theory of general ideas, and is open to the same criticisms. It follows that the degree of certainty reached in reasoning depends upon the number of perceptual experiences upon which the concepts are based. Thus the security of the conclusion $2+3=5$ is extremely high because the number-concepts are so extremely "general."

Starting in this way, it is not surprising that Prof. Ostwald repeats Mill's misunderstanding of the syllogism (p. 65), and restricts deduction to the comparatively small *rôle* of applying "principles . . . acquired through the ordinary incomplete induction . . . to special instances which, at the proposition of the principle, had not been taken into consideration" (p. 41). It is difficult to regard this as an adequate statement of the aim of Newton's "Principia," or of Maxwell's "Electricity and Magnetism"; yet both these treatises must be held to give a "deductive" treatment of their subject-matter. So anxious is the author to reduce all knowledge to repeated "experiences" that he holds mathematics to have been proved to be an empirical science by the fact that certain laws in the theory of numbers have been found empirically and have not yet been proved deductively (p. 56). The same ultra-empiricism seems responsible for the remarkable statement (p. 76) that the power of "a few highly developed individuals," such as Julius Cæsar, to "keep up several lines of thought" simultaneously proves that time is not necessarily to be conceived as unidimensional.

It will be seen that, in the reviewer's opinion, Prof. Ostwald's work suffers from the capital defect of misrepresenting seriously the relations between ideas and perceptual experience. It is true that no one has yet formulated an adequate account of these relations. Nevertheless no theory of science can be satisfactory unless it takes account, on one hand, of the criticisms of the inductive process which we owe to such logicians as Bradley and Bosanquet, and, on the other, of the patient, unbiassed, and penetrating researches concerning the objects of cognitive processes which we associate with the names of Husserl, Meinong, Bertrand Russell, and others. Although he makes good use of modern views about mathematics which have a certain connection with the latter researches, yet Prof. Ostwald, from lack of sympathy or for some other reason, appears to have assimilated very little from these typically modern doctrines about the fundamentals of his subject.

(2) In his familiarity with the present situation in logical criticism and philosophy, Graf Keyserling has a manifest advantage over his scientific compatriot. For this reason the six discourses which form his latest work offer most instructive as well as attractive reading even to those who cannot accept all his contentions. He sees with perfect clearness that the central question of natural philosophy is the question how conceptual thought is related to perceptual experience—in other words, how it is that we are able to theorise successfully. To understand the problem aright we must recognise that theories deal in the first place with entities—"universals," relations, numbers, &c.—which are distinct from the entities revealed to us in physical phenomena, and yet are really quite as external to our minds, quite as "objective" as the latter. Conversely, the phenomena commonly called external are known just as immediately and as truly as the objects of thought. It follows that the *a priori* laws which regulate our "inner" experience are entitled to be called "laws of nature" equally with the sequences determined *a posteriori* among "outer" experiences. A mind capable of taking in the universe at a glance would, in fact, see, not two worlds, but one world of reality, the elements of which are knit together by a univocal necessity.

This conception of the universe admitted, it is possible to understand that perpetual miracle—the power of "prospective and retrospective prophecy" wielded by the man of science. Consider one of the most notable instances: the power to predict and reconstruct phenomena by means of Newton's laws of motion. Since mathematical thought and the spatio-temporal series of external events run their courses under a single system of laws, it is always possible that in a given instance the mathematical realities and the empirical will, to use Graf Keyserling's word (p. 44), "coincide." Suppose this relation to hold good between Newton's laws and a group of mechanical events. Then whatever consequences follow by "logical" necessity from Newton's laws must be exhibited empirically; nature is bound, so to speak, to actualise this particular series of possibilities (p. 44). This account of the matter explains why induction does *not* (as the empiricists contend) involve essentially the contemplation of numerous instances. The essence of the process is (as Prof. Bosanquet and other writers have urged) the analysis of a given phenomenon with the view of discovering the "mathematical realities" which "coincide" with the empirical observations. If the details of the coincidence can be brought to light by the examination even of a single instance predictions based upon such an examination may have the highest certainty.

It is not possible to follow here the important consequences of Graf Keyserling's views. It must suffice to say that he develops them with great ability and in a very interesting way. He finds occasion to offer illuminating criticism of the pragmatists and of writers whose works are now the centre of much attention—for example, Hans Driesch and Henri Bergson. It is not extravagant to say that by his understanding of the problems and methods, both of philosophy and of science, his lucidity and his literary charm, he produces in no mean degree the same impression as the great Frenchman. The book is one which should find a welcome in an English translation.

T. P. NUNN.

TWO INTRODUCTIONS TO THE STUDY OF EVOLUTION.

(1) *The Doctrine of Evolution: its Basis and its Scope.* By Prof. H. E. Crampton. Pp. ix+311. (New York: The Columbia University Press, 1911.) Price 6*s*. 6*d*. net.

(2) *Einführung in die Deszendenztheorie.* Fünfunddreissig Vorträge. By Prof. Karl C. Schneider. Zweite Auflage. Pp. xii+386+3 Taf. (Jena: Gustav Fischer, 1911.) Price 9.50 marks.

(1) PROF. CRAMPTON has written a careful and interesting introduction to the study of evolution in the wide sense. It consists of eight lectures given in New York to "mature persons of cultivated minds, but who were on the whole quite unfamiliar with the technical facts of natural history," and for such an audience, which is certainly widespread, the book can be strongly recommended. But even those who know a good deal of natural history may read Prof. Crampton's lectures with great profit, for although they have not perhaps the keenness which marked the author's important contribution to the theory of natural selection (his study of *Philosamia cynthia*), they are characterised by scientific restraint, by careful workmanship, and by a wide outlook. The outstanding feature of the book is that half of it is devoted to the higher reaches of the evolution-process—to the ascent of man and the establishment of human societies.

After an introductory discourse on the living organism, Prof. Crampton sets forth the evidences of evolution from comparative anatomy, embryology, and palæontology. The fourth lecture is on "Evolution as a Natural Process," and here the author avoids controversy, contenting himself with a balanced statement of the various interpretations that have been offered. He then passes to the evolution of the human species and the human races, to mental evolution, and to social evolution. These three chapters are full of fresh illustrations of great interest. The book ends up with a courageous chapter on those "evolved products" which we call (1) ethics, (2) religion and theology, and (3) science and philosophy, the author's particular point being that here also evolution proves to be real. Not only are the higher elements in human life subject to analysis, classification, and formulation, but there are natural reasons in human evolution why there should be a developing ethics, religion, theology, science, and philosophy. The author ends up finely with a statement of the practical value of evolutionist conceptions:—

"The doctrine of evolution enjoins us to learn the rules of the great game of life which we must play, as science reveals them to us. It is well to remember that a little knowledge is a dangerous thing, but because evolution is true always and everywhere, an understanding of its workings in any department of thought and life clears the vision of other realms of knowledge and action. . . . Evolution as a complete doctrine commands everyone to live a life of service as full as hereditary endowments and surrounding circumstances will permit."

After reading this admirable course of lectures, one general criticism arises in our mind—one, however, involving for its statement a longer discussion than is possible here and now. It appears to us that the author has not sufficiently analysed his "deeply grounded conviction that evolution has been continuous throughout." We wish to know more about this continuity—what it is that is continuous, and whether the continuity implies that there is an identity of causes throughout. The genetic method is certainly applicable, but do the same categories serve throughout? Is the truth with Spencer or with Bergson? It seems to us to be giving a false simplicity to the facts to conclude that "human social relations are biological relations," or that "identical biological laws, uniform in their operation everywhere in the organic world, have controlled the origin and establishment of even the most complex societies of men." It seems to us a matter for regret that a zoologist of Prof. Crampton's eminence should adopt, especially in a work of this sort, the mechanistic hypothesis without giving a statement of the other side. We are unaware that a mechanical description has been given of any complete vital operation, and if it were given we do not think that it would be what the biologist wants, for he cannot get away from the fact that the organism is a historical being.

We are only stating our opinion, but we think there is need for reconsidering, even in the light of other parts of the book, such a deliverance as this:—

"Does science teach us, then, that the ultimate elements of human faculty are carbon-*ness* and hydrogen-*ness* and oxygen-*ness*, which in themselves are not mind, but which when they are combined, and when such chemical atoms exist in protoplasm, constitute mental powers? Plain common-sense answers in the affirmative."

And this:—

"What can be the source of mentality, if it is not something brought in from the outer world along with the chemical substances which taken singly are devoid of mind? Scientific monism frankly replies that it is unable to find another origin."

Such a presentation of the old problem seems to us disappointing, especially when it comes from the country of William James and Josiah Royce.

(2) Prof. Schneider has prepared an enlarged edition of an admirable book which was reviewed in NATURE of January 10, 1907. It then consisted of six lectures introductory to the study of organic evolution, and was marked by clearness and freshness of exposition. It had also the crowning merit of being short, and was a pleasing contrast to a number of larger books of similar aim, which take a longer time to say less. In its new edition, however, it has surrendered the charm of brevity in the hope of securing other excellencies. It has become thirty-five lectures instead of six, and each lecture occupies about ten closely printed pages. What are the features of this practically new book, which, it may be noted, is not to be confused with the author's "Versuch einer Begründung der Deszendenztheorie"?

Perhaps the chief characteristic is the elaboration of the concept of "Anlagen" or primordia. The common way of looking at these as simply material structures will not stand criticism. In place of the view that morphogenetic differentiation may be interpreted in terms of the chemico-physical properties of the primordia, Schneider seeks to substitute a rehabilitation of the "idea-theory" of Plato and Goethe, with which he combines the Aristotelian-Scholastic concept of potency, "elaborated in a modern exact fashion." Another feature of the book is a judicious eclecticism. For while there is much that is personal and original throughout, such as the author's theory of vitalism, his welcome, but all too short, discussion of the importance of periodicity, his criticism of the ordinary Darwinian position, and so on, there is a praiseworthy attempt to recognise a measure of validity in the suggestions of the various schools. He pleads for less purely argumentative criticism, for a deeper inquiry into fundamental principles, for a study of biological method, and for more determined effort to get away from preconceptions which influence even the experimenters. The Lamarckian, he says, will not hear of mutations, and the Mutationist will not hear of modifications. The Darwinist rejects the psychical theory of adaptations, and the psycho-Lamarckian rejects determinants. The student of chromosomes does away with Anlagen, the "Orthogenetiker" with adaptations, the vitalist of Driesch's persuasion with vital energy, the Weismannist with the transmission of acquired characters, the Mechanist with all vitalistic principles, and so on. But all these views have factual relations, and there is a kernel of truth in each. They cannot be lumped together, but no view is as yet complete enough to dispense with the aid of others. Cooperation as well as criticism is needed among the evolutionists.

In his sketch of the evolutionism of the future, Prof. Schneider distinguishes primary or constitutive principles and secondary or auxiliary principles. The primary principles are three:—(1) The idea, which interpenetrates every organism and binds it into unity; (2) entelechy, which is "a kind of cohesion in the idea," holding the constellation of Anlagen in a specific order, a correlating, regulative, formative principle; and (3) vitality, a form of energy, like heat in the inorganic realm, which brings into material explicitness what is implicit in the idea, and includes two main factors, of assimilation, growth, and reproduction on one hand, of variation on the other.

The secondary or auxiliary principles, which represent a complication of the primary simplicity of idea, entelechy, and vitality, are of two kinds, ectogenous and endogenous. The ectogenous principles operate from without; they do not originate within the organism. They include the influence of environmental changes on assimilation and the like, and the influence of psychical impulses and needs relating to the external conditions of life. In both these ways a "somation" (corresponding to a somatic modification of most authors) may arise; it is an ectogenous change in contrast to an autonomous mutation. The endogenous secondary principles, which are also called entropic, include amphimixis and death.

THEORETICAL AND PRACTICAL PHYSICS.

(1) *A Text-book of the Principles of Physics.* By Dr. A. Daniell. New and revised edition. Pp. xxv+819. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1911.) Price 17*s.* net.

(2) *A Textbook of Physics.* By Prof. L. B. Spinney. Pp. xii+605. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1911.) Price 12*s.* net.

(3) *Principles of Physics: Designed for Use as a Text-book of General Physics.* By Prof. W. F. Magie. Pp. ix+570. (London: G. Bell and Sons, Ltd., 1911.) Price 7*s.* 6*d.* net.

(4) *Treatise on Practical Light.* By Dr. R. S. Clay. Pp. xv+519. (London: Macmillan and Co., Ltd., 1911.) Price 10*s.* 6*d.* net.

(1) IT is presumably the duty of a reviewer to try in reading a text-book to take up the point of view of the students for whom it is primarily designed. This attitude it is not at all easy in many cases to assume. But the third edition of Dr. Daniell's text-book scarcely admits of doubt in this respect. Regarded from a purely physical point of view, the book undoubtedly contains much useful information, notwithstanding the fact that it is presented in a peculiarly disjointed fashion. But to propose it as being suitable for medical students seems very misleading. Those who are experienced in teaching medical students, or, at any rate, the majority of them, know with what simplicity the principles of physics must be treated. The subject is one which the students themselves think is foreign to their medical course, and the complexity of detail with which this book abounds would surely make them adhere more strongly than ever to that opinion. But apart altogether from the question of suitability for any special class of students the book is in several other respects open to serious objections. In the first place, the unfortunate tendency in many recent physical text-books of quoting unproved numerous mathematical formulæ is especially prominent in this particular case. This is, in all probability, the main cause of the disjointed nature of the text already referred to. It must be admitted, of course, that such procedure is occasionally inevitable and even desirable, but when it becomes the rule and not the exception, it encourages students to regard physics as a series of formulæ to be committed to memory, and having no logical sequence.

Further, the mode of statement is often peculiarly involved, and sometimes inexact. The latter is illustrated by the statement that "a body free to fall in vacuo would be subject to a constant downward acceleration of about 981 *cm. per sec.*, or 32·2 *feet per sec*"—a statement quite in keeping with the unconvincing way in which the distinctions between velocity and acceleration have been previously treated. The following also is surely a rather extraordinary view to express:—"Kinetic friction is accordingly not a Force; it is a Resistance or Reaction."

The present edition has a supplementary chapter on radio-activity and kindred subjects added. Attention is directed to the chief points in recent work, but the numerical data in connection therewith have scarcely been brought up to date, the old value $3{\cdot}4\times10^{-10}$ E.S. being given, for instance, as the unit of electricity. The author has also adopted a uniform notation, and gives an index of symbols at the beginning of the book, but although, in this index, 10^9 is defined as being equal to 1,000,000,000, we frequently find very large numbers expressed in the uncontracted form. The arrangement of the mathematical treatment is also unfortunate from the point of view of facility in reading, being printed in small type, and from line to line, just like the ordinary text.

(2) Prof. Spinney's book will without doubt serve admirably the purpose for which it has been written. In nearly every respect it fulfils the necessary conditions. Being written for engineering and technical students entering upon a course of physics, it deals in a straightforward and logical way with the various sections into which the subject is usually divided. As is to be expected, particular prominence is given to mechanics, the principles of which are illustrated by familiar phenomena and practical contrivances. Although the mathematical treatment is intentionally limited, what is given is exact, and involves no blind learning of formulæ. Also, notwithstanding the professedly elementary character of the work, the author contrives to convey clearly the underlying principles of such subjects as surface tension, kinetic theory of gases, and polarisation of light in a way not often achieved. To each chapter is appended a series of numerical examples; the printing and arrangement of paragraphs and chapters are excellent, and the heavy type used for the more important statements is a distinct gain. The diagrams have evidently been carefully prepared, and are reproduced in a manner quite above the average. To all students desiring a thorough introduction to the science of physics, whether they be engineering students or not, this book can be unhesitatingly recommended.

(3) In some respects this book is unique. On several previous occasions have historical treatises on special parts of physics been published, but no general elementary text-book of physics based upon a historical outline has until now, we believe, appeared. The author's chief reason for adopting this mode of procedure—and it seems to be a good one—is that it directs attention to the lines upon which discovery has proceeded, and trains the mind of the reader in the processes which may lead to further discoveries. Whether this be the case or not, it is certain that the historical treatment makes the subject eminently readable, particularly to those somewhat acquainted already with the principles of physics. From the point of view of the beginner, however, difficulties might arise owing to the historical sequence necessitat-

ing the omission of practice in the application of the physical laws. These difficulties the author has to a large extent surmounted by adding to each chapter a series of worked examples, thus avoiding the introduction of them into the text. Interest is undoubtedly added to the subject by the historical setting, and it is quite possible that students may be induced to regard physics with more favour on account of it. The printing is good, but the diagrams are neither so numerous nor so well produced as they might be. As evidence of the lack in this respect, not one of the four methods of determining the velocity of light is illustrated diagrammatically.

(4) The most surprising feature of Dr. Clay's book on practical light is the fact that considerable space is devoted to pin optics. The size of the book suggests that its scope will cover experiments of a much more elaborate character. This is indeed found to be the case, repetitions by more accurate methods of the rough pin determinations being described at a later stage. As a result the book appears unequal, and the omission of the pin experiments would have been a gain rather than a loss. The ground covered is very extensive, particular attention being paid to the chapters on the compound lens, the microscope and colour, on account of the importance of their industrial applications. Colour, especially, is treated much more fully than is usually the case in text-books of practical physics, and the numerous experiments described in this connection add considerably to the value of the book. The diagrams with which the experiments are illustrated are exceedingly good, so much so that a student, having here before him the perspective view of the arrangement of apparatus, could scarcely fail to set it up correctly without other aid. It may also be pointed out that, with the exception of one, all the diagrams have been specially prepared for this work. The general arrangement of the experiments is normal and logical, and the two appendices, containing useful practical hints, are very desirable. In short, notwithstanding the rather unfortunate inclusion of pin optics referred to, Dr. Clay's book will certainly form a very useful reference work, not only for students of physics, but also for those engaged in industrial applications of the principles of light.

INDIAN FRESH-WATER INVERTEBRATES.

The Fauna of British India, including Ceylon and Burma. Edited by Dr. A. E. Shipley, F.R.S. Fresh-water Sponges, Hydroids, and Polyzoa. By Dr. N. Annandale. Pp. viji+251+v plates. Published under the authority of the Secretary of State for India in Council. (London: Taylor and Francis; Calcutta: Thacker, Spink and Co.; Bombay: Thacker and Co., Ltd.; Berlin: R. Friedländer & Sohn, 1911.) Price 10*s*.

THIS volume differs in some important respects from those that have preceded it in the "Fauna of British India." It is the first of the series to be written entirely in India, and since, as the author very justly remarks, "biological research on Indian animals can only be undertaken in India," it is only fitting that a large part of the volume should be devoted to observations on the bionomics and life-history of the organisms dealt with. It is thus far more than a merely systematic monograph, and contains a great deal that is of interest and importance, not only to the special student of the Indian fauna, but also to the general biologist.

The Indian region is especially rich in fresh-water sponges. Thirty-six species, subspecies, and varieties are enumerated (including three added in the appendix), although on p. 51 the number is given as only twenty-nine, possibly because of doubts as to the systematic or geographical status of some of the forms. Of these no fewer than twenty-two have been discovered and named by Dr. Annandale, who, however, pays a generous and well-merited tribute to the pioneer work in this field of the late Dr. H. J. Carter, of Bombay.

Little is yet known as to the seasonal cycles in the life-histories of fresh-water animals living under tropical conditions, and on this subject Dr. Annandale has many interesting observations. He points out that in temperate regions the approach of winter affects most of the less highly organised inhabitants of fresh waters in the same way, leading to the production of gemmules, statoblasts, and the like, which lie dormant during the unfavourable season. In India, on the other hand, the reaction to seasonal changes is by no means identical, even in closely allied species.

"Some species flourish chiefly in winter, and enter the quiescent stage at the beginning of the hot weather (that is to say, about March), while others reach their maximum development during the 'rains' (July to September), and as a rule die down during winter, which is the driest as well as the coolest time of the year."

A striking example of specific idiosyncrasy in this respect is given in the case of two sponges, *Spongilla bombayensis and Corvospongilla lapidosa,* found in Bombay. They

"resemble one another considerably as regards their mode of growth, and are found together on the lower surface of stones. In the month of November, however, *C. lapidosa* is in full vegetative vigour, while *S. bombayensis,* in absolutely identical conditions, is already reduced to a mass of gemmules, having flourished during the 'rains.'"

The Hydrozoa dealt with consist only of two species of Hydra, Dr. Annandale's important discovery of a fresh-water medusa (Limnocnida) in streams of the Western Ghats (NATURE, August 3, 1911) having come too late to be included in this volume. One of the species of Hydra is the familiar and widely distributed *H. vulgaris,* and Dr. Annandale has much that is new to tell regarding the bionomics even of this much-studied animal. Especially interesting is the account of the way in which the larva of a small midge, *Chironomus fasciatipennis,* preys upon Hydra. The larva, which protects itself with a tubular case of silk, entangles the Hydra with a silken thread, and binds it firmly to the outside of the tube, to be afterwards devoured at leisure.

Of Polyzoa about sixteen forms are recognised. One of the most interesting is *Hislopia lacustris,* which was formerly placed among the Cheilostomata. Dr. Annandale confirms Jullien's statement that it belongs to the Ctenostomata, and he shows that it is closely related to Arachnoidea, which was at one time cited as evidence for the marine origin of the fauna of Lake Tanganyika.

A number of misprints have escaped correction. On p. 19 the words "co-type" and "paratype" seem to have changed places, with the disastrous result that we are left in doubt as to the sense in which these terms are used throughout the volume. In the sentence, "Some of these species . . . are identical with others . . . closely related to European forms" (p. 12), "and" preceded by a comma should apparently be inserted after "with." On p. 177 it is stated that Kraepelin's classification of the Polyzoa is "less liable to criticism than that followed by Braem," where the context appears to imply that it is more so. It is not clear in what way the "force of gravity" can account for the mutual attraction of gemmules floating on the surface of water (p. 118).

THE PHYSICS OF ELECTRIC LAMPS.

Der elektrische Lichtbogen: Experimentalvortrag auf Wunsch des wissenschaftlichen Vereins zu Berlin gehalten am 11 *Januar,* 1911. By Prof. H. Th. Simon. Pp. iv+52. (Leipzig: S. Hirzel, 1911.) Price 2 marks.

Les Lampes Électriques. By Prof. H. Pécheux. Pp. 186. (Paris: Gauthier-Villars, n.d.)

PROF SIMON'S monograph is a reprint of a lecture delivered in Berlin, and gives in an interesting and consecutive form a brief summary of the principal physical aspects of the electric arc. The numerous physical phenomena presented by the arc have long afforded a most interesting field for research, and it is remarkable into how many bypaths these researches have led. Although the arc in its practical application is primarily a source of light, the most efficient which we possess, and secondarily a source of heat, neither of these aspects receives more than a very brief mention in the pamphlet before us.

It is indeed somewhat remarkable that so little attention has been given by physicists to the problem of the emission of light by the flame arc, a field of research which would seem to be of great theoretical and practical value. But for some reason or other the electrical characteristics of the arc have always appealed more to investigators, and these have been explored far more thoroughly, with valuable and interesting results. Notably the investigations of Prof. Simon himself on the telephonic arc and of Duddell on the musical arc may be referred to; these have led to the use of the arc as a source of sustained oscillation for the transmission of wireless signals, a direction in which its utility could scarcely have been foreseen.

These phenomena and their theoretical explanation will be found clearly described in Prof. Simon's little book, which, if it does not attempt to add much to our existing knowledge, summarises it well. In addition to a number of diagrams the book is illustrated by a coloured reproduction of an autochrome photograph of a flame arc, which is fairly successful considering the difficulty of the subject. The general effect, however, is far too red.

M. Pécheux's little book forms one of the volumes of the "Encyclopédie Scientifique des Aide-Mémoire," and is a brief and well-written description of the various types of electric lamp in use. A good deal of space is devoted to the subject of the electrical characteristics, a subject which always seems attractive to writers on incandescent lamps, and has received somewhat more attention than its importance warrants. On the other hand, the amount of attention given to the light-emitting properties and efficiency is perhaps somewhat meagre.

M. S.

OUR BOOK SHELF.

Farm and Garden Rule-book: a Manual of Ready Rules and Reference. With Recipes, Precepts, Formulas, and Tabular Information for the Use of General Farmers, Gardeners, Fruit-growers, Stockmen, Dairymen, Poultrymen, Foresters, Rural Teachers, and others in the United States and Canada. By L. H. Bailey. Pp. xxv+587. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1911.) Price 8s. 6d. net.

THIS book affords a striking commentary on the progress of agriculture and horticulture in these latter days; whereas a generation ago the cultivator could carry all his rules and recipes in his head, he now finds such a bewildering number of possibilities open to him that, without the help of some such volume as this, he will be wholly unable to make any use of the stores of knowledge accumulated at numerous experiment stations throughout the world.

The first section shows how to use the weather map and to interpret as far as may be the weather indications; then follow directions for making observations and using them. Next comes an account of the soil, the elements of which it is composed, water statistics, and so on, and finally rules to be followed in order that fertility may be maintained. Considerable space is devoted to chemical fertilisers, as the importance of the subject warrants; in particular the farmer is shown how to calculate the fair value of a manure from its guaranteed composition, and how to convert one form of guarantee into another. Typical mixtures of manures for various crops are suggested, the range in both cases being wide, so as to ensure that the tables shall have as large a value as possible. Dates for sowing, planting, and propagating various plants in the different regions are given, followed by tables showing the number of plants that should go to one acre and also the distance apart at which the plants must be set. Several pages are devoted to the yields of field crops in the different States, wherein some very interesting and suggestive data occur. The best yield is commonly double and sometimes three times the average for a particular State, a fact which shows that there is still room for much levelling up in the farming efficiency of the cultivators, even when allowance has been made for the fact that some of the high yields are partly due to exceptional climatic conditions.

Then we get into fruit and greenhouse figures, and find tables containing such uninteresting but valuable data as the legal size of apple barrels in various States, standard dimensions of flower pots, recipes for painting hot-water pipes, making liquid putty for glazing, &c. This section ends up with a list, eighty pages long, of fungus and insect pests the grower may reasonably expect, together with a few short hints showing how each pest may be more or less controlled.

The section on live stock runs on lines similar to those adopted for crops; tables are given showing the composition of feeding stuffs, typical rations, and methods of computing variants, together with much information about the animals themselves. Altogether the book will be found very useful for reference purposes, and, as it is well indexed, it is very easily consulted.

Mineralogy. By Dr. F. H. Hatch. Fourth edition, entirely rewritten and enlarged. Pp. ix+253 (London: Whittaker and Co., 1912.) Price 4*s*. net.

IN this "fourth edition" a revision has for the first time been undertaken. The consequent doubling of its size and price is fully justified by the enhanced value of the work, which for twenty years has been handicapped by its modest size. The addition of eighty pages to the section dealing with descriptive mineralogy has allowed a much fuller treatment of the ores, this portion being trebled in length, while ore-dressing processes (electromagnetic, oil-concentration, &c.), find brief reference under properties of minerals. The portion on optical properties, formerly relegated to a couple of pages, is enlarged sevenfold, thus permitting of an explanation of double-refraction phenomena. Coupled with the fuller description of rock minerals, this renders the book of some use in microscope work. The use of the letters 𝔞, 𝔟, 𝔠 to indicate elasticity axes is regrettable, owing to the likelihood of confusion (both in writing and speaking), with the *a*, *b*, and *c* crystallographic axes; the substitution of X, Y, Z, as adopted in Iddings's "Rock Minerals," avoids this difficulty.

The arrangement of the descriptive portion under the four heads Rock-forming Minerals, Ores, Other Salts, and Gems is convenient, if inconsistent, and it is supplemented by a list of mineral species, chemically classified. We are surprised to find so small a book including among "the more important minerals" metacinnabarite, hauerite, &c. The treatment of mineral names is not always satisfactory; thus nowhere is mention made of the name kupfernickel, so commonly used as a synonym of niccolite; dialogite appears in the text as such, but in the index as diallogite. Wolfram and wolframite (though used as synonyms) are used apparently indiscriminately in the text, but are separately indexed.

The typography is good and misprints very rare (on p. 57 *statical changes* evidently means *charges*), but some illustrations of crystals, like Figs. 63 and 75, might be improved. R. F. G.

Revolving Vectors, with Special Application to Alternating-current Phenomena. By Prof. Geo. W. Patterson. Pp. vi+89. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1911.) Price 4*s*. 6*d*. net.

THIS brief but excellent little treatise can be recommended as a good introduction to the modern topic of revolving vectors, and particularly to the use of the symbolic notation in the development of the subject. It opens with a brief historical note on the discovery in 1797, by Wessel, of the use of the imaginary $\sqrt{-1}$ as an operator having a geometric function of rotation through a right angle. From this the author leads on to the treatment of complex quantities, and their use in representing harmonic motion. The latter half of the book deals with the application to alternating electric currents and other electrical matters. It is satisfactory that the author conforms to the convention adopted by the International Electrotechnical Commission in its recent session in Turin, in using the counter-clockwise sense of rotation as positive.

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.]*

Contour Diagrams of Human Crania.

IN the last number of *Biometrika* (viii., 1, 2, 1911) Prof. Karl Pearson has edited and published a very valuable paper by the late Dr. Crewdson Benington on cranial type-contours. The work is based on long series of skulls of various races, *e.g.* English of the seventeenth century (from the Whitechapel Plague Pit), modern English (Royal Engineers), various Negro races from the Congo, Guanche, Egyptian, Eskimo, and the prehistoric Cro-magnon skull. For each series three typical contours are selected, viz.:—(1) a "transverse vertical," passing through the auricular points and the apex of the skull; (2) a sagittal or median section; and (3) a horizontal section through the glabella; and in each case all the individual skulls of a series are combined into a single "type" by a process of arithmetic averages. Lastly, the diagrams thus obtained are reproduced on tissue-paper, so that one may be superposed upon another, and the characteristic differences easily compared.

I venture to think that we may go a little further, and may, by a simple device, get a new series of diagrams which shall throw into still greater relief the presence and the amount of essential difference of form: for, after all, comparison of the two superposed contours is a matter of individual judgment, and there is a lack of fixity and

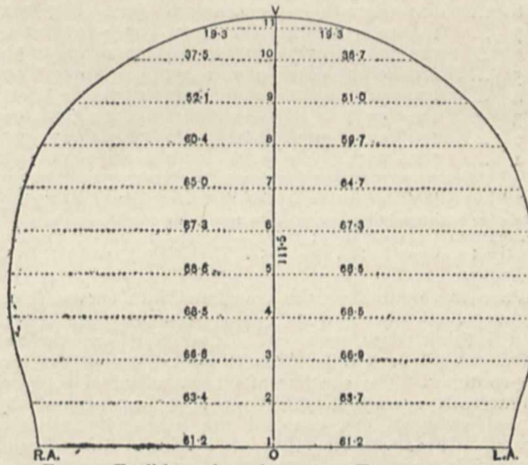


FIG. 1.—English crania, 17th century. Transverse contour.

precision in our interpretation of the result. Moreover, it is obvious that we have, in the first instance, no clear and easy distinction between differences of size and differences of form.

Taking the case of the transverse, or vertical interauricular, section of the skull, Dr. Benington's diagrams represent it for us as in Fig. 1, where a median vertical axis is divided into ten equal parts (the uppermost of these also by a point one-quarter of a division from the apex), and at each of these points of division the horizontal distance to the contour-line is measured and recorded. Thus we are in possession of such tabular statements as the following:—

	A	B
Vertical Height	111·5	121
Transverse diameters 11	19·3	20
10	37·5	37
9	52·1	55
8	60·4	67
7	65·0	72
6	67·3	74
5	68·6	74
4	68·5	72
3	66·6	69
2	63·4	64
1	61·2	62

Dimensions (in mm.) of the transverse cranial section (right side). A English skulls of 17th century; B, Cro-magnon skull.

In order to isolate differences of form from differences of general magnitude, I have reduced all measurements to the scale of a standard vertical height, of 100 mm., with the following result:—

Vertical Height ...	A	B	C	D	E	F	G	H
	100	100	100	100	100	100	100	100
11 ...	17·3	16·5	18·1	18·1	16·0	12·7	15 5	17·1
10 ...	33·6	30·6	33·5	34·7	31·9	27·4	32·0	33·7
9 ...	46·7	45·5	45·5	47·5	46·0	41·6	46·0	47·6
8 ...	54·2	55·4	52·9	55·5	54·6	48·9	53·5	55·3
7 ...	58·3	59·5	56·8	58·9	59·1	54·4	56·9	58·9
6 ...	60·4	61·2	58·8	60·1	60·9	57·0	58·3	60·1
5 ...	61·5	61·2	59·5	60·3	61·7	58·2	58·6	60·4
4 ...	61·4	59·5	59·0	59·3	61·5	58·3	58·2	60·1
3 ...	59·7	57·0	57·2	57 3	59·0	57·6	55·8	57·3
2 ...	56·9	52·9	54·5	54·3	55·7	56·0	53·3	54·4
1 ..	54·9	51·2	52·0	53·3	54·5	56·0	51·4	52·5

Horizontal dimensions of the transverse cranial section, reduced to a common vertical height.

A, English (17th century); B, Cro-magnon; C, Living English; D, Egyptian; E, Guanche; F, Eskimo;, G, Congo Negro (Fernando Vas, 1864); H, Congo Negro (Batetelu).

Lastly, we may write any of these in terms of percentages of any other; and so, for instance, we may take the seventeenth-century English skull as our type, and translate the data for all the rest into percentage proportions thereof, as follows:—

	A	B	C	D	E	F	G	H
11 ...	100	95·4	104·6	104·6	92·7	73·4	89·6	98·8
10 ...	100	91·1	99·7	103·3	94·9	81.6	95·4	100·3
9 ...	100	97·5	97·4	101·7	98·5	89·1	98·4	101·9
8 ...	100	102·2	96·9	102·4	100·8	90·2	98·7	102·0
7 ...	100	102·0	97·4	101·0	101·4	93·3	97·6	101·0
6 ...	100	101·3	97·3	99·5	100·9	94·4	96·5	99·5
5 ...	100	99·5	96·7	98·0	100·3	94·7	95·3	99·8
4 ...	100	96·9	96·1	96·6	100·1	95·0	94·8	97·9
3 ...	100	95·5	95·8	96·0	98·8	96·5	93·5	96·0
2 ...	100	92·9	95·8	95·4	98·0	98·5	93·7	95·6
1 ...	100	93·3	94·7	97·1	99·2	102·1	93·6	95·6
Mean ...	100	97·1	97·5	99·6	98·7	91.7	95·2	98·9

Relative horizontal dimensions of the transverse cranial section.

A, English (17th century); B, Cro-magnon; C, Living English; D, Egyptian; E. Guanche; F, Eskimo; G, Congo (Fernando Vas); H, Congo (Batetelu).

When these numbers are translated into curves (plotting heights vertically and percentage-breadths horizontally), then, I think, they show us in a striking way the nature and degree of such differences as exist between the several type-contours. The contour of our standard of comparison (seventeenth-century English) is now represented by a vertical straight line, and all the others by appropriate curves. It is obvious that if a skull differ from the standard in some simple way, as, for instance, by greater or less breadth, uniformly distributed, its curve will approximate to the form of a straight line parallel to the vertical; if the tendency to broaden or to narrow increase from below upwards, then the curve will be more or less of a straight line set at an angle to the vertical; while if the changes are more complicated or irregular, then the new curve will be more or less sinuous. Indeed, the sinuosity of the curve will be a rough measure of the fundamental differences in form between it and the standard of comparison.

As my object here is to illustrate a method rather than the results derived from it, I will deal very briefly with the curves shown in the following figures.

In Fig. 2 the sinuosity of the Cro-magnon curve (1) indicates striking differences from the standard in the essential form of its contour; it is much narrower below, in the auricular region, then gets broader, and, finally, it is sharply constricted near the apex. The Guanche skull (2) is nearest to the Englishman's, but is narrower above. The Negro (Fernando Vas) (3) is everywhere narrower, and its curvature has a trend similar to that of the Guanche. The Eskimo (4), broad below, narrows to a great degree in the apical region.

In Fig. 3 we compare with the seventeenth-century Englishman (6) the living Englishman (Royal Engineers) and (5) the Egyptian. The latter, by its somewhat greater sinuosity, shows a greater difference than the former, it being narrow in the lower half of the section and broader or more flattened above; but the differences are obviously not nearly so great as, for instance, those between the English skull and the Eskimo or the Cro-magnon. At the same time, the differences between the Egyptian and the

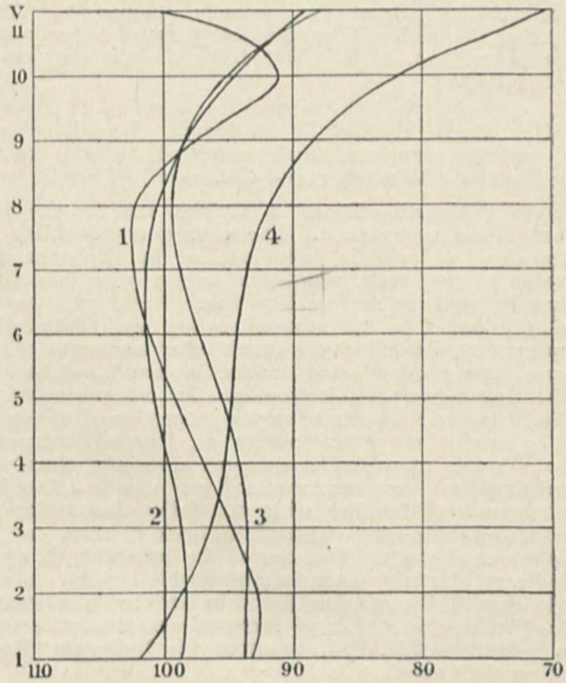


FIG. 2.

English skulls are opposite in character to all those illustrated in the former figure.

In the next figure (4) we compare (1) the transverse contour of the living Englishman with the Englishman of

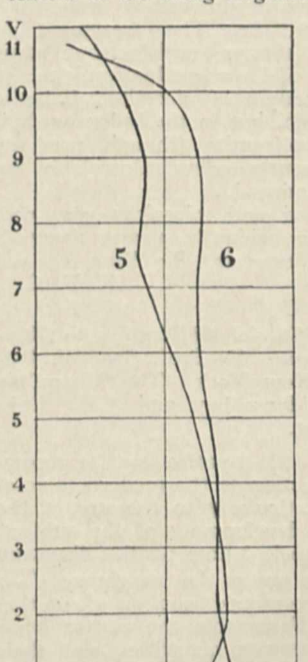


FIG. 3.

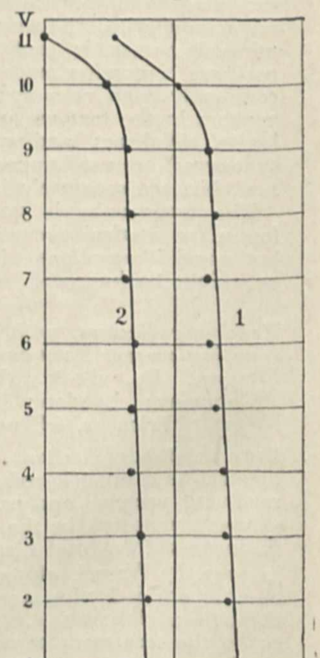


FIG. 4.

the seventeenth century, and (2) two Congo tribes one with another. (The curves in this instance have been slightly smoothed.) Save for a slight accentuation of apparent differences in the immediate neighbourhood of the apex, the curves are in each case all but straight, and are nearly parallel to the vertical. They show (1) that the skull of the living Englishman, that is to say, of the Royal Engineers, is a little narrower than that of the seventeenth-century Londoner, the difference being greatest across the ears, and that, in like manner, the skull of the Batetelu Negro is a little broader than that of the Negro from Fernando Vas. In both cases the general similarity, or identity of type, between the two skulls under comparison is clearly brought out.

Lastly, we may use the method to compare the left side of the skull with the right. And so we find (Fig. 5) that

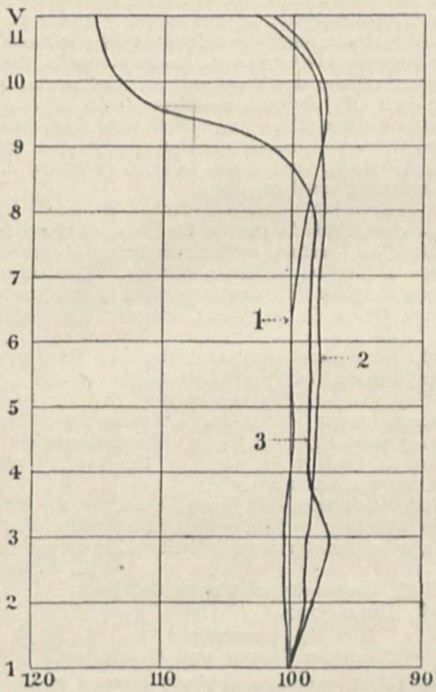


FIG. 5.

in the English skull there is approximate identity throughout most of the section, the left side being narrower in the upper portion only; in the Negro (Fernando Vas) the left side is throughout inferior, while the Cro-magnon skull is markedly unsymmetrical, the left side being the narrower below, but expanded or flattened above in a striking degree.

January 27. D'ARCY W. THOMPSON.

Microscope Stands.

THE correspondence which has ensued on the interesting article on the above subject which appeared in NATURE of December 21, 1911, has afforded much material for reflection. There must be a best possible design for a microscope stand, but it is evident that the one required by the expert amateur is different from that which is acceptable and advantageous to the professional in the laboratory. The former demands, and can with advantage utilise, many refinements that never appeal to the latter. The best English microscopes undoubtedly supply the needs of the expert—that appears to be admitted—and assuming that the design of the Continental instrument is preferred in the laboratory, it might be that the worker would derive fuller benefit from his microscope if only some additional conveniences were at his disposal and he knew how to use them.

So far, the correspondence has been contributed by experienced technical microscopists; but the views of the other side would be welcome and informing.

To revert to the article in question, no one who has had the use of a centring substage would be disposed to accept a centring adjustment to the nosepiece in preference. It is stated that the latter adjustment is provided in the Continental models, but I am unable to find a centring nosepiece listed or described in either of the catalogues of the two leading German manufacturers of microscopes, excepting only in connection with petrological microscopes. Some centring device is admitted to be necessary, and continual working with condensers having large aplanatic cones soon reveals the necessity for the centring substage.

It is suggested that the correction collar fitted to objectives is superior to the rackwork draw-tube for adjusting for varying thicknesses of cover glasses. This is quite correct; but probably not more than 1 per cent. of the objectives that are sold have correction collars, and in consequence of the perfection in which even students' lenses are now made, the sensitiveness to thickness of cover glass necessitates careful adjustment by variation of tube length. There is another important feature of the mechanical draw-tube, and that is it gives a maximum and a minimum body length which permits of the use of any objective, whether corrected for the short or the long tube, though this is subsidiary.

As to the standardisation of the substage fittings, a definite size is given by the Royal Microscopical Society, and if this is adhered to there can be very little trouble about interchanging. It has to be remembered that one-thousandth of an inch in the diameter of a tube makes all the difference between a tight and a slack fitting; tube fittings are particularly liable to variation in consequence of slight bending. Objectives do not always interchange, though all are ostensibly made to the standard size; but the alterations needed are exceedingly slight, and the differences in the substage apparatus of standard size are rarely such as cannot be quickly corrected. It seems reasonable to assume that if it be good to have a standard size for eyepieces and objectives, it is equally advantageous to have one for the substage. The English makers work loyally to the one standard of the Royal Microscopical Society, while the Continental makers each have two or three different ones.

At the bottom of all questions relating to the use of the microscope is the urgent necessity for systematic teaching in the elementary technique of the instrument. It is not unusual to meet men of eminence who are constantly working with microscopes who do not even know that a substage condenser requires to be focussed. How is it possible that the refinements of the English microscope can appeal to their students? F.R.M.S.

The Inheritance of Mental Characters.

To the discussion on the question of the inheritance of mental characters (v. NATURE, December 28, 1911, p. 278) as one who takes an interest in the subject, but can lay no claim to having expressly studied it, I should be glad to be allowed to contribute a few experiences.

In a girls' primary school the writer knew a child who from the age of five until eleven (when her education was complete) was, owing to her daring athletic feats, a torture to her teachers. They were in a perpetual worry lest she should break her bones or her neck. Punishment—and it was pretty liberal—was of no use; when their backs were turned she was at it again. They—and some of them were old teachers—had never met one like her. The other children, about 150 in number, were normal. This one had no peculiar environment, no special opportunities. But her father was a professional showman. She, like the Greek Œdipus, had never seen him, nor did her mother ever speak of him. He had been "raised" on a small farm. His brothers were commonplace workmen. The teachers were unaware of the showman parentage. Some few of us knew, and watched with interest the developments.

This case seems an instance of the inheritance of an acquired taste.

True it, no more than any case that can be brought forward, is not beyond question; for just possibly in the child—as very likely previously in the father—the mere abnormal potentiality was there. This perhaps some accident revealed to her. We always like to do what we can do better than others, let it be tragedy writing or standing on our heads. In children this love of admiration or notoriety, instead of being judiciously cloaked, is ingenuously explicitly manifested. So, not impossibly, once discovered, this initial potentiality might have been developed.

In the elementary school in which the writer himself graduated, after every show or circus we always tried, as boys will, to emulate the somersaulting, walking on the hands, and the various bodily contortions which won our admiration in our favourite demi-god. Far and away the most successful of us—we numbered eighty or ninety—were invariably a barber's three sons. This barber, though he was then for a score of years hard and fast at his trade, had been in early life for many years a circus rider. We were all then very young, between seven and twelve. We and they were then unaware of this circumstance. Even if aware of it they could not have been in any way impelled by it except as an instinct.

This case is adduced as supporting the former instance and its deduction. In picking up facts out of books—the sole idea of education in our neighbourhood—the barber's boys were not quite so good as the average of us, but to double somersaulting they took like ducks to water.

As correlative to the saying that it takes three generations to make a gentleman, you will find among tradesfolk the statement that it requires an equal number of generations to turn out a first-rate craftsman. I met this opinion first in a pottery district. I came across it since among people of the same class in three countries, and in many distinct districts of one of them. Now if this opinion be sustainable—and personally I think so—then increasing potentiality from generation to generation, or, what it amounts to, the inheritance of acquired powers, is a fairly legitimate inference.

The transmission of like fundamental potentiality, indeed, should scarcely be questioned. The transmission of acquired potentialities, or of capacities enlarged and increased by use, is a further matter; but countless instances such as those given above could, I am convinced, be adduced in support of it. It would be hard to resist their accumulated force. It is anyway *a priori* what is to be expected, and the principle is so important that on its truth depends the perfectibility, at least, of man. To explain the transmission of this fresh inheritance remains, I think, the sole problem for men of science. Its solution, so far as I have observed, is hardly yet within sight.

The Stauhaun, Drogheda. J. M.

The Mnemic Theory of Heredity.

FIFTEEN years ago NATURE allowed me to direct attention to certain variations in the arrangement of hair on the animal body, and this was followed by several other communications elsewhere on the same subject. The conclusion from these observed facts, which were very numerous, though intrinsically unimportant, was that only by the doctrine that acquired characters can be transmitted were they to be explained. No biologist has ever challenged this conclusion, except by criticising some detail in the observations, or by saying, in effect, "Let us change the subject!" But this large body of small facts remains on record, and the smaller the individual facts are shown to be the stronger is the evidence that they are removed from the province of Selection.

If it were not for the statement, made on the high authority of Prof. Dendy, as to the "rapidly accumulating evidence" in favour of the doctrine that acquired characters can be transmitted, I would not have ventured to bring up this vexed question. But the evidence of these facts is entirely in agreement with the mnemic theory of heredity, as it seems to me; and in view of the attitude of Dr. Beard, and many other biologists, towards the doctrine of the possibility of the transmission of acquired characters, it seems necessary to bring forward facts, and more facts, however small they appear to be. After all, "things are what they are," and theories very soon after they become orthodox have a way of breaking down. WALTER KIDD.

February 12.

Distaste of Birds for Butterflies.

IN view of the recent discussions in NATURE regarding the distaste of birds for butterflies (December 21, 1911), it will doubtless be of interest to know of the results of an investigation into the relation of birds to an outbreak of butterflies (*Eugonia californica*) in northern California during the summer of 1911.

The fact that in the examination of some 40,000 stomachs by the U.S. Biological Survey there have been but few instances where birds have been found to feed on butterflies makes the results of the investigation carried on by the California Fish and Game Commission with respect to the recent outbreak of still greater interest.

During the early part of the summer the snow brush (Ceanothus sp.) was entirely defoliated by the work of the larvæ of *Eugonia californica* in many places in the mountain districts of the northern part of California. During the latter part of July and the first weeks of August the great army of caterpillars had transformed into butterflies. These insects were so numerous that the ground was often blackened by them, and great swarms of them filled the air from morning until evening.

Field observation showed the Brewer blackbird (*Euphagus cyanocephalus*) to be the most efficient destroyer of the butterflies, certain individuals being observed to eat an average of five butterflies a minute. Two other birds, the western kingbird (*Tyrannus verticalis*) and the western meadowlark (*Sturnella neglecta*), were seen to feed on the insects.

Stomach examination revealed the fact that two other birds, the blue-fronted jay (*Cyanocitta stelleri frontalis*) and the Say phœbe (*Sayornis sayus*), fed on the butterflies to some extent. Sixty-one stomachs in all were examined, representing twenty-one different species. Forty-five species of birds were noted in the locality where the investigation was carried on.

The most important fact brought out by the work was that birds will turn to food which is abundant and readily accessible, even though it be a little-relished type of food.

H. C. BRYANT.

East Hall, University of California, Berkeley, Cal., January 27.

Thomas Young and Göttingen.

THOMAS YOUNG, more particularly famous as the founder of the wave theory of light, and whom Helmholtz described as one of the most clear-seeing men who had ever lived, matriculated at Göttingen University on October 29, 1795, and took the doctor degree there in medicine on April 30, 1796.

This fact is little known, even among Young's admirers. Indeed, it had escaped the knowledge of the Göttingen authorities. With the view of perpetuating Young's memory at Göttingen, the present writer brought the matter before the notice of Dr. E. Riecke (professor of experimental physics at Göttingen University). Prof. Riecke placed the matter in the hands of the Pro-Rektor, Geh. Rat. Prof. Dr. W. Voight, who instituted inquiries as to the place of Young's abode.

It transpired that Young had lived in the building which later became the Physikalisches Institut, and is now the Institut für Angewandte Mechanik und Mathematik. It is a pleasing coincidence that in this same building Gauss and Weber did their work on the first electromagnetic telegraph.

Shortly before Christmas, as a result of Prof. Voigt's representations to the Magistrat of the town, a neat little tablet to the memory of Thomas Young was affixed. This tablet is in appropriate proximity to that in memory of Gauss and Weber.

To Prof. Voigt grateful acknowledgment is due for the enthusiastic and warm-hearted manner in which he has superintended the erection of this little memorial to one of the greatest of all physicists. H. S. ROWELL.

Glazed Frost.

REFERRING to the letters of Mr. Charles Harding and Prof. Meldola on the phenomenon of freezing rain, I remember the occasion referred to; it was on January 11, 1868, when trees were covered with ice by rain which froze instantly on touching a solid object. In driving through Richmond Park I noticed the branches bending under a weight of clear ice, and, what was even more remarkable, the windows of my cab becoming thickened by a layer of ice while the temperature was just at the freezing point. Rain had been falling continuously until the afternoon, when the drops began to solidify on contact. From roofs and gates long icicles were formed, increasing in size; the grass was sheeted with ice, although the ground had not been chilled by frost.

It is not easy to explain the passage of very cold drops through a warm layer of air without their temperature being raised nearly to that of the layer, but, since the objects on which they fell must have been above or about the freezing point, the drops must have brought with them a degree of cold sufficient not only to cause instant solidification, but to retain the solid state some time after falling and to refrigerate the objects. The size of the drops was not unusual.

ROLLO RUSSELL.

PROF. MELDOLA in his letter (NATURE, February 1, p. 447) refers to a similar occurrence to that described by me in NATURE of January 25, and he says, "it must, I think, have been in 1866 or 1867." Prof. Meldola adds that there must be many Londoners now living who can remember the occasion.

I well remember the occurrence, and my brother, Mr. J. S. Harding, skated round Belgrave Square and the immediate neighbourhood for two or three hours.

May I give the following extract from my Meteorological Register, kept in the neighbourhood of Belgravia, which shows the time and nature of occurrence?

"1867, January 22.—Slight rain from 7.20 p.m. to 10 p.m., half congealed before it reached the ground, and forming almost simultaneously with its fall a sheet of ice upon the earth, evidently the result of rain falling from a stratum of warm air at no great distance from the earth, and not having sufficient time to be converted from rain before reaching us."

This was the close of an exceptionally severe frost; my screen temperature on January 5 was 6·5°, the lowest I have observed, and the Greenwich reading was 6·6°.

I think some meteorologists would call the phenomenon referred to by Prof. Meldola a silver thaw; it is perhaps somewhat different in character from a glazed frost, and is a sure precursor of a thaw.

CHAS. HARDING.

THE following note is to be found amongst the "Meteorological Observations" at the end of "The Natural History of Selborne" under the title of "Frozen Sleet," and appears to be an example, and a remarkable one, of the phenomenon of "glazed frost":—

"January 20.—Mr. H.'s man says that he caught this day in a lane near Hackwood Park many rooks, which, attempting to fly, fell from the trees with their wings frozen together by the sleet, that froze as it fell. There were, he affirms, many dozen so disabled.—White."

ANDREW WATT.

Scottish Meteorological Society, Edinburgh,
February 10.

ON Monday, February 5, I was in Bruges; about 8.15 p.m. I heard what I thought was hail beating upon the window panes. On leaving the house about fifteen minutes later I found that everything was covered with a film of ice at least a quarter of an inch thick. The phenomenon of "glazed frost" was very well marked, particularly upon the iron railings which run along the side of the canals, and upon the twigs of the trees. The stone cobbles with which the streets are paved were completely covered with smooth ice, and the roads were almost impassable; I saw five people fall down in as many minutes.

FRANCIS G. BELTON.

336 Belgrave Road, Birmingham.

THE letters of Mr. Harding (NATURE, p. 414) and Prof. Meldola (NATURE, p. 447) recall the following:—

On February 5, about 7.30 p.m., a heavy shower of rain, which lasted for fifteen minutes or so, suddenly fell. Being caught in this shower, naturally I hurried, but quickly found myself slipping rather than walking along, since as soon as the raindrops came in contact with the earth they apparently froze, the roadway quickly becoming covered with a coating of ice, which had a very glazed appearance. A stick which I had in my hand also became coated, and was quite "glassy" to the touch.

Although the shower was of so short a duration, the younger element of the people about at the time enjoyed themselves sliding along the Promenade and down the main street (which has a fair slope).

The temperature during the day was about 32° F., but at the time of the shower it was about 33° F.

E. WYNDHAM JEFFREYS.

University College of Wales, Aberystwyth,
February 10.

Human Eyes Shining.

WITH reference to the last paragraph in the letter by Colonel J. Herschel in NATURE of January 18, I have sometimes seen human eyes reflecting light in the way described, though, as indicated in the letters to NATURE, it is difficult to get in the right position for seeing such an occurrence. I have never tried a dark lantern. The best instance I have seen was in 1876, when I observed the light from an oil lamp inside a little girl's eyes. It was best seen when my head was between the lamp and her, and when the shadow of my head nearly came upon her eye. It appeared to be her retina that was illuminated; it was a bright orange-red, but varied in the amount of red. When my eye was nearly in the same direction as the lamp, the whole pupil was equally illuminated, but when less nearly in the same direction the side of the pupil next my shadow was the brightest, or the only part illuminated. The illumination was stronger when she looked to one side of the lamp than when she looked at it. Her sister exhibited the phenomenon less strongly, though still brightly, but her father very slightly. In the external appearance of these eyes there was nothing unusual.

I have tried to see this phenomenon in my own eyes in a looking-glass, with the sun as illuminator, but could only see a very faint illumination, very different from the above-instanced cases.

I have never used an ophthalmoscope, but I understand that when an eye is so observed the light is red or orange.

T. W. BACKHOUSE.

West Hendon House, Sunderland, February 10.

Chalk and Ice.

I HAVE read with much interest the letter on "Chalk and Ice" in NATURE of February 8, as I had observed the same phenomenon on January 7 of last year.

There had been heavy rain all the previous day and a sharp frost at night, when, in walking over Ballard Down from Swanage to Studland, in the early morning, I noticed lumps of chalk with fibrous masses of ice adhering, the ice in some cases being larger than the chalk fragment.

The soil consisted of sandy clay resting on the dip slope of the chalk, and fragments of the latter were very numerous, each with its adherent ice, which, on account of its prismatic structure, sparkled in the sunlight with bright flashes of colour, the effect being very beautiful.

The formation of ice below the surface, as suggested, is interesting, as it would certainly be an important factor in the gravitation of soil on a chalk slope during cold periods.

R. W. POCOCK.

28 Blomfield Road, W., February 9.

Candlemas Day.

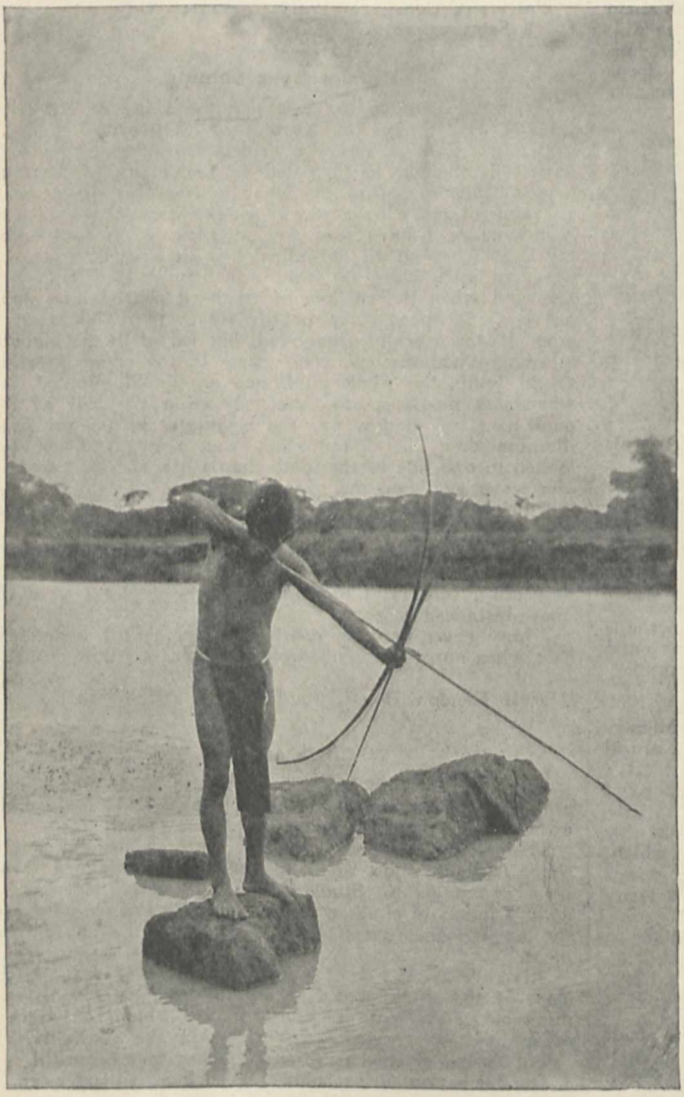
IN addition to the proverbs about the weather on the second of February quoted among the Notes in last week's NATURE, allow me to give the following, which was told to me by the late Dr. Corrie, Master of Jesus College, Cambridge:—

"Si sol splendescat Maria purificante,
Majus erit frigus post festam quam fuit ante."

O. FISHER.

NATURE STUDIED IN THE FORESTS OF GUIANA.[1]

MR. RODWAY is known as the author of works on history dealing with that part of the New World where he has for some years resided. Whilst he was working up historical facts, he was at the same time making occasional excursions for the purpose of studying the forest and its inhabitants. The result is contained in this charming and readable book, first published in 1894, and now as a new edition with four new chapters and some new illustrations.



The fisherman.—From "In the Guiana Forest."

The first chapter gives a general review of the forest; then comes a pleasing description of the most important inhabitant, the gentle Arawak Indian; a new chapter in this edition devotes special attention to the Indian as a hunter, and another to him as a fisherman. Then follows an outline sketch of the animals, with a new chapter on the insects. The next chapter, on interdependence of plants and animals, serves to introduce plant-life, and the last half of the book is given up mainly to considering the struggle for life among plants.

While this book is quite different in plan from Waterton's delightfully sentimental account of his "Wanderings" in the same region, and from Im Thurn's "Among the Indians of Guiana," it appeals, like the former, rather to the general reader than to the student.

The account of the Indian from his birth to manhood is well told. His explanation of "beenas" (*i.e.* charms) seems more satisfactory than that of Im Thurn. The latter writer considers only the pain suffered in using the charm, and suggests that the custom was adopted with the idea of preparing to meet without flinching any pain or danger that may arise during the chase. That is no doubt the effect, and it confirms the Indian in the use of charms, but it is no explanation of the selection of beenas. Rodway points out that the leaves of Caladiums which are in use as charms are of various shapes and are mottled or spotted with red and other colours; "to the Indian these shapes and markings mean something; they indicate the special use of the plant. It is the old doctrine of 'signatures' so well known to the European herbalist, who once considered lungwort to be a remedy for diseases of the lungs, because its leaves were spotted like that organ." There is a special beena for every game beast, bird, and large fish. "That for the deer is one of the arrow-shaped Caladiums with ruddy veins, and a colour somewhat resembling the animal. In this case the leaf with its pointed lobes represents the facial outline and ears, while the colour is another part of the signature." The tubers of these plants contain an acrid juice which the Indian rubs into gashes made in his flesh with razor-grass. The stinging pain caused by the juice and borne without flinching signifies that the charm is powerful and is working, thereby ensuring success in the hunt.

It is a pity that the chapter on the "senses of plants" was not omitted in this edition. The author appears to think that plants have three out of five senses, that they suffer pain (p. 292), and that they can be credited with the foresight to strive for a particular object (p. 283). The word feeling is used loosely to express touch, and also a consciousness of touch. When the roots of a plant absorb different quantities of various materials, they are said to exercise the senses of taste and smell, and to distinguish suitable from unsuitable food! Schopenhauer somewhere remarks that consciousness sleeps in the stone, dreams in the plant, and wakes up in the animal. Mr. Rodway seems to go very much further, and to put plants in the same class as animals. But in plants there are no differentiated organs, nor nervous system. When a root bends, the cells at the tip where the stimulus is received do not differ, except in being younger, from those higher up along which the stimulus passes, nor from those where the response is made and the bending takes place. It is scarcely scientific to apply to plants terms which are properly restricted to man and the higher animals.

[1] "In the Guiana Forest." Studies of Nature in Relation to the Struggle for Life. By J. Rodway. New, revised and enlarged edition. Pp. 326. (London: T. Fisher Unwin, n.d.) Price 7*s*. 6*d*. net.

The last two chapters are on the causes of the struggle and nature's laws; they are somewhat discursive, and are not very helpful towards a better understanding of the subject.

The illustrations are from photographs and are well done; one of a fisherman is reproduced here.

ATMOSPHERIC CIRCULATION OVER THE TROPICAL ATLANTIC.[1]

THE general circulation of the atmosphere provides meteorology with one of its most fascinating problems, because the details must ultimately be known by observation, while the theoretical results hitherto obtained cannot, with reasonable values for friction, be made to agree quantitatively with the observed motions. In the region of the trade-winds, the average conditions persist with sufficient regularity to make them the necessary basis of any wind-chart and a fundamental criterion as to the general truth of the conclusions deduced hydrodynamically on the assumption of a known distribution of temperature. It was for a long time confidently believed that above the trade-winds themselves, at no very great heights, there prevailed a counter-current, as steady and regular in its main features as the wind beneath it. Every schematic representation of the circulation by Maury, Ferrel, James Thomson, though differing in other features, agreed in this one, and the conclusions drawn by Hildebrandsson from the observations of clouds supported them.

It was therefore a surprise when Prof. Hergesell reported in 1904 that observations made over the Atlantic on the Prince of Monaco's yacht, *Princess Alice,* had revealed the existence of an apparently persistent and extensive N.W. wind above the N.E. trades. The conclusion was based on observations made during the course of one summer only, but the different observations were sufficiently concordant to give Hergesell confidence in the conclusion. Clearly such a N.W. wind could not prevail around the whole tropical belt because the flow of air southward in the trades must be balanced by a corresponding flow northwards. It is, moreover, impossible to devise a scheme of pressure distribution which would satisfy the elementary principles of atmospheric motion, and permit of N.W. winds at all points on a parallel of latitude. The view was therefore received with some scepticism, and in order to obtain further, and, if possible, conclusive evidence on the point, M. L. Teisserenc de Bort and Prof. Rotch organised a more systematic investigation of the conditions over the Atlantic, and the results of the observations made on voyages in 1905, 1906, 1907, are published in the present volume. In 1905, 1907 the observations were made solely in the N.E. trades in the summer months, July, August, and in 1907 in September also. In 1906 two separate expeditions were made, the first in February in the N.E. trades, the second from May to the middle of August, in the region between the Azores, 38° N., and Ascension, 8° S. The actual observations were made by Prof. H. H. Clayton and M. H. Maurice and other assistants.

The first quarter of the book is devoted to description and discussion. In an introductory chapter of fourteen pages, the authors refer briefly to the reasons which induced them to undertake the work, summarise the results obtained, and add some notes on the boat, the *Otaria,* a "fish carrier," and on the methods employed. They express their thanks to the Admiralty, who, at the request of Dr. Shaw, readily undertook to supply coal to the *Otaria* at Ascension, where there are no private supplies, but it is rather humiliating to reflect that this represents the total contribution of England to these recent investigations over the Atlantic.

M. H. Maurice, assistant at the Trappes Observatory, who accompanied the expedition, contributes a long article of thirty-six pages, giving the history of the investigations and details of the methods used. The article is illustrated by many photographs taken on the voyages. Some of these are useful in helping the reader to understand the procedure adopted for making ascents, and others, such as the photographs of clouds, form a contribution to meteorological art, but it is difficult to see the special meteorological significance of a photograph of a "Group of Women and Children" at the Cape Verde Islands.

A short notice of seven pages by Prof. H. H. Clayton deals with the meteorological conditions in the region of the trade-winds up to heights of 2000 metres. It is based upon results obtained during the voyages of 1905, 1906, and is accompanied by a series of diagrams showing the distribution of humidity and temperature at different heights and latitudes. One of the most interesting features is the relatively warm and dry body of air at an altitude of about 1000 metres, which was found in every month between latitudes 15° and 30° N. The paper is an example of concise discussion, and it is to be regretted that it does not embrace the whole of the observations for all heights reached.

The remaining three-fourths of the book contain the results of the individual ascents, together with plates illustrating the routes followed in the different expeditions, and showing the character of the observed motion at different places for heights up to 20 kilometres. These results are proving of the greatest value, not only for dealing with the problems which the authors set out to solve, but in connection with such questions as the motion in the stratosphere in the equatorial regions and the gradient of pressure at high levels.

The general conclusion drawn from the observations is that the N.E. trade-winds form a layer the mean height of which is only 1000 metres; above this comes a region where the wind has still a northerly component, and usually blows from N.W. These N.W. winds are, however, not found further south than lat. 20° in summer, which is about 12° north of the region between the two systems of trade-winds. Above the region of N.W. winds, anti-trades prevail, beginning at a height of about 3000 metres near the Canaries, lat. 30° N., and at 1800 metres, near Cape Verde Islands, lat. 15° N. They blow from S.E. near the equator, changing gradually through S. to S.W., near the northern limit of the trade-winds, and finally passing over into westerly winds in the latitude of the Azores. The N.W. winds discovered by Hergesell appear to be a prolongation over the trade-wind region of a current from higher latitudes, similar to that indicated by James Thomson, and attributed by him to "a revolutional momentum brought from equatorial regions and not yet exhausted." The inter-tropical circulation is therefore in its main features in agreement with the views held by the majority of meteorologists before any actual investigations by means of kites and balloons had been undertaken. It is extremely gratifying that the authors have been enabled by this prolonged series of observations to reach definite conclusions where previously nothing but plausible hypotheses existed. It is earnestly hoped that the investigations will not end here, but that a united effort will be made to obtain observations

[1] "Travaux Scientifiques de l'Observatoire de Météorologie Dynamique de Trappes, avec la collaboration de l'Observatoire de Blue Hill." "Travaux de l'Atmosphère Marine par Sondages Aériens Atlantique Moyen et Région Intertropicale." By MM. L. Teisserenc de Bort et A. L. Rotch. Pp. 243+xvii plates. (Paris: Gauthier Villars, 1909.)

simultaneously along a parallel of latitude, and, if possible, to combine these with regular series of ascents at places distributed as nearly as possible along a meridian. When this has been done a firm foundation for a survey of the atmosphere will have been laid.

There is a certain lack of coherence about the present work, so that although each individual contribution is excellent, the collection does not reach the same standard. Something of this kind is perhaps inevitable where different authors, separated from each other by the Atlantic, undertake to write different sections of a scientific report which are closely related to each other, and require to be published without undue delay. E. GOLD.

PRECISION OF LEVELLING OPERATIONS.[1]

THE volume referred to below, containing the account and discussion of the precise levelling operations in India from 1858 to 1909, is published at an opportune time. The revision of the main lines of levels in this country and the establishment of really permanent bench marks is, we understand, a task that our Ordnance Survey intends to take up at an early date. The experience gained in the Indian work as recorded in this volume cannot fail to be of great value.

As with any other physical measurement, we find in the case of levelling that increased precision means that problems unimportant or often unthought of in earlier days rise to prominence and demand solution. Thus at the very outset of the subject we are confronted by a question of definition; what do we mean when we say that two points are at the same level? Do we mean that the distance of each point from the surface which would correspond with the mean sea surface, assuming the land to be removed, measured along the normal is identical, or do we mean that our two points lie on the same equipotential surface? The former definition gives us the so-called "orthometric" height, while the latter gives what has, perhaps not very happily, been called the "dynamic" height.

Thus consider the case of a lake. The dynamic height of every point on the water surface is evidently the same, but the actual vertical distance above sea-level varies from point to point, the rate of variation being a maximum along a north and south line and zero, if we exclude second-order distortions of the spheroid, along an east and west line.

Authorities vary as to which system is on the whole the more convenient for practical use, so that the Indian Survey has followed the safe plan of printing both values. We may, however, venture the remark that a convention which assigns different "levels" to different points upon the surface of still water is repugnant to a very large class of practical men, namely, the engineers. The difference between the heights of a station, measured on the two systems, amounts to a maximum of nearly two feet in the case of Bangalore, 3000 feet above the sea, a figure which would obviously be largely exceeded if the levelling were extended to regions of great elevation, and if the mean latitude were differently selected. It is not quite clear in choosing a mean latitude of 24° for the zero of their dynamic heights, and thereby making the system valid only for India, that the Survey experts have adopted the best course. It is an arguable question, which we merely mention here without, be it understood, expressing any definite opinion, whether, if dynamic heights are to be used at all, they should not be based upon a universal datum, and therefore referred to a mean latitude of 45°.

The discussion of the level errors is of great interest and importance. The conclusion arrived at is that for the Indian work the error of a circuit varies neither directly as the length nor as the square root of the length, but in accordance with an intermediate formula:—

$$\text{Error in feet} = \sqrt{(0{\cdot}004)^2 M + (0{\cdot}00034)^2 M^2},$$

where M is the distance in miles.

This gives one-tenth of a foot for a line of 235 miles, and one foot for about 2800 miles, a very satisfactory degree of precision.

The importance of both accurate and permanent bench marks is rightly insisted upon. Many cases have been found where the marks have moved, and obviously no deductions can be drawn as to elevations or subsidences in the earth's crust unless the stability of the bench marks is beyond suspicion.

E. H. H.

[1] "Account of the Operations of the Great Trigonometrical Survey of India." Vol. xix., Levelling of Precision in India (1858–1909). By Colonel S. G. Burrard, R.E., F.R.S. Pp. xiii+484+xviii plates. (Dehra-Dun: Office of the Trigonometrical Survey of India, 1910.) Price 10.8 rupees.

DR. HENRY TAYLOR BOVEY, F.R.S.

WE announced with regret last week the death of Dr. H. T. Bovey, late rector of the Imperial College of Science and Technology, and formerly dean of the faculty of applied science in McGill University, Montreal, which occurred at his residence in Eastbourne on February 2. The funeral service was held at St. John's Church, Eastbourne, on February 6, and his remains were interred in Eastbourne Cemetery.

Dr. Bovey was born at Torquay in 1852, and after being educated in a local school, entered Queens' College, Cambridge, in 1870. He graduated in 1873 as twelfth wrangler, and was elected a fellow of his college in 1876. He entered the profession of engineering, and joined the staff of the Mersey Docks and Harbour Board. Whilst at Liverpool he took part in founding the Liverpool Society of Civil Engineers, and he had every reason to look forward to a prosperous professional life in England. But an accident occurred which gave his life a new bent, and afforded opportunity for a brilliant career elsewhere. Like the best type of Cambridge honours man, Dr. Bovey was a keen supporter of athletics. Whilst taking part in a game of football, he was thrown down and had several ribs broken. He made a good recovery, but one lung had been slightly injured, and he was advised to spend the next winter in a dry climate, lest the wound should become a focus for pulmonary disease. He therefore accepted from Sir William Dawson, principal of McGill University, the offer of a chair in civil engineering and applied mechanics, but declined to bind himself to hold this post for longer than a year.

When Dr. Bovey arrived in Montreal in 1881, he found that his post was indeed a sinecure. Not only was there no laboratory of any description, but his chair was attached to the "Arts" faculty, and his subject had to compete with literary subjects as an option for a degree. At that time in McGill the principal qualification for the success of an optional subject was constituted by its claims to be considered a "soft snap," *i.e.* by demanding light work and having easy terminal examinations. The mathematical teaching provided by the University was quite unsuited to engineering students, and Dr. Bovey's efforts to have it modified met with no success. Next year, therefore, Dr. Bovey resigned his chair, and was about to return to England, but he was pressed by the principal to draw up a scheme for the better instruction of engineering students. This he did, and the scheme provided for the establishment of a separate faculty of applied science, with its own chair of mathematics. The principal then said that if Dr. Bovey would remain his scheme would be carried into effect as soon as funds permitted. Dr. Bovey agreed to remain, and by constant and heroic struggles during the next twenty-five years, he gradually built up one of the finest engineering schools in the world.

Money came in at first very slowly, and only Dr. Bovey's marvellous tact and the respect and affection which he everywhere inspired enabled him to make any headway with his scheme. At last he succeeded in interesting Mr. (now Sir William) Macdonald, a rich and respected Montreal merchant, in his plans. This gentleman travelled with Dr. Bovey over the United States in order to inspect the fine engineering schools of that country. Dr. Bovey stimulated his friend's Canadian patriotism by pointing out how far behind Canada was in this matter. On their return to Canada Sir William Macdonald announced his intention of building and endowing the finest engineering school on the continent. This was Sir William Macdonald's first important donation to McGill; it was followed by so many others that he can justly be regarded as the second founder of the University. At Dr. Bovey's suggestion, Sir William built and equipped the splendid physical laboratory, and founded the chair in physics, the two first occupants of which have been Profs. Callendar and Rutherford. Dr. Bovey adhered with unflinching firmness, in spite of the grumbling of his more "practical" colleagues, to the necessity of a thorough mathematical training for engineering students; and as the excellence of McGill engineering graduates became known, they were so much sought after that Dr. Bovey used to have on his desk more offers of positions for his graduates than his entire graduating class could occupy.

As his success became evident, honours flowed in on him. He was given honorary degrees, was elected fellow of the Royal Society, honorary fellow of his college at Cambridge, and he was finally, in 1908, selected as first rector of the Imperial College of Science and Technology. At that time the faculty of applied science in McGill comprised more than 600 students, and was attracting men from all over America, and even from England. Alas! unknown to Dr. Bovey himself, the fatal disease which was to cut short his career had already fastened on him, and his short tenure of the rectorship of the Imperial College was a struggle against increasing ill-health until his resignation in 1909. Nevertheless he did the College invaluable service. Though a mathematician and engineer, his sympathies were not confined to those subjects; he took the broadest view of the possible services of the College to science, and gave cordial and effective support to the reorganisation and re-equipment of the biological departments of the College.

Dr. Bovey married in 1882 Miss Emily Redpath, a lady equally popular with himself, and a member of a leading Montreal family. He is survived by his widow, two sons, and three daughters. The elder son is pursuing a brilliant career at the Montreal Bar; the younger is a King's scholar at Westminster. No words could do justice to the attractiveness of Dr. Bovey's character. His sympathy, wise counsel, and practical helpfulness will long live in the memory of his friends, amongst whom were all the junior members of his staff in McGill, and especially those new to Canadian life. To those who, like the writer, were privileged to enjoy his intimate friendship, his death is an irreparable loss. E. W. M.

SIR WILLIAM ALLCHIN.

SIR WILLIAM ALLCHIN died in a nursing home in London on February 8, in his sixty-sixth year, some days after an operation and after several months of illness. The son of a doctor in Bayswater, he was, like his father, educated medically at University College Hospital. After being medical officer to the s.s. *Great Eastern,* which was employed in laying the submarine cable, he became assistant physician, and subsequently dean of the medical school at the Westminster hospital, with which he remained connected in the capacities of physician, consulting physician, and vice-president until his death. He was also consulting physician to the Victoria Hospital for Children, the Western Dispensary, and the St. Marylebone General Dispensary. He played a very active part in medicine in London, holding numerous offices and lectureships at the Royal College of Physicians, and at the Medical Society of London, of which he was president in 1901–2. He contributed articles mainly on abdominal diseases to standard works on medicine, such as Allbutt's "System of Medicine," Quain's Dictionary and the "Encyclopædia Medica," and edited, for Messrs. Macmillan, "A Manual of Medicine," in five volumes, the last of which appeared in 1903. His distinction as a physician was shown by his appointment as Physician Extraordinary to H.M. the King.

Sir William Allchin devoted much time and trouble to the University of London, and had an exhaustive knowledge of the tangled problems which have exercised medical educationists during the last twenty-five years. He was the representative of the Royal College of Physicians on the Senate of the University of London from 1902 to 1910, and probably his last appearance in public was as a witness before the Royal Commission on University Education in London in July, 1911, when he gave expression to his own views based on forty-five years' experience, during which he had been actively concerned in medical education and examinations.

At various times he examined at the Universities of London, Durham, and Glasgow, at the Conjoint Board of the Royal Colleges of Physicians and Surgeons, for the Naval, the Army, and the Indian Medical Services, and was also a member of the Advisory Medical Board of the Admiralty. He had a considerable knowledge of old medical books, and did much in arranging the library of the Medical Society of London, of which he was honorary librarian for eighteen years. He was also a high authority on precedence. He was not an original thinker or investigator, but his judicial mind, high standards, and conscientious devotion to the somewhat tedious work of committees have been of great value to the cause of medical education. H. D. R.

NOTES.

WE notice with the deepest regret the announcement of the death of Lord Lister, on February 10, in his eighty-fifth year. An account of his work appeared in our series of "Scientific Worthies" on May 7, 1896, and we hope to supplement this next week with a further appreciative statement of his services to science and humanity. The King has sent a message of sympathy to Lord Lister's family. Queen Alexandra and other members of the Royal Family have sent telegrams also, Queen Alexandra's message being in the following terms:—"Pray accept my most sincere sympathy in the great loss which the whole nation shares at the death of Lord Lister, whose name will ever be honoured and gratefully remembered as that of the greatest benefactor to suffering humanity throughout the world." Sir Ray Lankester has received the following telegram from the directors of the Institut Pasteur, Paris:—" L'Institut Pasteur vous prie d'exprimer à la famille de l'illustre Lister et à la Société Royale les regrets que lui cause la mort du rénovateur de la chirurgie.—Roux, Metchnikoff." We learn from *The Times* that the Dean of Westminster offered that the remains of Lord Lister should be interred in the Abbey, subject to the condition of cremation. The Royal Society and the Royal College of Surgeons also made representations to the Dean in the hope that this offer would be made. It appears, however, that Lord Lister expressed the desire that he should be buried in the Hampstead Churchyard, where his wife lies. The first part of the funeral service will be held in Westminster Abbey on Friday, beginning at 1.30 p.m. The Dean, accompanied by the Abbey clergy, will conduct the service. This evening the coffin will be taken from Lord Lister's London residence in Park Crescent into the Abbey, and placed in St. Faith's Chapel. There it will remain until to-morrow morning, when it will be removed to a spot facing the altar. Only members of the family will be present at the interment in Hampstead Churchyard.

WE regret to see the announcement of the death, on February 12, at ninety-three years of age, of the Rev. Francis Bashforth, distinguished by his experiments in ballistics, and for some time professor of applied mathematics to the advanced class of Royal Artillery officers at Woolwich. *The Times* of February 14 gives the following account of his work:—Between the years 1864 and 1880 Mr. Bashforth carried out a series of experiments which really formed the foundation of our knowledge of the resistance of the air, as employed in the construction of ballistic tables. He published, notably, "A Report on the Experiments made with the Bashforth Chronograph, &c., 1865–1870," and another report dated 1878–1880, as well as "The Bashforth Chronograph" (Cambridge, 1890). These experiments were calculated to show that the resistance of the air can be represented by no simple algebraical law over a large range of velocity. Having abandoned, therefore, all *a priori* theoretical assumption, Mr. Bashforth set to work to measure experimentally the velocity of shot and the resistance of the air by means of equidistant electric screens furnished with vertical threads or wire, and by a chronograph which measured the instants of time at which the screens were cut by a shot flying nearly horizontally. Formulæ of the calculus of finite differences enabled the experimenter from the chronograph records to infer the velocity and retardation of the shot, and thence the resistance of the air. In consideration of the importance of these experiments and of his inventions, Mr. Bashforth received a Government grant of 2000*l.*, and was also granted a pension.

WE regret to learn of the death, on February 4, of Mr. George Edwards Comerford Casey. Born on March 19, 1846, Mr. Casey graduated at Lincoln College, Oxford, taking subsequently the degree of M.A. Although a teacher by profession, Mr. Casey spent the happiest days of his life on the sunny shores of the Mediterranean, and he will be best known to biologists as the anonymous author of "Riviera Nature Notes" (London: Bernard Quaritch), a stimulating and original book which, perhaps partly because not written on the conventional lines of a scientific treatise, imparts a living reality to the facts which it describes such as is very difficult of attainment in our modern text-books of "nature-study." The English translation of Prof. Strasburger's "Streifzüge an der Riviera" (London: T. Fisher Unwin) was prepared by Mr. Casey's two daughters.

ON Saturday, February 24, Sir J. J. Thomson will begin a course of six lectures at the Royal Institution on "Molecular Physics." The Friday evening discourse on February 23 will be delivered by Mr. G. K. B. Elphinstone, on "The Gyrostatic Compass and Practical Applications on Gyrostats"; on March 1 by Dr. W. J. S. Lockyer, on "The Total Solar Eclipse in the South Pacific, April, 1911"; and on March 8 by Dr. A. W. Ward, on "The Effects of the Thirty Years' War."

THE council of the Society of Engineers (Incorporated) may award in 1912 two premiums of books or instruments, to the value of 8*l.* 8*s.* and 4*l.* 4*s.*, as first and second prizes, respectively, for approved essays on the subject of "How to Improve the Status of Engineers and Engineering, with Special Reference to Consulting Engineers." The competition is open to all, but application for detailed particulars should be made to the secretary before entering. The last date for receiving essays is Friday, May 31.

AT the anniversary meeting of the Royal Astronomical Society, held on February 9, the following officers and council were elected:—*President,* Dr. F. W. Dyson, F.R.S.; *vice-presidents,* Mr. E. B. Knobel, Dr. W. H. Maw, Mr. S. A. Saunder, and Prof. H. H. Turner, F.R.S.; *treasurer,* Major E. H. Hills, C.M.G., F.R.S.; *secretaries,* Mr. A. S. Eddington and Mr. A. R. Hinks; *foreign secretary,* Sir David Gill, K.C.B., F.R.S.; *council,* Sir R. S. Ball, F.R.S., Sir W. H. M. Christie, K.C.B., F.R.S., Rev. A. L. Cortie, S.J., Dr. P. H. Cowell, F.R.S., Dr. A. C. D. Crommelin, Rear-Admiral H. E. Purey Cust, C.B., R.N., Prof. Alfred Fowler, F.R.S., Dr. J. W. L. Glaisher, F.R.S., Mr. J. A. Hardcastle, Prof. H. F. Newall, F.R.S., Rev. T. E. R. Phillips, and Mr. F. J. M. Stratton.

As a result of the recommendations recently made by a joint committee of the South African Association for the Advancement of Science and the Royal Society of South Africa, a general committee, we learn from the December (1911) issue of *The South African Journal of Science*, has been constituted for the purpose of considering applications received for grants. Five grants, amounting in all to 250*l.*, were made at the first meeting of the committee held towards the end of last year. The grants were:—(1) 40*l.* to Prof. W. A. D. Rudge, of Grey University College, Bloemfontein, to obtain a continuous record of the variations in the atmospheric gradient at various places, and to ascertain the relation between potential gradient and altitude, and between the diurnal variation of the gradient and the variation in the atmospheric pressure; (2) 45*l.* to Prof. A. Young, of the South African College, Cape Town, to investigate the occurrence of semi-diurnal, diurnal, and spring and neap tides observed in connection with an artesian well in the Cradock district; (3) 75*l.* to Miss D. F. Bleek, to proceed to the Kalahari, so as to obtain phonographic records of the spoken language of the Bushman tribes north of the Orange and Vaal Rivers; (4) 50*l.* to Mr. R. N. Hall, to visit localities in Rhodesia, where Bushman paintings exist; (5) 40*l.* to Mr. W. T. Saxton, of the South African College, Cape Town, for the purpose of studying the fungus diseases of trees in the Transkeian forests, investigating the ecology of the typical formations of the Transkeian territory, investigating a reported occurrence of the typical Western Province flora at St. John's, and to collect material for the study of the two genera of South African cycads, Stangeria and Encephalartos.

IN *Man* for February, Dr. C. G. Seligmann describes a cretinous skull found by Prof. Flinders Petrie while exploring a temple of Thotmes IV. at Thebes. He distinguishes this specimen from others of the achondroplastic type, because the arrest of the development of the nasal bones is very marked. In achondroplastic skulls, on the contrary, the nasal bones and the nasal processes of the maxillæ develop normally, though, owing to the shortness of the base, the angle made with the frontal may be abnormal. This specimen thus agrees in this particular with undoubtedly cretinous skulls, and may be regarded as that of an eighteenth-dynasty cretin.

MR. THOMAS E. SMURTHWAITE sends us a booklet entitled "Practical Anthropology," in which he has expanded his method of racial analysis. Mr. Smurthwaite's method is founded on a study of the contour of the head and face. In every nation or people he finds there are six types of head and face, and believes, therefore, that there were six original races. By a compounding of these original races the various nations and tribes have been evolved. We fear Mr. Smurthwaite's proposal to apply his methods to a racial analysis of school children is doomed to failure, because of the uncertainty in the recognition of the various types he seeks to differentiate.

WE note that Dr. Robert B. Bean employs a series of types in his description of the natives of the Philippine Islands. In a series of papers which have recently appeared in the *Philippine Journal of Science*, *American Naturalist*, and *American Anthropologists*, he classifies all men and women into three types—Primitive, Iberian, and Australoid. These three forms he regards as the fundamental units of mankind. He recognised them amongst the Negritoes and among the various tribes to be found in Luzon and Mindoro. Dr. Bean's colleagues, however, will find his excellent and numerous photographs more helpful than his text. It is very evident that the inhabitants of the Philippine Islands represent a most interesting congeries of peoples. Besides the small negroids—some of them might pass as natives of Equatorial Africa—it is plain that there are, in addition to the dominant Malay race, peoples who recall the Japanese, the Chinese, and the Ainus. Perhaps the most interesting discovery made by Dr. Bean is a native type of man with long bushy beard and European features. It seems possible that there are elements within the native tribes of the Philippine Islands which may throw light on the origin and distribution of the various races which are found on the shores of the Pacific Ocean.

THE last number of *The Bulletin of Entomological Research* (vol. ii., part iv., p. 357) contains an important memoir by Mr. R. W. Jack entitled "Observations on the Breeding Haunts of *Glossina morsitans*." A number of places in which the puparia of the fly were found are described, and illustrated by very good photographs. The puparia were always found at the bases of trees, in the soil, either sheltered by a hollow in the tree-trunk or under the exposed roots. On the other hand, negative results were obtained from careful search in the soil under bushes, although shaded, loose, full of humus, and covered with leaves; the writer is of opinion that the instinct of the parent fly is to avoid such places, where the pupæ would be in danger from the scratching of game-birds, &c. Along the Gorai River great numbers of guinea-fowl, "pheasant" (Pternistes), and francolin occurred, and there all the ground under the bushes had been scratched over and over again. The writer considers that "the tsetse-fly is such a comparatively slow breeder that it can scarcely afford to expose its pupæ to the scratchings of the game-birds." The practical bearing of these observations seems perfectly obvious: it is that fowls or other scratching birds should be encouraged or introduced in the forests or amongst the trees where the fly deposits its pupæ, especially in the vicinity of villages or homesteads, where the wild game-birds are naturally scared away.

Naturen for January, which appears in a new type of cover, contains a portrait and biography of Prof. W. C. Brøgger, the well-known geologist, and Rector of Christiania University. Its contents also include the first portion of the natural history results of the Danish oceanographic cruise of the *Thor* in the Mediterranean in the summer of 1910.

IN 1909 Mr. F. F. Outes, of the La Plata Museum, published the first part of what was intended to be a monograph of the morphology of the early inhabitants of Entre Rios, dealing in that instance with certain abnormalities in connection with the cranial sutures. The plan, as we learn from a second communication by the same author, published in vol. xviii. of the *Revista del Museo de la Plata*, has now been abandoned. Mr. Outes accordingly contents himself in the paper cited with describing certain cranial variations and abnormalities observable in the remains of these people preserved in the La Plata and Buenos Aires Museums.

No. 61 of *Publications de Circonstance*, issued at Copenhagen by the Conseil Permanent International pour l'Exploration de la Mer, is devoted to a report on the investigations on herrings in the North Sea conducted during 1910, the first part, by Messrs. J. Hjort and E. Lea, dealing with the whole question, and based on observations extending from 1907 to 1911, while the second, by Mr. Lea, discusses the growth of herrings. An important part of the investigation has consisted in the "grading" of herrings, that is to say, the determination of the range of variation presented by the individuals of the same age, or, in other words, of particular year-groups. There were from the first reasons to believe that the members of a shoal belonging to the same year and spawning together might represent different growth-types, and the features presented by those of 1904 proved this to be the case. In one lot of these herrings the growth-rings on the scales were of a normal, and in another of an abnormal, type. The abnormal type occurred in all the samples of what are known as "fat herrings" from Nordland in that year, and it served to show that by the autumn of 1909 the herrings in more southern waters were largely reinforced by a migration from the north. It has also been demonstrated that the "fat herrings" are fish of from one to seven, but chiefly of from two to four, years old, and that the youngest classes of the "large" and "spring herrings" are three-year-old fish, while the majority are from four to eight years old, although the shoals may include individuals up to sixteen or eighteen years. As regards the economic importance of such determinations, it is known that a great falling-off took place in the fisheries between 1904 and 1906, and that in 1907 there were no fish older than three years, and in 1908 none exceeding four years. This means that "fat herrings" were practically absent in 1902 and 1903. Obviously, then, determinations of this nature will afford means of predicting good or bad catches in the future when sufficient data are available.

MR. N. HOLLISTER, assistant curator of the Division of Mammals, U.S. National Museum, announces the discovery of four new animals from the Canadian Rockies in a paper just published by the Smithsonian Institution. During last summer a small party of naturalists from the Smithsonian

Institution accompanied the expedition of the Alpine Club of Canada to the Mount Robson region, where they made the first natural history collection ever taken in that vicinity. The natural history work of the expedition was under the charge of Mr. Hollister, who paid especial attention to the mammals, four of which he describes—a chipmunk, a mantelled ground-squirrel, and two bats. All the specimens come from the neighbourhood of Mount Robson, which lies in one of the wild and unexplored parts of British Columbia, at about 14,500 feet elevation. The chipmunk is a new species, and all the specimens of it come from the region along the boundary line between British Columbia and Alberta, from Yellowhead Pass northward. The ground-squirrel is a beautifully marked and highly coloured form of the genus, and was found living in the alpine meadows and rocks of the snow-covered region above timber-line. The head and shoulders are a rich and glossy Mars brown, and the sides are marked by conspicuous lateral stripes. While the two new species of bats resemble some well-known forms, externally they are distinct and readily distinguishable by the shape of the skull. One of them most resembles a species known only from Mexico. This paper forms No. 2062 of the Smithsonian Miscellaneous Collections.

THE Imperial Geological Survey of Austria has decided to reserve a whole volume of its *Abhandlungen* for a new and exhaustive description of the Miocene fossils of the Vienna basin. It is nearly half a century since Hoernes completed his well-known monograph on the fossil Mollusca of this region, and so much progress has been made during recent years in studying the fossils from corresponding deposits in other Mediterranean areas that a renewed examination of the Viennese collections has become necessary for comparative work. Dr. Franz X. Schaffer has begun the revision by a study of the bivalved shells from the Miocene of Eggenburg, and his results occupy the first part of the projected new volume, which has been recently issued. The concise descriptions are illustrated by forty-seven fine plates, towards the cost of which a large contribution has been made by the Krahuletz Society of Eggenburg. Dr. G. de Alessandri follows with a brief account of the cirripedes from the same formation, which, as might be expected, belong to genera and species of shallow-water habitat.

THE biennial report of the Connecticut Agricultural Experiment Station forms a ponderous volume of nearly 900 pages, containing reports of the analyst, entomologist, botanist, and forester. The station is required by statute to analyse yearly at least one sample of every commercial fertiliser offered for sale in the State, and to publish the results, together with the name of the dealer. A paper is contributed by Mr. East on the transmission of variations in the potato in asexual reproduction. All the observed asexual variations were losses of character, no new characters coming out. Otherwise there is a close parallel with the variations produced in sexual production.

THE report of the director of agriculture of the Federated Malay Straits shows that there has been a considerable change in the staff of the department, and in consequence no new work could be originated. There has been a great increase in the rubber output, which amounted in 1910 to 12,563,220 lb., as against 6,083,493 lb. for 1909; greater increases are anticipated during the next few years. Labour presents some difficulties, but on the whole the factors involved in the production of rubber are tolerably well understood. The working up of the raw rubber is still in the experimental stage. What is said to be wanted is a simple and trustworthy test for the strength of rubber as it leaves the plantation factory comparable with the polariscope test for sugar; at present rubber is judged only by colour and general appearance. Only two fungoid diseases were said to be serious, a root disease due to *Fomes semitostus*, and "die-back," due to *Thyridaria* (*diplodia*) *tarda*. *Termes gestroi* appears to be the most serious of the insect pests. Cocoa-nuts are also grown, and incidentally their husks furnish useful fuel for smoking rubber where this is carried out.

PROF. W. PFEFFER's paper on the mechanical prevention of sleep-movements in plants (*Abhandl. K. Sächs. Ges.*, 1911) is a continuation of his important work, "Investigations of the Appearance of Sleep-movements in Plants," published in the same journal in 1907—a paper in which nyctitropic movements were for the first time automatically recorded by a thoroughly good method. The most interesting result of the present paper is the discovery that the internal changes, on which sleep-movements depend, continue their normal course even when the leaves are fixed so that they cannot execute the normal movements. Thus a plant fixed in the diurnal position will assume the night position if released at the right hour, and in the same way a plant fixed in the night position wakes if freed in the morning. Similar conclusions are drawn from the study of leaves not kept absolutely still, but so as to show very minute sleep-movements.

IN the *Zeitschrift der Gesellschaft für Erdkunde* for 1911 there has appeared a series of descriptions of sheets of the 1 : 100,00c map of the German Empire, in which the principal geographical characteristics of each sheet are clearly summarised. Structure, surface, and erosive action are indicated wherever they are well shown, as well as the settlements, communications, and the general development of the region whenever these have been clearly influenced by the geography. More than one hundred and fifty sheets are also classified by the geographical forms which they represent, so as to be of use for geographical instruction.

WE have received a copy of the Almanac for 1912 which is compiled in the offices of the Survey Department for use in the Government offices of Egypt. Since five calendars are ordinarily in use, viz. the Mahommedan, Coptic, Jewish, Julian, and Gregorian, such a compilation is indispensable. The almanac also contains a large amount of information relating to the regulations, procedure, &c., of different Government departments, which is otherwise not always easy to obtain. It is of special interest to note that substantial brass plates have been laid down in a permanent manner at the headquarters of the administration in each province for the verification of the chains which are now generally used for land-measurement. Lengths of 20 metres and of 5 qasabas (17·75 metres) are defined by marks engraved on these plates.

IN the last number of the *Mitteilungen der k.k. Geographischen Gesellschaft*, Vienna, for 1911, Prof. A. Böhm von Böhmersheim discusses the definition of the critical angle of slope of an ocean basin as given by Prof. Krümmel in his recent manual of oceanography. The subject, as well as that of the critical depth, is discussed at length, new definitions are proposed, and formulæ are developed for computing these values, both on the sphere and on the spheroid. Besides the general case, special cases of the Black Sea, the Celebes deep, the Straits of Dover, and the Atlantic Ocean are examined, and the differences between the points of view of the two writers are indicated.

IN *The Geographical Journal* for February Mr. W. Harding King describes his journeys into the Libyan Desert to the south-west of Dakhla Oasis. He traversed a considerable sandstone plateau rising to an altitude of about 1800 ft., and forming part of the general plain of about 1200 ft. above sea-level, which probably extends to the oases of Kufra, which lie about 400 kilometres to the westward. The vast tract of sand dunes traversed by the Rohlf's expedition in 1874 was found to terminate a little to the north of latitude 25° N., and beyond this there only occurred small patches of drift sand and three of the narrow, but long and persistent, lines of dunes which are so characteristic of the Libyan Desert. The same number gives a summary of the results obtained by the expedition sent to South America by Mr. Bullock Workman to determine the altitude of Mount Huascaran, in Peru, which had been stated to be more than 24,000 ft. M. E. de Larminat measured a base of 1606·6 metres at a height of 3790 metres on the flanks of the chain, levelled up from the Pacific Coast to one of the triangulation stations, and finally obtained triangulated values for the different peaks of Huascaran ranging from 6763 to 6418 metres above sea-level.

THE Hon. Miles Staniforth Smith, Administrator of the Territory of Papua, gave an account of his recent expedition into the western part of the territory before the Royal Geographical Society on Monday, February 12. The expedition entered the hilly country from the end of the navigable portion of the Kikor River, and made its way with great difficulty across the southern portion of a deeply dissected limestone plateau, which rose generally to a height of about 5000 ft. The country was covered with dense jungle, and in the course of the march Mount Murray, the highest peak met with, 8000 ft., was ascended without any view of the summit having been obtained when its foothills were first encountered. The dominant trend of the valleys was north-west to south-east, and along them the expedition marched until it reached a point believed to be near the Strickland River. Being very short of food and water, the mountain slopes had to be left for the valley floor, which proved to be occupied by a rushing torrent flowing between precipitous rock walls. Compelled to build rafts, the expedition was wrecked in the rapids, losing the whole of its instruments, baggage, food supplies, records, and collections, only reaching a base camp of a relief expedition after the greatest hardships. The country is described as the forward edge of an elevated and strongly dissected plateau of coral limestone, in which intrusive basalt occasionally occurs, and the boulders found in the stream bed seem to point to a greater development of this rock to the northward. Part of the plateau is of the "karst" type, water being scarce, streams sinking into swallow-holes, and subterranean river courses being extensively developed. Coal of a hard quality was found at several points, and is ascribed to Carboniferous or Permo-Carboniferous age, but the evidence for this was not stated. The expedition succeeded in maintaining the best relations with the natives, who aided with food and with information, often on very critical occasions.

THE fourth part of the current volume of the *Mitteilungen aus den Deutschen Schutzgebieten* is mainly taken up with the meteorological observations from Togo and from German East Africa for the year 1909. Improved determinations of humidity are obtained by the use of Assmann's aspiration psychrometer at all stations in Togo for the humidity observations, and at several stations in German East Africa. The mean maxima observed at Dar-es-Salam with a radiation thermometer are given for each month for 1899 to 1908. Another article gives a summary of geological investigation in the Cameroons, the principal localities in which mineral deposits have been located being shown on a small map of the colony.

THE synoptic weather charts of the North Atlantic and adjacent coasts for January 11–17, prepared from reports by radio-telegraphy and otherwise, and published in the Meteorological Committee's chart for the current month (first issue), exhibit a very interesting situation. Large anticyclones lay over northern Europe and North America; on January 14 the barometer in Finland rose to 31·2 in. Over the Atlantic the weather remained in a very disturbed state, with frequent south-westerly gales east of longitude 30° W., and strong north-westerly winds on the further side of the ocean; a very deep secondary disturbance gradually embraced practically the whole of the North Atlantic. On the evening of January 14, in latitude 52° N., longitude 30° W., barometer readings were below 28·2 in., just 3 in. lower than over northern Europe. From the latest reports received the Meteorological Office was able to give valuable information as to the probable weather between Ireland and mid-ocean during the next few days.

THE Australian Central Weather Bureau has issued an average rainfall map of South Australia and the Northern Territory, on the same plan as those already published for other States; only stations with at least fifteen years' records have been used. The chart shows clearly the rapid decrease of the rainfall from the agricultural areas northwards to the interior, where, in the Lake Eyre basin, the average annual fall is under 5 in.; the area in square miles in which the fall is under 10 in. is given as 317,600 in South Australia and 138,190 in the Northern Territory. In the latter district the mean annual rainfall is given as 24·65 in., ranging from 62·12 (at Port Darwin) to 5·54 in.; in the Pastoral Interior 7·26 in., ranging from 12·99 to 3·79 in.; in the agricultural settled districts 18·93 in., varying from 46·99 (at Stirling West) to 7·12 in. The line (14–16 in.) representing the limit of safe agriculture is plotted on the map.

THE recent publications of the U.S. Coast and Geodetic Survey include volumes of magnetic observations at the observatories of Porto Rico and Baldwin (Kansas). The Porto Rico volume covers the two years 1907 and 1908. In April, 1907, the magnetographs were moved from a room in Fort Isabel Segunda, on Vieques Island, which they had occupied since their erection in 1903, to a site about a kilometre distant, on Vieques Sound. They were re-erected in a new building, the construction of which is described. It is wholly above ground, but suffices to secure a satisfactorily uniform temperature, the climate having small temperature variations, whether daily or annual. As in previous volumes, particulars are given of the hourly readings of the curves, and diurnal inequalities are derived from ten quiet days a month. Copies are given of some of the most disturbed curves. During 1908 the horizontal force magnetograph had a large drift of zero, and numerous discontinuities also appeared in the curves, so that the records do not seem altogether trustworthy. The second volume gives data for Baldwin from January, 1907, to October, 1909, when the observatory was discontinued and the instruments transferred to a new observatory at Tucson, Arizona. The contents are similar to those of the Porto Rico volume. The copies of highly disturbed traces include that of September 25, 1909, the only magnetic storm during the period included which reached the highest grade of disturbance. Temperature changes in Baldwin Observatory were so large as to be decidedly prejudicial to the working of the magnetographs. The vertical force instrument naturally suffered most, but even the declination instrument gave trouble at times.

THE leakage of steam past piston valves has formed the subject of a research conducted at Birmingham University by Mr. H. Denzil Lobley, and the results are given in an article in *The Engineer* for February 9. A special jacketed cylinder was used, and could be supplied with either saturated steam or with steam superheated up to 900° F. The valve could be driven at different speeds by means of an electromotor. The principal conclusions are as follows:—(*a*) Piston-valve leakage is not responsible for any appreciable amount of the "missing quantity," or the leakage of a well-fitted piston valve is practically negligible. (*b*) The leakage does not follow the law K=CP/L. (*c*) The leakage diminishes proportionally to the increase of temperature until 500° F. is reached, after which the distortion of the rings causes it to increase. From these results it appears that the piston valve has advantages over the flat slide valve other than those due to the fact that the piston form is balanced. It is probable, and indeed is almost proved by Callendar and Nicholson's experiments, that the great difference in leakage of the two types is owing to the fact that slide valves warp, and thus lift off the face. Warping is eliminated in piston valves, except at high temperatures, and hence the leakage is very small.

MR. FRANK FIELDEN deals with a few problems in bituminous suction-gas plants in *Engineering* for February 9. An examination of the specifications issued by suction-gas plant makers shows that in most cases a good average quality of dry anthracite coal of a certain size is expected to be used to fulfil the guarantees as to fuel consumption and quality of gas to be produced. There are, however, strong incentives to the engineer to construct a suitable suction-gas generator for the satisfactory gasification of native coals, which have hitherto been unemployable for the purpose. Mr. Fielder summarises the ideal suction plant as follows:—It will consume all the volatile matter contained in the coal in addition to the solid carbon; to effect this, some mechanical feeding of the fuel at a regular rate to suit the load on the engine would seem desirable. Caking coal will be so treated as to prevent arching over, and consequent obstruction to an equable air and vapour supply in the main fuel column of the generator. Suitable facilities will be provided for the effectual removal of ash and clinker without interfering with the quality of gas produced; this is essential for all coal used on extended periods of running. It is, of course, assumed that the ordinary factors will also be considered, such as amount of space occupied, simplicity of construction, minimum amount of attention, and reasonable first cost.

OUR ASTRONOMICAL COLUMN.

THE CHANGES ON SATURN'S RINGS.—From the current number of *The Observatory* we learn that Prof. Todd claims an alternative translation for his telegram (which was in Latin) concerning the changes on, and probable "dissipation" of, Saturn's rings. It is suggested that the term "dissipation" did not refer to the actual rings.

EPHEMERIS FOR BORRELLY'S COMET, 1911*e*.—In No. 4552 of the *Astronomische Nachrichten* M. Fayet gives a bi-daily ephemeris for comet 1911*e* extending to May 13. The comet is at present in Perseus (R.A.=3h. 54·8m., $\delta=+45° 57'$), and is travelling towards Auriga in a direction slightly north of east; it is, however, very faint, and is receding from both the earth and the sun.

STELLAR SPECTRA IN THE VISUAL REGION.—Although the photographic spectra of many stars have been more or less exhaustively studied in the region more refrangible than $H\beta$, the study of the less refrangible region has been restricted, except for a few of the brighter stars, by the lack of sensitiveness of photographic plates in that region. An attempt to remedy the omission appears in No. 4552 of the *Astronomische Nachrichten*, where Dr. Hnatek publishes reductions of the spectra of γ Andromedæ, α Cassiopeiæ, α and γ Cygni, and α Persei in regions less refrangible than λ 4861. The spectra were taken in 1907, for another purpose, by Herren Eberhard and Ludendorff with Spectrograph V. of the Potsdam Observatory; pinacyanol-bathed plates, by Wratten and Wainwright, were employed, but the spectra are still under-exposed.

The reductions are not very exhaustive; for example, Dr. Hnatek gets nine lines in the spectrum of α Cygni between λ 4861 and λ 5316·85, whereas the South Kensington published reduction gives twenty-eight. Further, he gives, generally, Rowland's origins and intensities, which in an "enhanced-line" star do not represent the facts; only occasionally does he refer to the enhanced lines published by Lockyer, and thus at times misinterprets the significance of an origin, or an exceptional intensity, of a line. For each star he has deduced from his measures the radial velocities at certain epochs, which he tabulates at the end of the paper.

STELLAR PARALLAXES.—A second series of stellar parallaxes, determined from meridian transits at the Washburn Observatory, Wisconsin, is published by Mr. A. S. Flint in No. 631 of *The Astronomical Journal*. The observing list consisted primarily of stars between magnitudes 1·5 and 2·5, but some fainter stars were added, and in the final list are given the parallaxes of 124 stars. Among the brighter stars the following large positive parallaxes are given:—β Persei, $+0·130''$; α Persei, $+0·109''$; β Canis Maj., $+0·163''$; α Geminorum (pair), $+0·174''$; γ Leonis, $+0·105''$; β Ursæ Maj., $+0·136''$; α Serpentis, $+0·151''$; and α Ophiuchi, $+0·127''$; while the 3·7-magnitude star ϵ Eridani has a parallax of $+0·379''$ in Mr. Flint's list. A general average of the probable errors of the final parallaxes is $\pm0·031''$, and after discussing the data in a number of different ways Mr. Flint concludes that the parallaxes given are sensibly free from systematic error.

THE SPECTRA OF COMETS.—The February number of *L'Astronomie* contains an interesting paper in which Comte A. de la Baume Pluvinel discusses the spectra of comets, more especially as revealed by the researches of the past few years.

After briefly summarising the earlier observations, he describes at length the spectrum of the Morehouse comet, and reproduces an excellent comparison showing the close identity of the doublets in that spectrum with doublets occurring in Prof. Fowler's spectrum of carbon monoxide at low pressure.

In conclusion, he points out that to answer the question, "What are comets made of?" would have been comparatively simple, say, a dozen years ago, but to-day the photographic method has revealed so much that was then unknown that the answer is not so easy. The composition of comets is complex, and all comets do not display the same composition. As our knowledge extends still further it may become necessary to classify comets in spectral classes; in fact, this has already been done in a simple fashion. Some comets are essentially gaseous and blue, *e.g.* Morehouse; others, like the great comet 1910*a*, are yellow, and contain much solid matter.

THE PARALLAX AND PROPER MOTION OF MIRA.—In No. 44 of the *Mitteilungen der Nikolai-Hauptsternwarte zu Pulkowa* Herr S. Kostinsky discusses at length the parallax observations of Mira made by him during the period 1903–7. The main discussion is printed in Russian, but there is a *résumé* in German, in which the principal stages and results are described.

Among other results, the author finds that the yearly parallax of Mira is probably zero, and in any case does not exceed $+0·05''$. The yearly proper motion in R.A. is extremely small, and in declination is about $-0·235''$.

CONTRIBUTIONS TO THE ETHNOLOGY AND ARCHÆOLOGY OF NORTH AMERICA.[1]

SO little information is available concerning the Indian tribes of the Lower Mississippi Valley and the adjacent coast of the Gulf of Mexico that Mr. Swanton's memoir is very welcome. In it he has published extracts from early French authors, and in a compact form we have all that is known about tribes now extinct or reduced to a few, much modified, survivors. There are seven linguistic families around the Lower Mississippi; of these, the Caddoan and Siouan are extensions or outliers of a wider distribution; the Muskhogean group extends in a broad band to the Atlantic; to this is related the small Natchez group. The Chitimachan people live at the mouth of the river, while westwards extend the cognate Atakapan

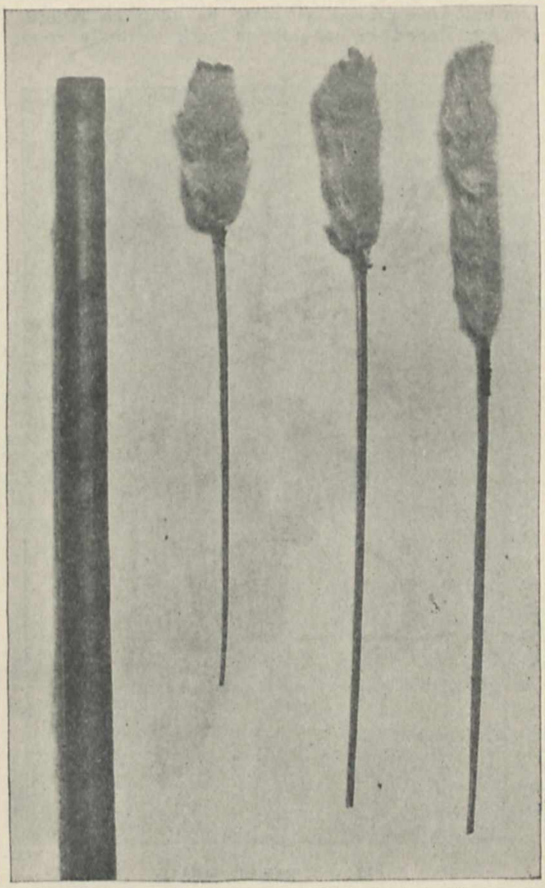


FIG. 1.—Blowpipe and cane arrows. The end of the blowgun has been ornamented by burning and the arrows feathered with down from the fireweed.

group, to which, probably, the small Tunican group are also allied.

By far the greatest space is given to the Natchez group, the authorities on which are quoted at length, a plan which has much to recommend it, though it leads to a certain amount of repetition, and the conflicting accounts cannot always be reconciled. Head-flattening occurred, and both sexes were freely tattooed, but the men only after having killed some enemy. The principal animals hunted were the bear, deer, and bison; agriculture had attained great importance; the cultivation of maize was done in common, pumpkins, water melons, tobacco, and probably beans were also grown. The work and play of the sexes is described. There was great licence before marriage. There was a peculiar, strongly centralised form of government; the great chief is called Great Sun; his heir is the son of the woman nearest related to him; his relations were little suns; nobility was reckoned through the females, but by the seventh generation nobles gradually sunk to the rank of stinkards or commoners. Princesses of the blood

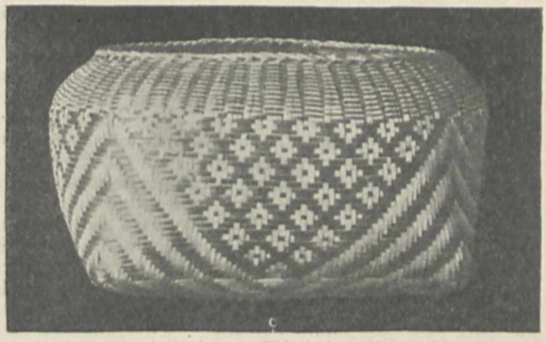


FIG. 2.—Chitimacha basketry. This design of large white spots with dark centre is called *tcēxt-kani*, "blackbird's eye."

always espoused men of obscure family, and had but one husband, who might be dismissed at will. The community consisted of (i) nobility of three ranks: (1) suns (children of sun mothers and stinkard fathers); (2) nobles (children of noble mothers and stinkard fathers, or of sun fathers and stinkard mothers); (3) honoured people (children of honoured women and stinkard fathers, or of noble fathers and stinkard mothers); and (ii) stinkards (children of stinkard mothers and honoured men, or of stinkard fathers

FIG. 3.—Betatakin—western end.

and mothers). The Great Sun was practically treated with divine honour.

The harvest feast was the most solemn of all; essentially it consisted in eating in common, and in a religious manner, new corn which had been sown for that purpose by warriors, with the great war chief at their head; the Great Sun presided at the feast. The war customs are described: "The great war chief pays to the family for

[1] Smithsonian Institution. Bureau of American Ethnology. Bulletin No. 43: "Indian Tribes of the Lower Mississippi Valley and Adjacent Coast of the Gulf of Mexico." By J. R. Swanton. Pp. vii+387+32 plates. Bulletin No. 50: "Preliminary Report on a Visit to the Navaho National Monument, Arizona." By J. W. Fewkes. Pp. iv+35+22 plates. (Washington: Government Printing Office, 1911.)

those whom he does not bring back, a circumstance which renders the chiefs more careful in leading their warriors." Smoking the calumet is associated with preparation for war and with peace treaties. The Natchez language appears to be the result of a mixture between a Muskhogean and a non-Muskhogean people.

The Chitimacha were less warlike and more cowardly than the tribes higher up the Mississippi; their culture differed from the latter principally by the increased importance of food from the waters and the decreased importance of food from land animals; but wild vegetable food was their mainstay, though they cultivated maize and sweet potatoes. Fish were caught mainly with hook and line, but nets and traps were used. The blowpipe was employed, the darts of which were made of slender pieces of cane feathered with thistledown (Fig. 1). Pottery was made; but the chief glory of the Chitimacha was, and still is, their basketry (Fig. 2). Like some other tribes of the district, there were nobles and commoners, with different terms of etiquette for each; but, unlike the Natchez, their nobles were constrained to take partners from their own ranks, thus forming a caste. Matrilineal totemic clans existed. Every village of any size had a bone-house, in which a fire was kept continually burning. The bones of people were dug up by "turkey-buzzard men" and kept in the house for some time, and finally buried in a mound. Every large village had also a dance-house for religious and social ceremonies, as, for example, the initiation of boys. Different from this was the solitary fast and confinement which each boy (and, it is said, each girl also) underwent in order to obtain a guardian spirit. The so-called "temples" of the Natchez and other Lower Mississippi tribes were only variants of the bone-houses of the Chitimacha and Choctaw. Further study may be expected to throw light upon the evident fusion of at least two stocks in the tribes recorded by Mr. Swanton. A number of old illustrations are reproduced, but many of the photographs are not very satisfactory; there is a useful map.

The excellent archæological work of Dr. Fewkes in exploring and conserving cliff-dwellings has been referred to already in NATURE. In Bulletin 50 he gives an account of his stewardship of the Navaho national monument in Arizona. The excellent illustrations to his report bring home to the reader the great interest of these remarkable remains (Fig. 3). He makes some suggestive remarks upon the significance of the dwellings. "The ancients chose this region for their homes on account of the constant water supply in the creek and the patches of land in the valley that could be cultivated. . . . Defence was not the primary motive that led the sedentary people of this canyon to utilise the caverns for shelter . . . the cause of their desertion was not so much due to predatory enemies as failure of crops or the disappearance of the water supply." Dr. Fewkes does not regard these ruins as of great antiquity; such evidence as has been gathered supports the Hopi legends that the inhabitants were ancient Hopi belonging to the Flute, Horn, and Snake families.

A. C. HADDON.

BACTERIAL DISEASES OF PLANTS.

THE second volume of Dr. E. F. Smith's work upon bacteria in relation to plant diseases, published by the Carnegie Institution of Washington, comes very opportunely to this country at a time when there are signs of an awakening interest in the subject of bacterial diseases of plants, and botanists, especially those interested in agriculture or horticulture, are beginning to turn their attention to the many economic problems in connection with this branch of phytopathology. The first volume, published in 1905, the author states, "had for its aim only the clearing of the ground by a discussion of methods of work in the general subject of bacteriology."

Although this department of botanical study is only some thirty years old, a considerable literature has arisen, even when the subject is taken in its narrowest sense, but when it includes, as in this case, many correlated topics, the list assumes large dimensions. Everyone interested in plant pathology will be grateful to Dr. Smith for bringing these papers together and for giving us a book of reference which has been long needed, and which embraces a concise historical account, leading up to the present position of the subject and embodying the most recent developments in this branch of research. A special feature of the book is the author's plan of including abstracts of many of the papers quoted, often of very considerable length, so that direct appeal can thus be made to original investigations; and although this method demands much space, the advantages are great, especially where controversial matter is being considered. Thus, under each sectional head, the author introduces extensive extracts from those original papers which he regards as critical studies, and concludes with a synopsis of the latest contribution to the particular phase of the question dealt with, adding always an extremely valuable bibliographical record. In the historical review Dr. Smith has missed the fact that the existence of a toxin and cytolytic enzyme secreted by the attacking bacterium was proved as early as 1899 as regards the "soft-rots," and in conjunction with carefully conducted

FIG. 1.—Crown gall on daisy.

Two tumours on the stem of a Paris daisy as the result of an inoculation of *Bact. tumefaciens* by needle-pricks, and on a branch above the upper one a secondary tumour on the petiole of a leaf. Age of primary tumours about three months; that on the leaf is much younger, perhaps four weeks old.

inoculation experiments; thus the bacterial nature of this class of diseases was fully established at that date.

The present treatise covers a wide field, and questions relative to the action of bacteria upon various tissues, the reactions of the plant, the interrelations of animal and plant parasites, individual and varietal resistance, and problems relating to prevention, come naturally within the scope of the work. A discussion of the various theories regarding the root-nodules of the Leguminosæ, and the question of symbiosis as it touches parasitism, are also usefully introduced, and the large chapter devoted to this relationship presents a valuable summary of results. But a *résumé* of conflicting views concerning bacterial symbiosis in insectivorous plants can scarcely be included under the titular definition of the book, nor the bacterial symbiosis in Cryptogams, as, for example, in kephir and the gingerbeer plant. Though exceedingly interesting and important to botanists, these discussions are rather foreign to the main theme, and might with advantage have given place to a further treatment of definitely established diseases; and more unity and balance would thus have been secured.

In seeking for some convenient classification of various diseases, the natural division into three large groups is adopted:—(1) the vascular diseases; (2) the parenchyma diseases without hyperplasia; and (3) cankers, tubercles, and tumours, in which there is a more or less distinct hyperplasia. Under the general considerations involved in a study of these forms of parasitism, such as the methods of infection and progress of the disease, the destruction of tissues and dissolvent action of enzymes, abnormal development of host tissues, &c., a great number of bacterial diseases are dealt with by way of illustration, but only three specific diseases are fully described as such. These—the wilt of cucurbits, the black-rot of cruciferous plants, and the yellow disease of hyacinths—belong to the vascular group, and are discussed in fullest detail with respect to the specific characters of the organism, the etiology of the disease, the morbid anatomy, geographical distribution, and remedial treatment, including an estimate of financial loss for which they are responsible. The account of the cucurbit wilt represents Dr. Smith's own work, and he has

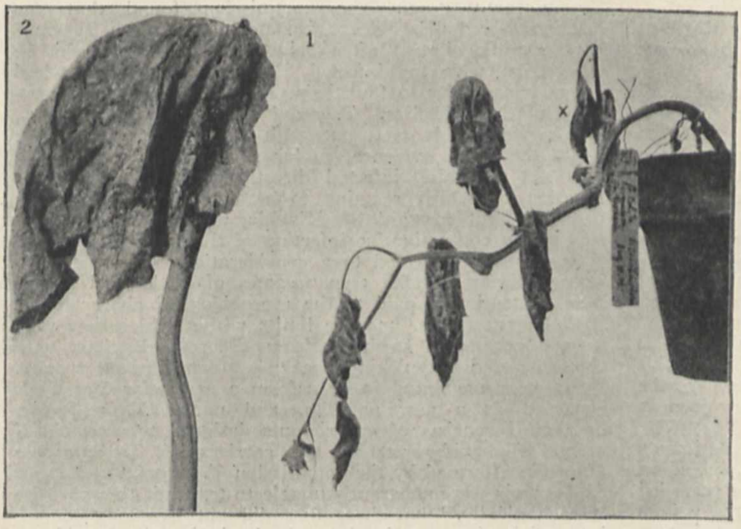


FIG. 2.—Wilt of cucurbits.

1. Cucumber-plant infected with a pure culture of *B. tracheiphilus* plated from the stem of a squash-plant. Plant inoculated August 10, 1905, by needle-pricks on blade of leaf marked ×. Photograph made on August 22. The vessels of the stem were plugged with a sticky white bacillus, which was plated out. Surface of stem sound. About one-sixth natural size.
2. Cucumber-leaf inoculated with *B. tracheiphilus* by *Diabrotica vittata* night of August 17, 1905. Blade shrivelled in some places and wilting in others. A natural infection. Photographed August 26, about half-size.

also carried out much original research upon the other special diseases enumerated. The three are placed each in separate chapters, and together occupy more than one-third of the whole volume. Perhaps we may look forward at some future date to a third volume dealing more completely with other important types.

The most notable recent work on bacterial disease is that by Dr. Smith upon the crown gall, and a very interesting epitome of his latest paper is included here. This brilliant piece of investigation has established beyond all question that the tumerous disease known as the crown gall (Fig. 1) is of bacterial origin, and the phenomena in connection with this type of bacterial disease appear, in the author's own words, "to throw a flood of light on the mechanism of the development of malignant animal tumours."

The book is fully illustrated by expressive drawings and photographs, made chiefly from material in the author's own laboratory. Two of the illustrations are here reproduced.

M. C. P.

THE PROGRESS IN OUR KNOWLEDGE OF THE TRANSMISSION OF SLEEPING SICKNESS AND OTHER TRYPANOSOME DISEASES IN AFRICA.[1]

THE latest report of the British Sleeping Sickness Commission is the outcome of the work of Colonel Sir David Bruce, Captains A. E. Hamerton, H. R. Bateman, F. P. Mackie, and Lady Bruce, the members of the third commission to Uganda during the years 1908–10. It is highly satisfactory to find that, in the volume before us, a distinct advance is recorded in our knowledge relating to important etiological questions connected with the spread of sleeping sickness and of certain animal diseases due to trypanosomes.

An introduction, illustrated by photographs, describes the chief features and arrangements of the camp at Mpumu, which was made the headquarters of the commission. The body of the work is divided into ten sections, the more important sections each comprising several groups of experiments. In a few cases these subdivisions represent the continuation or elaboration of an experiment previously recorded (in Report No. x.); in such, the result obtained from the original experiment is first of all briefly recapitulated. At the end of the volume is a comprehensive analytical index (to both Reports x. and xi.) which will be found very useful.

The first section (A), which is in many respects of the greatest interest, deals with the development of *Trypanosoma gambiense* and other trypanosomes in *Glossina palpalis*, and the question of their transmission by this tsetse-fly. As regards *Trypanosoma gambiense*, the following important conclusions are reached by the commission. Mechanical transmission, that is to say, transmission by means of interrupted feeding, plays a much smaller part, if any, in the spread of the parasites (and consequently of sleeping sickness) than has hitherto been supposed. After the first few hours, the bite of the fly was found to be non-infectious until at least twenty-eight days had elapsed since the fly fed on the original infected animal.[2] At the end of this "incubation period" the fly may become infective, and may retain its infectivity for at least ninety-six days. This means that the developmental cycle of the parasites in the insectan host was found to take about twenty-eight days, and only when this development was completed could the infection be transmitted back again to the vertebrate host. Once a fly becomes infective, it appears only too likely that it may remain infective for the rest of its life. On the other hand, against this alarming result may be set the fact that only a small proportion of flies (laboratory bred) appear to become infective, the commission having found that the trypanosomes develop only in about 1 in 20 of such flies fed on an infected animal; and the proportion of infective to non-infective flies occurring wild in nature is very much less, probably not more than 1 in 500. An interesting account is given of the various developmental phases of the parasites observed in the different organs of the fly. Stress is laid by the commission upon one fact, namely, that in the salivary glands, and in them alone, were the trypanosomes found to revert to the blood-type. Further, the occurrence of this type of the parasites in the salivary glands was found to coincide, broadly speaking, with the onset of permanent infectivity of the fly. The commission consider that without this invasion of the glands there can be no infectivity, and that the reversion of the parasites to the blood-type is

[1] Reports of the Sleeping Sickness Commission of the Royal Society. No. xi. Pp. 294+15 plates, text-figures, and maps.

[2] It may be mentioned that Kleine and Taute, associated with the German sleeping-sickness Commission, have found that flies may become infective about twenty days after being fed. This variation in the incubation-period is probably dependent on variations in the surrounding conditions, food, &c.

a *sine qua non* in the infective process; in other words, the stumpy type of form developed in this situation is regarded as the essential propagative phase. It should be mentioned, however, that the commission found also that injection of the intestines only of infected flies, after twenty-four days or more had elapsed since feeding, produced an infection in some of the inoculated animals. Hence either the blood-type must occur in the intestine also,[3] or else some other form or phase is also capable of transmitting the infection. With regard to the latter possibility, there is one point upon which we should like to comment. A characteristic type of parasite, long and very slender and possessing a peculiar elongated nucleus, was found, but not very commonly, in the fore-gut or proventriculus at intervals after twenty days. This very distinct type of form is known to occur also in the life-cycle of other trypanosomes, from widely different vertebrates, when in the invertebrate host; it has been described, for instance, in the case of *Trypanosoma brucii* in *Glossina fusca*, in the case of fish trypanosomes in leeches, and in the case of an avian trypanosome in a mosquito; in these cases it is either known with certainty to be the propagative phase or else is regarded with some probability as such. We think, therefore, that the fact of its occurrence in *Trypanosoma gambiense*, as described by the commission, should be noted, and the possibility that it may be a propagative form also in this case borne in mind. At any rate, the occurrence of this type in very different species of trypanosomes suggests that it has an important significance.

It is interesting to compare with the above account of *Trypanosoma gambiense* in *Glossina palpalis* the relations of *Trypanosoma vivax*, a dangerous parasite of cattle, to the same species of tsetse-fly, on which light has also been thrown by the commission. Flies were found to be able to transmit *T. vivax* after an incubation period of from seventeen to twenty-eight days, a shorter period, it will be noticed, than in the case of *T. gambiense*. The parasites develop, moreover, in a much larger percentage of flies—in about 20 per cent. A striking point of difference is that the development is restricted to the proboscis and pharynx of the fly, where the parasites occur in large numbers;[4] and, further, the predominating type of form met with is not, as in the other case, trypanosome-like. From this brief comparison it will be realised how greatly the developmental cycles of different species may vary even in the same insectan host.

The second section (B) consists of series of experiments designed to ascertain if, among various animals, including cattle, antelope, &c., there are any which can be regarded as a reservoir or source of *T. gambiense*; and the results obtained by the commission have already attracted considerable attention, and may prove ultimately to be of great economic importance. The conclusion arrived at is that it is possible both for cattle and antelope living in a fly area to act as a reservoir, and so maintain the infectivity of *Glossina palpalis* in regard to sleeping sickness; but up to the present the commission has not been able to prove that this actually takes place in nature. The facts brought forward in this connection, however, are very suggestive. In antelope the parasites are extremely scarce and difficult to find by microscopic examination of the blood, even when the animal was proved by experiment to be infective for flies. In one instance a buck was shown to remain infective for nearly three months. Infected animals remained apparently in good health, even though kept in captivity (in one case for at least four months). It is evident that in antelope and cattle the infection produced by *Trypanosoma gambiense* is of the chronic type, and apparently similar in character to the infection of wild game by *T. brucii*. In addition, there is the fact, shown by the commission, that the tsetse-flies from the lake-shore have now remained infective for three years since the removal of the population, the zone

[3] Kleine and Taute found blood-forms (apparently not quite corresponding, however, to those referred to above) in the intestine of most of their infective flies. Further, these workers do not attach much importance to the presence of the parasites in the salivary glands; in view of the marked correspondence shown by the British Commission between the period when the Trypanosomes were found in the glands and the time when the flies became infective, this discrepancy is difficult to explain.

[4] This localised type of development has been termed by Roubaud "évolution par fixation directe."

being given over to the wild game. Unfortunately, the commission was able to shoot only five buck, which were negative in respect of *T. gambiense*; from such a small number it was impossible, of course, to draw any conclusion. If the further investigation undertaken by Sir David Bruce proves that the wild game in the district is naturally infected with the parasites, a very serious etiological factor is introduced, since the removal of infected human beings from the zone of the fly will not be sufficient to cause the disappearance of the trypanosome.

We have dealt somewhat at length with the first half of the report in view of the widespread interest and importance attaching to all research that bears in any way upon the serious question of sleeping sickness. Consequently, we are unable to refer as fully as might be desired to the remaining half of the volume, which contains much that should be noted by workers on trypanosomes and trypanosomoses in general. It must suffice to indicate briefly the scope of the other sections, permitting ourselves to remark upon one or two particular experiments.

The third section (C) describes series of miscellaneous experiments carried out, for the most part in connection with *Glossina palpalis*. One of these series (No. 22) was to ascertain if laboratory-bred *G. palpalis* become infected with flagellates when kept in the same cage with, or in contact with cages containing wild flies infected with, *Trypanosoma grayi*. The commission found that the laboratory-bred flies did not become infected with *T. grayi* (or other flagellates) after being kept for six weeks in association with the infected flies, and after having had ample opportunity to foul their proboscides with the excrement of the wild flies. *T. grayi* is known to form cysts, which presumably pass out with the dejecta of the fly; hence the above evidence, so far as it goes, points to the flies not becoming infected directly from the cysts, the function of which remains to be determined. The idea originally put forward by Minchin was that they might serve for a contaminative infection of the vertebrate host.

Section D is devoted to a consideration of certain well-known disease-causing trypanosomes of cattle in Uganda. Much attention is paid to the morphological characters of the different forms, and the limits within which they vary in the case of "strains" from different districts, with the view of distinguishing clearly between different species. A trypanosome found in oxen from a particular locality is regarded as a new parasite, and named *T. uniforme*. Section E consists of experiments designed to ascertain if certain Tabanidæ act as the carriers of *Trypanosoma dimorphon* (termed by the commission *T. pecorum*). Species of Tabanus were apparently unable to transmit this parasite "mechanically," but these flies did not live long enough in captivity for it to be determined whether they could act as true hosts or not. We may point out that the flagellate parasites which were found in some of the (wild) Tabanids were most probably phases in the life-cycle of a trypanosome of some vertebrate, quite possibly a natural (*i.e.* harmless) parasite of the cattle themselves;[5] such a form would not be likely to live in rats. Sections F and G describe trypanosomes (including new species) and other parasites from various animals. Section H is concerned with the disease of natives known as "Muhinyo," which turns out to be Malta fever. Section I is a very useful account of the distribution, so far as it is known up to the present, of biting flies in Uganda, illustrated by a map in the case of the more important species. Lastly, Section J, together with the appendices, furnishes an epitome of the commoner diseases of cattle occurring in the different districts of the Uganda Protectorate.

It will be evident from the above digest that a mass of very useful information is contained in the latest report, which in our opinion is one of the most valuable of the series. No elaborate study of the numerous experiments is required to realise the very considerable amount of time and labour their prosecution must have entailed. The members of the commission are to be congratulated on the addition of an important quota to the ever-growing sum of our knowledge of the devastating trypanosome diseases of tropical Africa.

[5] Knuth and Rauchbaar have recently shown that a Trypanosome occurs naturally in cattle in Germany; this is most likely transmitted by Tabanids (*e.g.* Hæmatopota spp.), from which, in fact, flagellate phases have long been known.

INDIAN FOSSILS.[1]

THE Geological Survey of India has done good service both to stratigraphical geology and to palæontology by entrusting to Messrs. Cossmann and Pissarro its collection of Mollusca from the Ranikot beds of Sind. These are the only undoubted Lower Eocene strata hitherto discovered in India, and an authoritative comparison of their fossils with those of the corresponding European formations is of great interest and importance. Most of the specimens described are from the zone of *Nummulites planulatus*, and a large proportion of them were collected by Mr. E. W. Vredenburg, who contributes some preliminary stratigraphical notes to Messrs. Cossmann and Pissarro's memoir. The corals of the same formation were determined many years ago by Prof. Martin Duncan, while the Echinoids were described by Duncan and Sladen.

The general geological results obtained from the new study of the Mollusca accord closely with those reached by these earlier authors from their examination of the other groups. There are numerous specimens of Velates, a genus which specially characterises the Lower Eocene of Europe. Some species of Calyptrophorus are closely similar to those from the Eocene of North America, and there are many interesting forms of Volutilithes, Ampullina, and Rimella. There are also several specimens of *Styracoteuthis orientalis*, a curious dibranchiate cephalopod previously known only by a single example from the Eocene of Arabia.

The second part of the late Prof. Victor Uhlig's memoir on the Ammonites of the Spiti Shales (Upper Jurassic) of the Himalaya consists mainly of technical descriptions of species, illustrated by a fine series of lithographed plates. There are, however, interesting discussions of possible lines of development among the genera, subgenera, and species of the Hoplites group and the Macrocephalites group. Many genera of Ammonites found in the Spiti Shales exhibit no very close relationship to those of Europe, but among the species of the genus Hoplites it seems possible to recognise a series of well-known European types. Moreover, it is remarkable that these species in Europe are partly Lower Neocomian, and even range upwards to the lowest zone of the Middle Neocomian. In the Macrocephalites group Prof. Uhlig identifies species of Simbirskites, which is also a Lower Cretaceous genus in Russia, North Germany, and England. The large majority of the so-called new species are represented only by a single imperfect specimen, and the differences between many of them are so difficult to appreciate that the wisdom of multiplying names in such cases may be doubted. The study of Ammonites is obviously making great progress, but much of it is obscured by injudicious nomenclature.

[1] "Paleontologia Indica, being Figures and Descriptions of the Organic Remains procured during the Progress of the Geological Survey of India." New series, Vol. iii., Memoir No. 1., The Mollusca of the Ranikot Series. Part 1., Cephalopoda and Gastropoda, by M. Cossmann and G. Pissarro; Introductory Note on the Stratigraphy of the Ranikot Series, by E. W. Vredenburg. Pp. iv+xix+83+viii plates. Price Rs. 2 or 2*s*. 8*d*. Series xv., Himalayan Fossils, Vol. iv., The Fauna of the Spiti Shales. Fasciculus 2, by Prof. Dr. V. Uhlig. Pp. 133–306+plates xix–xlviii*a*, and lxxvii–xci. Price Rs. 12.4 or 16*s*. 4*d*. (Calcutta: Geological Survey Office, 1909 and 1910.)

JUVENILE EMPLOYMENT AND CONTINUATION EDUCATION.

DURING recent years the efforts of reformers of our national system of education have been concentrated to a considerable extent upon two great problems, namely, the early age at which education ceases for most boys and girls, and the entry of so many boys into "blind alley" industries, resulting a few years later in their being thrown, unqualified and unskilled, upon the labour market. With regard to continuing elementary education to a later date, but little progress has been made of recent years. Unfortunately, Mr. Runciman's Bill of 1911, dealing with questions such as the raising of the "leaving age," the abolition of "half-time," and compulsory attendance at continuation schools, was not pressed through, and no intimation has yet been given that the Government intends to bring into operation, if possible, even one of the reforms covered by the Bill of 1911.

Considerable progress is being made, however, in the direction of attempting to lessen the evils of the "blind alley" industry. It is obvious this can best be done by acquainting parents with the future prospects offered by the various trades or callings into which the boy may enter on leaving school, by personal advice as to the necessity of attending continuation classes and the educational course it is best for the boy or girl to pursue when attending evening classes. The first public recognition of this was the Education Act of 1908 for Scotland, authorising the School Boards of Scotland to maintain voluntary agencies which should advise boys and girls upon the suitable employments open to them on leaving school. Later in the same year clauses were inserted in the Labour Exchanges Bill authorising the Board of Trade to establish Juvenile Labour Exchanges. Somewhat later, the Education (Choice of Employment) Bill gave powers to the English and Welsh education authorities "to give boys and girls information, advice, and assistance with respect to the choice of employment." This duplication of powers to the Board of Trade and the education authorities, respectively, gave rise to some friction at first; but this has now been smoothed away, the Board of Trade only exercising its powers independently if the education authority decides not to put the Act in operation.

Already a number of local education authorities have prepared schemes for the exercise of their powers under the Act. The schemes provide for the cooperation of the Labour Exchanges of the Board of Trade with local committees nominated by the education authority. The Board of Education has formally approved of the schemes proposed by the Liverpool and Birmingham Education Authorities respectively. It is understood that about twenty other authorities have submitted schemes for approval, and that a number of other authorities are preparing schemes at the present time.

The success of the Act will depend mainly, of course, upon the local committees appointed to carry out the duties imposed upon them by the Act. Apparently these committees will contain a fair sprinkling of representative local employers, social workers, elementary teachers, and the like. It is important that due representation should be given, if possible, to those with firsthand knowledge of continuation and technical school work, in order that the best possible advice be given respecting attendance and courses of work at evening continuation and technical schools.

In further support of the agitation to limit the evils of the "blind alley" occupation, a long letter appeared in the daily Press on Thursday, February 1, signed, among others, by the Bishop of Hereford, Mr. Cyril Jackson, Mr. Ramsay Macdonald, M.P., Mr. J. L. Paton, and Dr. M. E. Sadler. In this letter attention is directed to such facts as that van boys work, on an average, from 96 to 100 hours per week, and that only about 36 per cent. of these boys secure positions later as carmen. About 53·7 per cent. of recruits from London for the Army began life as van boys and errand boys. It is clear from the long hours worked by van boys and the like that attendance at continuation schools is impossible. The signators of the letter recommended that boys engaged in such callings as those just mentioned should, between fourteen and eighteen years of age, be permitted to work only for thirty hours per week, and be compelled to attend continuation schools for another twenty hours.

Incidentally, it may perhaps be suggested that sometimes educational institutions such as university colleges, medical schools, and technical schools, are not entirely guiltless on these questions of "blind alley industries" and the lack of facilities for continued education given to the boys passing direct from the elementary schools to the position of assistants in the laboratories or workshops of the colleges or schools.

J. WILSON.

THE PRESSURE OF A BLOW.[1]

THE scientific analysis of a blow requires, first, the determination of the actual pressures or forces set up between the colliding bodies, and, secondly, an investigation of the distribution of these pressures and of their physical effects. The pressure produced by a blow does not differ in kind from that produced by any other agency, such as

[1] Discourse delivered at the Royal Institution on Friday, January 26, by Prof. Bertram Hopkinson, F.R.S.

an hydraulic press, but it differs in degree because of its great intensity and of its extremely short duration, and these characteristics, as we shall see, have a marked influence on the effects which it produces.

The first part of the problem, that is, the calculation of the pressure in tons or pounds, is based on the familiar principles of mechanics which were first precisely stated in Newton's laws of motion. The cause of the pressure is the rapid change of motion of the colliding bodies which occurs when they come into contact, and, according to Newton's second law, the force is simply proportional to the rate at which this change is effected. The rate of change may be measured in terms of energy and distance or in terms of momentum and time. Thus a hammer head moving at a rate of 16 feet per second, and weighing 1 lb., possesses 4 foot-lbs. of energy, because its velocity could have been acquired by falling freely through 4 feet. If it strikes a nail and drives it one-eighth of an inch, the energy which was generated by the weight of 1 lb. acting through 4 feet is destroyed in 1/400 part of that distance, and the force necessary to effect this change of motion is 400 times as great—say, 400 lbs. The same effect would be produced by a 4-lb. hammer striking with the velocity which would be acquired by falling through 1 foot, namely, 8 feet per second. Regarding the same instance from the point of view of momentum, the 1-lb. hammer would take half a second to fall 4 feet, and the quantity of motion or "momentum," reckoned as the product of the force acting into the time required to generate it, would be one-half of a pound-second unit. While driving the nail in, the hammer covers a distance of ⅛ inch with a velocity which starts at 16 feet per second and drops to zero. To cover the distance of ⅛ inch with the average velocity of 8 feet per second takes 1/800 of a second, which is 1/400 of the time (½ second) which it takes the weight of the hammer head (a force of 1 lb.) to generate its motion. Thus the pressure required for the rapid stoppage is, as before, 400 lbs.

We may take another instance essentially similar to the hammer and nail, but differing greatly as regards scale. A 14-inch armour-piercing shell weighs about 1400 lbs., and when moving at 1800 feet per second possesses about 31,000 foot-tons of energy, or about 15,000,000 times as much as our hammer head. Such a shell would just pierce a plate of wrought iron 2½ feet thick, and the average force which must be exerted to pull it up in that distance, which is, of course, the pressure which it exerts on the plate, is 30,000 divided by 2½, or about 12,000 tons. This is equivalent to some 80 tons on the square inch.

When a hammer strikes a nail, the force acting during the blow is practically constant, and the average value obtained as above by dividing the energy by the distance moved, or the momentum by the time taken, is equal to the actual force exerted throughout the impact. In many cases, however, this force is not constant, and it is then necessary to divide the course of the impact into short intervals either of space or of time, calculate the change of energy or momentum in each, and add the result. A familiar instance is that of two billiard balls. We may suppose one ball to strike the other full with a velocity of 16 feet per second, which corresponds to a fairly hard stroke. It simplifies the consideration of the problem if instead of one ball moving and the other at rest we suppose them to be travelling in opposite directions with equal velocities of 8 feet per second. At the instant when the balls first touch there is no pressure between them, but as they continue to approach each flattens the other at the point of contact. The balls no longer touch at a point, but over a circular area which rapidly increases in diameter. Corresponding to any given amount of flattening or distance of approach, there is, of course, a definite pressure, which might be measured by actually squeezing the balls together under known forces and measuring the corresponding amount of approach. Or the relation between pressure and distance could be calculated, as was done by Hertz. The area of the curve connecting pressure and distance up to any point gives the number of foot-pounds of energy destroyed. When this is just equal to the original energy of the balls they will have been reduced to rest, and in the case supposed the distance of approach is then 14/1000 of an inch, and the total pressure between them 1300 lbs. This pressure is distributed over the circle of contact, which is one-sixth of an inch in diameter, and the average intensity of the pressure is 27 tons per square inch. The distribution, however, is not uniform, the pressure at the centre being 1½ times the average. The balls are then like compressed springs, their original energy of motion having been completely transformed into strain energy in their substance. The reason of the high intensity of pressure developed is that this strain energy is concentrated into a very small volume of ivory near to the point of contact. The balls then begin to separate, and the whole process of compression is gone through in reverse order, the strain energy being transformed back into energy of motion by the pressure. Finally, the balls rebound unstrained, with nearly the velocity with which they approached.

If for the ivory balls we substituted hollow balls of steel having the same mass, the pressure produced by the blow would be greater, because the steel is much more rigid than ivory, and gives less under a given force. Thus the distance of approach is less, the circle of contact smaller, and the maximum intensity of pressure much greater. It reaches 280 tons per square inch averaged over the surface of contact. Such a pressure could only be sustained without permanent effect by a very hard steel. Ordinary mild steel would begin to flow when the pressure passed about 100 tons, a permanent flat would be left by the blow, and the balls would rebound with less velocity than that of approach. The theory the results of which I have given does not, of course, apply to such a case, as it depends on the assumption of perfect elasticity.

It is rather remarkable that materials can sustain without injury such large pressures as are produced by these blows. Mild steel balls are not crushed perceptibly until the pressure reaches 100 tons per square inch, yet a short column of the same steel would be crushed by a pressure of 30 tons per square inch. One reason is the extremely short duration of the pressure—it has no time to produce much effect. The other is the fact that in the blow it is accompanied by large lateral pressures exerted by the metal surrounding the area of contact. Pressure equal in all directions, such as is exerted by the water at the bottom of a deep ocean, produces generally no permanent effect on solids or liquids. To produce breakage or permanent deformation there must be difference of pressure in different directions, and the most important, if not the only, factor determining whether such breakage or deformation shall occur is the amount of the difference. If, for example, our column of mild steel, which in the absence of lateral support begins to crush at 30 tons, were surrounded by a jacket exerting a radial pressure of 30 tons, it is probable that the end pressure might be increased to 60 tons without any movement occurring. In the impact of balls the metal surrounding the point of contact, by resisting the lateral expansion of the compressed part, sets up radial pressure of this kind. It can be shown, in fact, that the lateral pressure at the centre of the circle of contact, corresponding to a maximum normal pressure of 100 tons per square inch, is 75 tons per square inch, leaving 25 tons effective for producing deformation or breakage.

These calculations of pressure are based on theory, and it may be asked what direct experimental evidence we have that the theory is correct. It is not, of course, possible actually to measure the pressures over the minute circle of contact between the balls, nor is it possible accurately to measure the amount of the flattening. We can, however, pursue the calculation a little further, and determine the time during which the balls are in contact from the moment when they first touch to the moment at which they separate on the rebound. In the case of billiard balls moving with a relative velocity of 16 feet per second, this time is 1/4000 of a second. A precisely similar calculation can be made for balls of steel or other metal, and it is not difficult to measure in the laboratory the time during which such balls remain in contact. The method is of considerable use in connection with impact problems, and it consists in making the two balls, by their contact, close a galvanometer circuit in which there is also a battery and resistance. A certain quantity of electricity, which is simply proportional to the time of contact, then passes through the galvanometer and produces a proportionate deflection in it. It has been found that the time of contact measured in this way for steel balls is exactly that predicted by theory, and it may be inferred that the theory is correct in all its details, and that the pressure calculated by its aid corresponds with the facts. This method was first used by Pouillet in 1845, and has recently been brought to great perfection by Mr. J. E. Sears, who showed, among other things, that the relation between pressure and deformation of steel is almost exactly the same when the pressure is applied for an excessively short time, as in the case of impact, as it is when applied steadily, as in a testing machine. The assumption that this is the case lies, of course, at the root of the calculations, and its verification was therefore a matter of considerable importance.

When one billiard ball strikes another the effect of the blow is practically instantaneously transmitted to every portion of the colliding balls, or, to speak more precisely, the time taken to transmit the pressure is short compared with the total time of contact. Except for the minute relative displacement near the point of contact, the balls move as a whole, every part having the same velocity at each instance of time and coming to rest at the same moment. In many cases of impact, however, and in those possessing the most interest from a practical point of view, this is by no means the case. We may consider, for instance, the impact of an elongated lead rifle bullet against a hard steel plate. Under the enormous pressures developed lead flows almost like water, and in the absence of lateral support it is as little capable of transmitting those pressures. Thus, when the nose of the bullet strikes, the metal thus brought into contact with the plate immediately flows out laterally, its forward motion being destroyed; but the hind parts of the bullet know nothing of what has happened to the nose, because the pressure cannot be transmitted to them, and they continue to travel on with the original velocity until they in their turn come up to the plate and have their momentum destroyed. The process of stopping the bullet is complete when its tail reaches the plate, and the time required is simply that taken by the bullet to travel its own length. Thus a Lee-Metford bullet is $1\frac{1}{4}$ inches in length, or, say, one-tenth of a foot, and if moving at 1800 feet per second, which is about the velocity given with a rifle, it would be stopped in 1/18,000 of a second. The bullet weighs approximately 0·03 lb., and possesses with this velocity about 1·7 lb. second units of momentum. The force required to destroy this in 1/18,000 of a second is 18,000 multiplied by 1·7 lb., or, say, 15 tons. This acts over the sectional area of the bullet, which is one-fourteenth of a square inch, giving a pressure of about 210 tons per square inch. This is the average pressure throughout the impact, but the pressure is probably nearly constant. It is to be noted that the pressure per square inch depends only upon the velocity (varying as its square), and not upon the length or diameter of the bullet. Increase in diameter only alters the area over which the pressure is applied, and increase in length the time during which it is applied.

If for the bullet of lead we substitute one of hardened steel which will not flow, the problem at once becomes much more complicated. In order to reduce it to its simplest terms, and to bring the theory into such a form that it can be tested in the laboratory, we may suppose that, instead of the bullet, we have a cylindrical steel rod, say $\frac{1}{2}$ inch in diameter by 10 inches long, with flat ends, and that it strikes quite fair against an absolutely unyielding surface. The latter condition could not be fulfilled in practice, because there is no substance more rigid than steel. So far as the effects on the rod are concerned, however, it can be fulfilled by making two rods, moving with equal velocities in opposite directions, collide end on; and this device has been used in the laboratory for imitating the effect of impact against an unyielding surface. We have to consider how long it takes to stop the rod under such conditions. When the end first strikes it is pulled up dead, just as in the case of the lead bullet, only it does not now flow out sideways. The pressure, however, set up at the end of the rod cannot be instantaneously transmitted through it, and consequently the hind parts do not at once feel this pressure, but continue to move on as before. The transmission of the pressure takes place with the velocity of sound, which for steel is about 17,000 feet per second, and it takes, accordingly, 1/20,000 part of a second before the pressure has been transmitted throughout the 10 inches length of the rod. A wave of pressure is initiated at the first contact and travels along the rod. At any instant the part of the rod which has already been traversed by the wave will be at rest and in compression, while the remainder which has not yet been reached by the wave, and accordingly as yet knows nothing of the impact, will still be moving forward with the old velocity. Each section continues to move on until the wave reaches it, when it is stopped with a jerk, the sections thus pulling up successively until the whole rod is at rest, which happens when the wave has travelled to the free end. From the momentum of the rod, and the time taken to stop it, the pressure can be calculated by the use of the principles already illustrated. Thus a rod 10 inches long is stopped, as we have seen, in 1/20,000 second, and if it be moving with the moderate velocity of 20 feet per second, the pressure required to pull it up in this time is 15 tons per square inch. This pressure is constant throughout the impact, and it is obvious that here again the intensity of pressure is dependent only upon the velocity, and not on the weight of the rod; for if with the same velocity the length is increased, the corresponding increase of momentum to be destroyed is cancelled by the greater time required for the transmission of the pressure wave, and if the area is increased the total pressure is merely increased in proportion, the pressure per unit area remaining the same. For a hard elastic body the pressure is proportional to the velocity, a principle which is probably generally applicable in the initial stage of all impacts.

At the instant of greatest compression, when the rod is reduced to rest, it is like a compressed spring, and there being no pressure acting at its free end to keep it compressed, it proceeds to expand again. Starting at the free end, a wave of expansion travels down the rod, the several portions being successively jerked into motion with approximately the original velocity. The whole process of restoring motion to the rod is completed when this wave reaches the impinging end, when the rod rebounds as a whole with the original velocity. The whole time of contact is, then, that taken by a wave of sound to travel twice the length of the rod. Here, again, by electrical measurement of the time of contact, it is possible to check the theory. It is found that the actual time is longer than that predicted. This is due to the fact that one cannot in practice make the rods hit absolutely true all over the ends; they strike at one point first, and the metal near that point has to be flattened out before the ends come into contact all over and initiate the simple plane pressure wave of the theory. The complete analysis of the discrepancies between theory and experiment so caused was long a puzzle to physicists interested in these matters. It was finally effected by Mr. J. E. Sears, who determined mathematically the corrections necessary on this account, and submitted his theory to experimental test with entirely satisfactory results.

Another simple instance of the propagation of waves along rods illustrates a point of importance in regard to the general effect of blows. Instead of maintaining the pressure during the whole passage of the wave up and down, as in the end-on impact, a pressure is suddenly applied to one end, maintained for a short time, and then removed. A corresponding pressure wave travels along the rod. Each portion of the rod is only stressed or in motion during the passage of the wave over it, and after the passage of the wave it is left with a certain forward displacement, but without any velocity or stress. Furthermore, the whole momentum of the blow is concentrated in the short length of the rod covered by the wave. On its arrival at the other end the wave is reflected, but the reflected wave is a wave of tension. As it comes back the head of the tension wave is at first wholly or partially neutralised by the tail of the pressure wave, but after a time it clears this, and the rod is then put into tension of amount equal to the original pressure. If there be a crack or weak place in the rod at a sufficient distance from the free end, the pressure wave will pass over it practically unchanged; but on the arrival of the reflected tension wave the rod will part, because the crack cannot sustain the tension, and the forward part will move on, having trapped within it the whole momentum of the blow. The rest of the rod will remain at rest and unstrained.

(The propagation of waves in rods was illustrated by means of a model, consisting of horizontal wooden bars fixed at equal intervals to a vertical wire.)

The fact that a blow involving only pressure may, by the effects of wave action and reflection, give rise to tensions equal to or greater than the pressure applied, often produces curious effects which may be illustrated in many ways. I shall choose by way of illustration some observations which I have been making recently, and which I think are new. I have here a small cylinder of gun-cotton. By the use of a small quantity of fulminate in the hole provided for the purpose it is possible to detonate the gun-cotton, which means that in an excessively short time it is converted into gas at a very high temperature. The time required is probably only three or four millionths of a second, and is so excessively short that the gas does not during the process expand appreciably into the surrounding atmosphere.

Thus the gas generated, which, when completely expanded, will fill a space several thousand times as great, is for a minute fraction of time confined within the volume of this small fragment of gun-cotton. This confinement implies great pressure—how much is at present a matter of doubt. I understand that Sir Andrew Noble estimates it at 120 tons per square inch. The only thing which restrains the expansion of the gas is the inertia of the surrounding air, and the pressure accordingly drops with very great rapidity. It is probable that the pressure is practically gone after 1/25,000 of a second. The same pressure is, of course, exerted by the gas upon any surface with which gun-cotton is in contact, and it will be seen that the force so produced has the characteristics of a blow, namely, great intensity and short duration. If such a cylinder of gun-cotton weighing one or two ounces be placed in contact with a mild steel plate, the effect, if the plate be half an inch thick or less, will be simply to punch out a hole of approximately the same diameter as the gun-cotton, just as though it had been struck by a projectile of that diameter. But if the plate be three-quarters of an inch thick, the curious result which I exhibit here is obtained. Instead of a complete hole being made, a depression is formed on the gun-cotton side of the plate, while on the other a scab of metal of corresponding diameter is torn off and projected away with a velocity sufficient to enable it to penetrate a thick wooden plank, or to kill anyone who stands in its path. The velocity, in fact, corresponds to a large fraction of the whole momentum of the blow. The scab behaves much in the same way as the piece which we saw would be shot off the end of a rod struck at the other end if the rod were divided or weakened, so as to be unable to sustain the reflected tension wave. The separation of the metal implies, of course, a very large tension, which can only result from some kind of reflection of the original applied pressure; but the high velocity shows that this tension must have been preceded by pressure over the same surface, acting for a time sufficient to give its momentum to the scab.

Wishing to ascertain how and where the separation originates, I caused a two-ounce cylinder of gun-cotton to be detonated in contact with a somewhat thicker plate. In this case no separation of metal was visible, the only apparent effects being a dint on one side and a corresponding bulge on the other. On sawing the plate in half, however, I was gratified to find an internal crack, obviously the beginning of that separation which in the thinner plate was completed.

The pressure exerted by the gun-cotton in the experiments which I have just described is practically confined to the circular area of contact between it and the metal, as is shown by the accurate agreement of the print on the plate with that circle. The effects of that pressure must, however, be largely conditioned by the fact that the metal upon which it acts is attached to the surrounding portions of the plate, and is by them held back. In order to get an idea of the effect of this factor, I have tried the experiment of removing this outside metal, leaving the steel cylinder opposed to the gun-cotton. If such a short cylinder of steel be placed in contact with a gun-cotton cylinder of equal diameter, the result of detonation was at first sight merely to flatten it out slightly, and to produce a depression on one side with something of a bulge on the other. No external crack was visible. But on sawing the piece in half a remarkable system of cracks was disclosed; the cracks spread in all directions, as though tension had been acting in every direction; in fact, it appeared as though the steel cylinder had begun to burst. The tension necessary to produce these cracks, which, as you will see, must have radial as well as axial components, must originate in some kind of wave action which follows the blow. The problem is very complicated, and I have not yet succeeded in finding a full explanation of the phenomenon; but there cannot be much doubt that the longitudinal tensions are due to a wave generally similar to that which we have been discussing in connection with the rod. To account for the radial tensions which the cracks show also to have been present, it is to be observed that the shortening of the cylinder in the direction of its axis, which is the immediate effect of the blow, must be accompanied by a corresponding increase in diameter. This increase takes place very rapidly, and implies that at first the metal is moving out in a radial direction with a high velocity. The stoppage of this radial motion requires radial tension, and this probably is greater at points near the axis, for much the same reason that when a stone is dropped into a pond the circular waves which it causes have their greatest amplitude at points near the centre of disturbance. In the case of the steel cylinder the radial tension wave travels inwards from the surface, and its amplitude increases as it goes in.

I have recently been attempting to measure the duration of the pressures produced by the detonation of gun-cotton. The method depends on the reflection of a tension-wave at the free end of the rod. A wave of compression travels along the rod, the length of the wave corresponding to the time during which the pressure has acted; that is, it is equal to the velocity of sound multiplied by that time. We may assume that the time was 1/20,000 of a second, which would give a wave just 10 inches long. This wave travels to the end of the rod, is there reflected as a wave of tension, and comes back. If the rod be cut across, the surfaces of the junction being accurately faced and in firm contact, the pressure wave will pass the joint without change, but on the arrival of the head of the tension wave at the joint the parts will separate and the end piece will fly off. If the tail of the pressure wave has then cleared the joint, the separated end-piece will have trapped within it the whole momentum of the blow, and the part left behind will remain at rest and unstrained. In the case supposed things will happen in this way if the end-piece is more than 5 inches long. If it be less than 5 inches long, say 4 inches, there will, on the arrival of the reflected wave at the joint, be still 2 inches of pressure wave in the other part of the rod, and the corresponding quantity of momentum. In this case, therefore, only a portion of the whole momentum is trapped in the piece, the balance being left in the other part of the rod, which moves forward with the corresponding velocity. In order to discover how long the pressure lasts, it is only necessary to try a series of experiments with the joint at different distances from the free end. It will be found that if that distance exceeds a certain amount, the rod which was originally struck remains at rest, the whole momentum being transferred to the free end-piece. If the distance be less, only a fraction of the momentum is so transferred, and the balance remains in the struck rod, which accordingly moves forward. By trying a series of experiments with end-pieces of different lengths, the rate at which the pressure disappears can be determined. In this way I have shown that the pressure developed by the detonation of 0·1 ounce of gun-cotton is practically all gone in 1/30,000 of a second.

I have on the table some specimens to show the effects of detonating larger quantities of gun-cotton. Here is a steel plate which has been broken by firing a charge of about 1 lb. in contact with it. It is interesting to note the character the fracture produced. This plate is a good quality of mild steel, such as is used for making boilers. It would be possible by a steadily applied pressure to bend it double without fracture, yet as the effect of the blow delivered by the gun-cotton it is broken with very little bending, almost as though it were cast iron or very hard steel. Time will not permit of my going further into the interesting question—of course a very important one in connection with our subject—of the effect on the character of the fracture produced of very big stresses lasting for a very short time. This case of the fracture of mild steel by gun-cotton shows, however, that one result may be that the property of ductility largely disappears under the action of a sufficiently violent blow. The mild steel, in fact, behaves very much like sealing-wax or pitch. The stick of sealing-wax which I hold in my hand has been bent by the continued action of a small force acting for several days, and the same force, had it continued to act, would ultimately have bent it double without breaking it. Yet under the application of a force many times as great it snaps like a piece of glass.

The pressures produced by the detonation of gun-cotton are of the same order of intensity as those developed in ordinary blows. We saw that in the impact of billiard balls the average pressure over the area of contact may reach a value of 27 tons per square inch, and with steel balls moving at quite small velocities, such as 2 or 3 feet per second, it is easy to get pressures of 100 tons per square inch or more. These pressures, however, are very local, the area over which they act being a few hundredths of an inch in diameter only. By means of gun-cotton similar pressures may be applied over any desired area, but the intensity is no greater. About 120 tons per square inch is probably the limit of simple static gaseous pressures produced by known practical explosives. Probably greater pressures are produced with fulminate, but that cannot be used except on a very small scale. For the production of destructive effects on hard steel greater pressures than this are required, and in order to develop them on any considerable scale we must again have recourse to the dynamic action of collision.

We have already seen that a lead bullet moving at 1800 feet per second probably generates a pressure of 200 tons per square inch or more. We went on to consider the impact of rods of hard metal, and it appeared that two rods of steel colliding end on with a relative velocity of 40 feet per second would develop a pressure of about 15 tons per square inch over the whole section of either. The theory on which that conclusion is based has been subjected to experimental test—indirect, it is true, but sufficiently searching—and is certainly correct for velocities and pressures of that order. According to the theory, the pressure is simply proportional to the relative velocity of the two rods, so that if they collided at 2000 feet per second, that is, fifty times as fast, the pressure would be 750 tons per square inch, assuming that the theory continues to hold under these very different conditions.

One of the fundamental assumptions on which the theory is based, however, would certainly break down long before such a velocity was reached. That assumption is that the pressure leaves no permanent effect on the material. I do not know what is the strongest steel for this purpose which has been produced, but I think it may safely be asserted that no known substance would stand an end compression, such as results from the blow of the colliding rods, of more than 300 tons per square inch. If it were ductile it would flow so rapidly under this pressure that there would be appreciable deformation even in the very short time during which the pressure lasts. If it were very hard it would be instantly shattered. In both cases the circumstances of pressure transmission would be completely altered. It is, however, fairly certain that in neither would the pressure exceed that calculated on the hypothesis of perfect elasticity, and that in both it would be greater than that calculated (as for the lead rifle bullet) on the hypothesis of no elasticity.

I am afraid, therefore, that at present our theories can throw but little light on the interesting question of the pressure developed when a hard steel armour-piercing shell strikes a hard steel plate with a velocity of 2000 feet per second. But a consideration of the visible effects of such a blow is suggestive in many ways, and by the kindness of Sir R. Hadfield I am able to describe and show some of them to you to-night.

You see before you specimens of modern armour-piercing shot. The shell is made of a special steel of great strength and considerable ductility, and after manufacture the point is hardened by thermal treatment, the base and most of the body of the shell remaining more or less ductile. In recent years it has become the practice to fit a cap of soft steel over the hardened point. I will speak of the functions of this cap later, and for the present we will consider the shell without it.

I first show the effect of firing an uncapped shell at a plate of wrought iron or mild steel. In this case the metal of the plate is so soft that pressures that are quite without effect on the hardened point of the shell are able to make it flow very rapidly. The shell simply ploughs its way through, pushing out the wrought iron before it, and emerges quite unscathed. It will be noticed that on the striking side there is a rim or lip of wrought iron which has been squeezed out in a direction opposite to the movement of the shell. A similar lip is formed if a hole is blown in a lead plate by means of a gun-cotton primer, and there seems to be a good deal of analogy between the two cases.

Completely to stop a 14-inch shell, such as that which you see before you, would require a thickness of at least 2½ feet of wrought iron, and almost as great a thickness of mild steel. I believe that some ships twenty-five years ago were fitted with armour of this sort of thickness, but, of course, the weight is almost prohibitive. Modern improvements in armour, whereby the same effective resistance is obtained with less than half the thickness, are based on the use of special steel having sufficient ductility to enable it to be worked and fixed in place on the ship, while possessing greater strength than wrought iron or ordinary structural steel. Even such a special steel, however, is handicapped as against the shell by the hard point of the latter, which is able to force the softer material aside, though itself undamaged. This disability, however, has been overcome by hardening the face of the plate, so that it now possesses a composite structure, the back being tough and ductile, but the face as hard as it is possible to make it. When such a plate is struck by the shell it is a case of Greek meeting Greek, and this is the result (photograph). Both the shell and the hardened face of the plate are shattered by the pressure, sufficient of which is transmitted through the substance of the plate to crack it right through, though, of course, none of the shell has penetrated it.

It would seem that when it acquired the hard face the armour plate more than overtook the shell in the race. Though the shell might by sheer energy pierce a somewhat thinner plate, I am told that it was apt to be smashed to pieces in the process. The balance has of recent years been more than restored by the addition to the shell of the soft steel cap. I have already shown you the effect of firing an uncapped shell; I will now direct your attention to that of firing the same shell with cap at the same plate. The shell goes through minus its cap, but otherwise so completely uninjured that I am told it might in many cases be used again. It punches a clean hole in the plate. The fate of the cap is interesting. The shell punches a hole in it, as of course it must do before it reaches the plate, and the cap forms a ring, which is held up by the plate, and through which the shell passes. The fragments of the cap are found on the front side of the plate, and in some instances they have been collected and put together, forming a ring. I have one such ring here. Its largest diameter is that of the shell, its smallest about an inch less, and it looks as though the ring had got intact as far as the shoulder of the projectile, but had then burst into several pieces.

The usual explanation of this remarkable effect of a soft steel cap is that it supports the point of the projectile. As I pointed out in connection with billiard balls, the destructive effect of pressure depends on the difference of pressures in different directions, and not on their absolute amounts, and it is obvious that by the exercise of a sufficient lateral pressure the point might be completely protected. The difficulty is to see how the comparatively weak material of which the cap is made can exert the very large pressures which are necessary for effective support. It seems hardly possible that such pressures could be generated by the mere act of stretching or expanding the cap over the end of the shell. If this be so, the inertia of the metal in the cap must play an important part. At the critical moment when the hard point of the shell meets the plate, there is a sudden distortion of the shell and plate near the point of contact. This distortion is the cause of breakage. One can see that the mass of mild steel surrounding the point of the shell, and pressed into firm contact with it, might by its inertia oppose a powerful resistance to this sudden change of form, and so support the shell during the minute fraction of time which determines whether it or the plate shall go.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—At the last meeting of the City Council the recommendation of the Education Committee to allot to the University the proceeds of a penny rate was discussed. The amount which would have been raised by such a rate is about 16,000*l.* at present, and would increase with the growth of the city. Some opposition to the recommendation was made by the supporters of the Birmingham and Midland Institute, who wished 1000*l.* per annum to be granted to that institution. Further opposition came from some of the Socialist members of the Council on the ground that the money would be better spent in increasing the facilities for secondary education to the poorer classes. A letter was read from the Board of Education pointing out that the ear-marking of so large a sum as that required by the Education Committee for additional scholarships would materially lessen the value of the grant to the University for the purpose of diminishing its present debt, and this would be taken into consideration in allotting the Treasury grant, which was to be allocated to the various applicants in proportion to the amount of local support forthcoming. The result of the discussion was the assigning of a sum of 15,000*l.* per annum from April 1 until further notice.

The annual reports of the University Council and Principal have been published, from which it appears that the total number of registered students during the past session was 1017, as against 958 for the previous session. The Principal again emphasised the need for a chair of Greek. He also hoped that some further development in facilities for agricultural studies would be made during the present session.

Prof. John Joly, F.R.S., has been appointed Huxley lecturer for the current session.

OXFORD.—The following letter has been addressed to the Vice-Chancellor by Prof. Karl Pearson, .F.R.S. :—

"Dear Mr. Vice-Chancellor,

"I feel very deeply indeed the honour which has been conferred on me by the award of the Weldon Prize. I realise fully also the difficulties under which the Electors have been placed owing to the terms of the statutes. But as one who was partly instrumental in founding the prize, and who also had many opportunities of knowing the views held with regard to such prizes by the man whose work it commemorates, will you allow me to be at once very grateful for the award and yet to ask the University to pass me over in its selection?

"I feel strongly that, whatever the formal wording of the statutes may be, the intention of the donors and the spirit of the late Prof. Weldon, which influenced their foundation, was the encouragement of younger men, to whom timely recognition may mean an all-important indication that their work is appreciated and their chosen path a fitting one.

"KARL PEARSON."

DR. A. H. FISON has been appointed secretary of the Gilchrist Educational Trust, in succession to the late Dr. R. D. Roberts.

MR. ALFRED SCHWARTZ has resigned the professorship of electrical engineering in the Manchester University and the School of Technology on his appointment by the President of the Board of Education to a staff inspectorship in engineering under the Board. The resignation dates from March 31.

THE issue for January of *The Technical Journal*—the organ of the Association of Teachers in Technical Institutions—is full of material of interest to the members of the association and others engaged in technical education. Among the most noteworthy contributions may be mentioned the statement of the evidence given by the Association of Teachers in Technical Institutions before the Royal Commission on University Education in London, and the presidential address of Mr. Barker North at the annual meeting of the association last November. A portrait is included of Mr. J. H. Reynolds, whose retirement from the principalship of the Manchester Municipal School of Technology will take place shortly.

IT is announced in *Science* that the directors of Bryn Mawr College have formally accepted the bequest of 125,000*l.* made by the will of the late Emma C. Woerishoffer, of New York, who was killed in an automobile accident last summer. The whole sum has been constituted as a permanent endowment fund. From the same source we learn that the sum of 10,000*l.* has been given to Beloit College by Mrs. Rufus H. Sage, of Chicago. The total endowment of this college—in interest-bearing securities—is now increased to 250,000*l.*, in addition to the value of the buildings. A third gift, reported in the same issue of our contemporary, is that of Mr. Robert W. Sayles, in charge of the geological section of the Harvard University Museum, who has given the sum of 1000*l.* to the Seismological Society of America, to aid in the publication of the society's Bulletin.

THE Child Study Society of London announces that a conference of combined societies will be held in the University of London on May 9 to 11 next under the presidency of Sir James Crichton Browne, F.R.S. The subject for discussion at the conference will be "The Health of the Child in relation to its Mental and Physical Development." Papers will be contributed to introduce discussions on the "Influence of Defects of Hearing, and of Vision, in relation to the Mental and Physical Development of the Child," by Dr. J. Kerr Love and Mr. N. Bishop Harman; "The Tuberculous Child," by Dr. Jane Walker; "Mental Hygiene in relation to the Development of the Child," by Dr. Theo Hyslop; and "Instruction of the Young in Sexual Hygiene," by Dr. G. Eric Pritchard. A lecture to the conference on "Eugenics and Child-study" will be delivered by Dr. C. W. Saleeby.

THE council of Bedford College has announced that the 100,000*l.* required to erect the new buildings at Regent's Park and to inaugurate an endowment fund has now been obtained. As has been recorded in these columns, 50,000*l.* had been raised by the beginning of November last for the building fund, 20,000*l.* of it being promised by the London County Council, who also promised 10,000*l.* more if the college could raise a similar sum immediately. By the end of last year the college raised the amount named, and secured the further grant. We learn from *The Times* that the council has now been informed by Lord Haldane, president of the building and endowment fund, that he has received from a donor who desires at present to withhold his name the promise of 30,000*l.* towards the fund. Simultaneously with this donation comes the promise from another anonymous donor of 10,000*l.* for the erection of a hall and common rooms, while the Worshipful Company of Goldsmiths has granted 5000*l.* towards an endowment fund.

THE International Commission on Mathematical Education will meet at Cambridge on August 22–28, on the occasion of the fifth International Congress of Mathematicians. It will be remembered that the commission owes its existence to a resolution of the Rome Congress of 1908. The educational subjects proposed for discussion are the following:—(1) intuition and experiment in mathematical teaching at secondary schools, in particular, the use of drawing, measurement, and calculation (numerical and graphical) in the upper classes of schools that prepare for the universities; (2) mathematics as needed in the study of physics. In preparation for these discussions, information is being collected as to the conditions prevailing in different countries. The information collected will be published in *L'Enseignement Mathématique* (Paris: Gauthier-Villars); and as regards the position of (1) in this country, a report in greater detail will be published by the Board of Education. The meetings and other proceedings at Cambridge will be open to all who pay the subscription of a guinea.

THE annual report of the council of the Institution of Mechanical Engineers includes as an appendix a draft scheme for associate membership examinations. Just as the Institution of Civil Engineers and the Surveyors' Institution have found it expedient to hold similar examinations, the council of the Institution of Mechanical Engineers is of opinion that the time has come for instituting an entrance examination for the younger applicants for admission to its institution. The council suggests (1) that the examination should be taken, especially by graduates, at as early an age as possible, and in order to bring such a scheme gradually into operation it might be desirable that it should apply in the first year only to candidates of twenty-eight years of age and under, in the second year to candidates of twenty-nine years of age and under, and in the third and subsequent years to candidates of thirty years of age and under; (2) that no examinations need be held abroad at present; (3) that, so far as possible, examinations of universities and colleges or other public examining bodies should be accepted as exempting from the institution examination, it being understood that only such examinations as are of at least a standard equal to the institution examination will be accepted. A list of examinations which might be accepted as exempting candidates is provided, and it may be noted this list includes the engineering degrees of British universities, the diplomas of the City and Guilds College, University College and King's College, London, and Whitworth scholarships and exhibitions. The suggested subjects of examination are grouped under general, scientific, and technical knowledge.

THE standing committee, of which Sir Matthew Nathan is chairman, dealing with the employment of boy labour in the Post Office, has issued its second report. In the first report, published last year, a number of recommendations were made, which have been acted upon. A scheme of education for the boys, designed to improve their qualifications and to fit them for further employment, has been approved by the Postmaster-General. The number of boy messengers was reduced from 15,790 in March, 1911, to 14,506 in September, 1911. Instead of there being only 1900 vacancies per year in the Post Office service for these boys to fill later, a revised estimate gives the number as 2350, of which 1280 are for postmen. The Navy and the Royal Engineers can also take some of the boys for special service. The report deals also with the boys' training for subsequent employments. A useful purpose is served by the boys' institutes, which are carried on mainly by the voluntary work of local officials, and receive grants amounting to 2000*l*. a year from the Treasury. The evening schools of local education authorities also have been made use of, half the boys' fees being paid out of institute funds. The number of boys who attended classes during the session 1910–11 in London and seventy-eight provincial towns was 6479, or about 70 per cent. of the whole number employed in those towns. To remedy irregular attendance, which has been somewhat pronounced, the committee recommended compulsory attendance at the classes, and a minimum of four hours a week, from September to April, was fixed, this being made a condition of employment during the boys' first two years of service. Special classes for the boys are recommended, and an essential feature is that the boys' attendances are to be arranged so that each class should always be composed of the same boys. The committee approached the Postmaster-General with these recommendations, and he approved of their being carried out without delay. The committee has come to the conclusion that the basis for permanent employment shall be a competitive examination in the subjects taught at the compulsory classes.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 8.—Sir Archibald Geikie, K.C.B., president, followed by Sir Alfred Kempe, vice-president and treasurer, in the chair.—Sir Norman **Lockyer**: The spectrum of comet Brooks (1911*c*). In this paper an account is given of the lines shown in a series of ten photographs of the spectrum of comet Brooks, taken between September 6 and October 31. Seven of the photographs were taken while the comet was an evening object, and three when it was a morning object. The instrument used was a 2-in. quartz-calcite prismatic camera. In the best spectrum (September 30), in addition to the well-established carbon or carbon-compound bands at $\lambda\lambda$ 3883, 4737, 5165, 5635, other radiations were seen at $\lambda\lambda$ 310, 316, 337, 405, 421, and 436. Line λ 421 is probably the cyanogen band, the head of which is λ 4216. So far as is known, the ultra-violet bands $\lambda\lambda$ 310, 316, 337 have not been recorded in the spectrum of any previous comet. Attempts have been made to ascertain the chemical origin of these lines by reference to published records of laboratory spectra, and to recent photographs of the spectrum of CO taken with the quartz-calcite prism, but with no success. Although no definite changes in the relative intensity of the cometary lines were noted amongst the earlier photographs, a comparison of the best of these (September 30) with that of October 31, when the comet was a morning object, showed the following changes:—(1) On September 30 line λ 4216 was weakest of the three subsidiary lines $\lambda\lambda$ 405, 4216, 436. On October 31 it was strongest. (2) Lines $\lambda\lambda$ 3883, 4737 were of about equal intensity on September 30. On October 31 λ 3883 was distinctly the stronger. (3) The ultra-violet lines $\lambda\lambda$ 310, 316, 337, shown in the spectrum of September 30, were not seen on October 31. A photographic comparison is given of the Kensington spectrum of comet Brooks (September 30) with that of comet Daniel (1911*d*), reproduced by Campbell in Lick Bulletin No. 135. Although the latter showed far more detail, being photographed with a slit spectrograph, it is fairly evident that the spectra of the two comets are very similar.—Hon. R. J. **Strutt**: A chemically active modification of nitrogen, produced by the electric discharge.—III. (1) Active nitrogen emits its energy more quickly, and reverts sooner to ordinary nitrogen, if it is cooled. This is apparently a unique instance of a chemical change accelerated by cooling. (2) If the glowing gas is compressed to small volume, it flashes out with great brilliance, and exhausts itself in so doing. This proves that the glow-transformation is polymolecular, *i.e.* that more than one molecule must take part in it. (3) Active nitrogen may revert to ordinary nitrogen in two distinct ways. One of those is a volume change, accompanied by glow; the other a surface action of the walls of the vessel, without glow. This is analogous to the behaviour of oxyhydrogen gas in its transformation to water, which may be a surface or volume effect, according to circumstances.—R. **Whytlaw-Gray** and Sir W. **Ramsay**: The atomic weight of radium. The material for this research consisted of 330 mg. of a mixture of radium and barium bromides, containing 206 mg. of radium bromide, supplied by the courtesy of the British Radium Corporation. The bromides were submitted to methodical fractional crystallisation, and yielded specimens of which the change in weight on conversion from bromide to chloride with gaseous hydrogen chloride, and from chloride to bromide with gaseous hydrogen bromide, was determined with the micro-balance. The atomic weight increased progressively from 220·7, through a series of approximations, to the final atomic weight 226·36, the last five determinations giving the figures 226·40, 226·25, 226·35, 226·35, and 226·45. The paper contains remarks on the differences in terms of multiples of the atomic weight of helium between the recorded determinations of the atomic weight of uranium and radium on the one hand, and of radium and lead on the other, and it is pointed out that a careful revision of the atomic weights of lead and of uranium, especially of the latter, is much to be desired.—Dr. J. A. **Harker** and Dr. G. W. C. **Kaye**: The emission of electricity from carbon at high temperatures. This paper discusses several new phenomena, among which are the generation of electric currents of considerable magnitude by what appears to be a new method. Two insulated carbon electrodes are inserted into a carbon tube resistance furnace at high temperatures, and are connected externally through a suitable current-measurer. If one of the electrodes is suddenly displaced to a colder or hotter part of the furnace, a reversible transient current is produced in the circuit without the application of any external potential. By such means, currents up to 2 amperes have been obtained. The production of an alternating current is thus rendered possible by the use of a suitable periodic device. A continuous current can be generated by suitably modifying the apparatus so as to maintain a large permanent temperature-difference between the electrodes. A steady current of 0·8 ampere has been thus obtained for a few minutes, and 0·1 ampere for more than an hour by water-cooling one electrode. These currents are such as would be produced by a discharge of negative particles from the hot electrode. At the lower temperatures positive currents have also been detected, but of much smaller magnitude. All the observations were made at atmospheric pressure. The extent of the ionisation of the furnace atmosphere at high temperatures was such that quite small E.M.F.'s, applied to two exploring electrodes, gave rise to steady currents of relatively enormous magnitude. For example, with 8 volts, currents up to 10 amperes have been obtained at a temperature of about 2500° C. Some of these observations have been repeated with furnaces of a non-electric character.—Prof. H. T. **Barnes**: The so-called thermoid effect and the question of superheating of a platinum-silver resistance used in continuous-flow calorimetry.—Prof. E. G. **Coker**: An optical determination of the variation of stress in a thin rectangular plate subjected to shear. The distribution of stress in a rectangular plate subjected to shear is examined by observing the optical effects in polarised light produced in a stressed plate of xylonite. Measurements of the shear stress at a point are obtained by using a specimen of material similar to the plate, and set along the direction of principal compression stress. A tension load is applied to this member of sufficient amount to produce a dark field at the point under examination. The intensity of tension stress so produced is twice the density of the shear stress in the plate. A survey of the central longitudinal section of a long rectangular plate shows that the shear stress rises very rapidly from a zero value at the ends, and reaches a maximum at a distance of rather less than the face width of the plate. As the distance from the ends increases, the stress decreases slightly in value until it reaches a minimum at the centre. A similar distribution also occurs at sections parallel to the central line. As the length of the plate is diminished the maximum and minimum stresses become more pronounced, and when the ratio of length to width is in the neighbourhood of two, the distribution changes in such a manner that there is a maximum at the centre. It is shown that the distribution is approximately parabolic when the length is equal to the width of the plate, and that when the length is greater than this the approximation is less close. The experiments show that a parabolic distribution of shear is only true within narrow limits, and that in a long rectangular section the distribution may be approximately represented by a uniform shear over the central section with a rapid fall towards the ends.—Dr. P. V. **Bevan**: Spectroscopic observations: lithium and cæsium. —Captain C. F. U. **Meek**: A metrical analysis of chromosome complexes, showing correlation between evolutionary development and chromatin thread-widths throughout the animal kingdom. Measurements of chromosomes in organisms representing the principal phyla and classes of the animal kingdom have shown that lengths appear to constitute members of a series in arithmetical progression, whereas three distinct diameters exist, viz. 0·21 μ in Protozoa, and 0·42 μ and 0·83 μ in low and higher metazoan phyla respectively. Consideration of these results has suggested the following working hypothesis:—The chromatin granules of simplest Protozoa are a visible expression of differentiation and aggregation of specialised particles concerned with transmission of hereditary characters, and as such probably do not represent the sole bearers of heredity in the cell. The granules become converted into rods by purely linear growth accompanying evolutionary development and greater somatic complexity, and, since the rate of growth is not the same in all chromosomes, rods of various lengths are evolved. A stage in phylogeny is later reached when a maximum rod length has been attained, such limit being imposed by spindle mechanism or other physical conditions; when this occurs, chromatin units conjugate in fours, and the normal thread-width is thus doubled. The newly formed chromosomes then segment into spheres of the same diameter, and these are prepared to enter a new course of linear growth accompanying further development. The same process is repeated when the length-limit has again been reached, and in this manner the greatest thread-width has evolved. The absence of correlation between chromosome dimensions and somatic characters is explicable on such an assumption, which postulates a series of cycles in the course of phylogeny. The heterotropic chromosome alone does not belong to the general series, and its great breadth may eventually be shown to be due to conjugation of normal rods; it is probably undergoing some process of development or disintegration, and may or may not be the determining factor in sex.

Linnean Society, February 1.—Prof. E. B. Poulton, F.R.S., vice-president, in the chair.—Fauna of the Seychelles and other islands of the Indian Ocean. (1) A. **Forel**: Fourmis des Seychelles et des Aldabras, reçues de M. Hugh Scott. (2) F. W. **Edwards**: Tipulidæ. (3) Dr. Günther **Enderlein**: Sciaridæ. (4) Claude **Morley**: The Ichneumonidæ. (5) C. Tate **Regan**: New fishes.

Mathematical Society, February 8.—Dr. H. F. Baker, F.R.S., president, in the chair.—A. C. **Dixon**: Exceptions to extensions of a theorem of Jacobi's.—W. **Burnside**: Some properties of groups whose orders are powers of primes.—G. H. **Hardy** and J. E. **Littlewood**: Some results concerning diophantine approximations.

Malacological Society, February 9.—R. Bullen **Newton**: *Presidential address*: "On the Lower Tertiary Mollusca of the Fayum Province of Egypt." The president referred to the discussion among writers on vertebrate palæontology as to the age of the Palæomastodon beds occurring near the base of the Jebel el Qatrani deposits in the north of the Fayum depression of Egypt. Such beds were regarded by Mr. Beadnell and Dr. C. W. Andrews as Bartonian, whereas Prof. Depéret and others had assigned them to the Sannoisian-Stampian division of the Oligocene period. Instead of regarding them as younger, Mr. Newton was of opinion that they might even be older, and he was much in favour of recognising the beds as belonging to the Lutetian-Bartonian stage of the Eocene, since the associated genera Mœritherium, Podocnemis, and Stereogenys occurred alike in these beds as well as in the Qasr el Sagha deposits below, which are undoubtedly of Lutetian or Middle Eocene age. Certain estuarine Mollusca, particularly *Potamides scalaroides* and *P. tristriatus*, occurred high up in the Jebel el Qatrani section and some 150 metres above the Palæomastodon bed; these gastropods have been determined by Dr. Blanckenhorn as indicative of the Bartonian horizon, and are therefore conclusively against the view that the vertebrates belong to the younger period of the Oligocene. Mr. Newton supported these molluscan determinations, and, moreover, upheld Dr. Blanckenhorn's opinion that the species were characteristic of the "Beauchamp Sands" of the Paris Basin, and consequently belonged to the older part of the Bartonian horizon.

PARIS.

Academy of Sciences, January 29.—M. Lippmann in the chair.—The president read a letter from Prince Roland Bonaparte giving a donation of 35,000 francs to the French School of Medicine at Beyrout.—G. **Bigourdan**: An unpublished work of Delambre, "Grandeur et figure de la Terre."—A. **Lacroix**: Lavas from the active volcano of Reunion. Complete chemical analyses are given of thirteen lavas, and a discussion of the results.—Ch. **André**: The total eclipse of the moon of November 16, 1910. The positions of three uncatalogued stars, referred to in the author's previous note on the eclipse, are given. —Hildebrand Hildebrandsson was elected a correspondant for the section of geography and navigation in the place of the late M. Davidson.—J. **Guillaume**: Observations of the sun made at the Observatory of Lyons during the third quarter of 1911. Observations were made on seventy-four days, the results being summarised in three tables.—Henri **Bénard**: The formation of lunar craters according to the experiments of C. Dauzère. A reproduction is given of a photograph by C. Dauzère showing the appearance of a surface of beeswax after solidification, and the bearing of this upon the author's theory of the causes of lunar relief is discussed.—G. **Pick**: Parallel lines and translation, and differential geometry in non-Euclidean space. The results published by the author in a recent paper in the *Comptes rendus* were obtained by M. Fubini in 1900. —J. E. **Littlewood**: Some consequences of the hypothesis that the function $\zeta(s)$ of Riemann has no zero in the demi-plane $R(s) > \frac{1}{2}$.—G. **Cotty**: A class of quadratic forms with four variables connected with the transformation of Abelian functions.—J. **Tamarkine**: The problem of the transversal vibrations of a heterogeneous elastic rod.—Louis **Chaumont**: The construction and verification of a quarter-wave plate of mica.—Emmanuel **Legrand**: Testing metallic lamp filaments for resistance to shock. A detailed description of the testing apparatus is given.—Georges **Meslin**: The application of wireless telegraphy to the measurement of coefficients of self-induction. The method is distinguished from those in ordinary use in that it reduces to a length measurement a quantity (self-induction) which has the dimensions of a length.—Albert **Colson**: The theory of solutions compared with experiment. The case of nitrogen peroxide. The author regards the identification of the dissolved particle with the gaseous molecule as not proven, and considers the thermal changes actually occurring during the process of solution disprove the van't Hoff theory. Experimental determinations by a new method of the partial pressures on NO_2 and N_2O_4 are given.—M. **Barre**: Some double carbonates of calcium. A description of the carbonates

$$CaCO_3.Na_2CO_3.2H_2O \text{ and } CaCO_3.K_2CO_3,$$

and a study of the conditions under which they are formed. —E. **Léger**: The constitution of chrysophanic acid. This acid is shown to be dioxy-1 : 8-methyl-3-anthraquinone.—A. **Mouneyrat**: The toxicity of the compounds of arsenic employed in therapeutics. For equal weights of the arsenic compound, the danger is greater the shorter the time between successive injections. The experiments were carried out on rabbits, and it was found that the animals showed varying degrees of tolerance to the drug.—A. **Guilliermond**: The leucoplasts of *Phajus grandifolius* and their identification with mitochondria.—François **Kövessi**: The influence of electricity (direct current) on the development of plants. The experiments were chiefly carried out with wheat, and show that the current is harmful to the germination of the seed and to the development of the plant.—Marin **Molliard**: Is humus a direct source of carbon for the higher green plants? If humus can be assimilated directly by green plants, it must be in very small proportions.—Louis **Ammann**: A comparison of the results obtained by maceration and diffusion in beetroot distilleries in agricultural centres. Both methods extract the sugar equally well; the maceration process requires less skilled supervision than the diffusion process, but the latter has the advantages of rapidity and of requiring less liquid.—A. **Marie** and Léon **MacAuliffe**: The morphology of French assassins, suicides, and murderers.—Marcel **Baudouin**: The wear of the teeth of the first and second dentition of men of the Neolithic period is due to earth-eating.—L. A. **Pelous**: The relations between the phenomena of osmosis and the electric discharge. The osmotic pressure is increased by the silent discharge.—A. **Magnan**: The surface of the intestine in mammals.—A. **Comte**: Variation in the moths of *Bombyx mori*.—M. **Trabut**: A disease of the date palm, khamedj, or rotting of the fruit bunch. The disease is due to a parasite, identified as *Phoenicococcus marlatti*.

MELBOURNE.

Royal Society of Victoria, December 14, 1911.—Prof. E. W. Skeats in the chair.—Olive B. **Davies**: The anatomy of the slug *Cystopelta petterdi*, var. *purpurea*. The structure was examined by dissections and by serial sections.—Janet W. **Raff**: Protozoa parasitic in the large intestine of Australian frogs, part ii. *Opalina tenius*, *O. dorsalis*, *O. acuta*, *Entamoeba morula* are described as new.—R. J. A. **Berry** and A. W. D. **Robertson**: Dioptrographic tracings in three normæ of ninety Australian aboriginal crania.—W. **Lowe**: The tropics and pigment. Pigment prevents the entrance of actinic rays, transforms them to heat, which indirectly stimulates the sweat glands and is dissipated.—N. **Macdonald**: Machine-drawn *versus* hand-drawn milk. With proper precautions as to cleanliness, the machine does no harm either to the milk or the cow.—A. J. **Ewart**: Bitter pit and the sensitivity of apples to poison. Ripe pulp cells of apples are extremely sensitive to poison. One part in ten thousand million of mercuric chloride is toxic. Poison can enter the sound fruit only by the breathing pores, and on doing so will produce bitter pit. Copper and lead are less poisonous than mercury. The poisonous action of copper sulphate and other similar metallic salts may be decreased by adding substances which decrease the percentage of free ions. Fungicides will kill the apple long before they kill the fungus.—J. A. **Gilruth** and L. B. **Bull**: Enteritis associated with infection of the intestinal wall by cyst-forming protozoa (Neosporidia) occurring in certain native animals (wallaby, kangaroo, and wombat). Wallaby, *Sarcocystis macropodi*, situated in submucosa; kangaroo, *Ileocystis macropodi*, situated in mucosa, apparently an epithelial infection, and *Lymphocystis macropodi*, apparently a mononuclear infection; wombat, *Ileocystis wombati*, epithelial infection.—K. A. **Mickle**: Flotation of minerals, part ii. Oil attachments. Sulphides adsorb oil more readily than does gangue in acid solutions. Finely divided sulphides in acidulated water attach the oil to form only plastic magma. After this additional oil attachments are unstable; with less oil, less coherent magma is formed, practically non-coherent with 0·1 per cent. oil. Gas attachments. Gas collected from finely divided dry sulphides *in vacuo* found to be CO_2 with smaller amounts N and O. This is probably present as adsorbed film. Gas collected from flotation product *in vacuo* consists of CO_2 with varying amounts N and O. Gas disengaged from flotation scum on bubbles bursting is found to consist of CO_2 and nitrogen, with smaller amounts of oxygen.

BOOKS RECEIVED.

Four Place Tables of Logarithms and Trigonometric Functions. Compiled by E. V. Huntington. Unabridged edition. Pp. 33. (Cambridge, Mass.: Haward Co-operative Society; London: E. and F. N. Spon, Ltd.) 3s. net.

Cambridge County Geographies:—Midlothian. By A. McCallum. Pp. x+208+maps. Buckinghamshire. By Dr. A. M. Davies. Pp. xii+222+maps. Northamptonshire. By M. W. Brown. Pp. xii+225+maps. (Cambridge: University Press.) 1s. 6d. each.

Earth and her Children. By H. M. Livens. Pp. 248. (London: T. Fisher Unwin.) 5s. net.

The British Bird Book. Edited by F. B. Kirkman. Section VII. Pp. 194+plates. (London and Edinburgh: T. C. and E. C. Jack.) 10s. 6d. net.

Irises. By W. R. Dykes. Pp. xiv+110+8 coloured plates. (London and Edinburgh: T. C. and E. C. Jack.) 1s. 6d. net.

Prehistoric Parables. By W. Bell. Pp. vii+63. (Halifax: Milner and Co.) 1s. net.

Electro-analysis. By Prof. E. F. Smith. Fifth edition. Pp. xi+332. (London: Kegan Paul and Co., Ltd.) 10s. 6d. net.

Waves and Ripples in Water, Air, and Æther. By Prof. J. A. Fleming, F.R.S. Second edition. Pp. xii+299. (London: S.P.C.K.) 2s. 6d. net.

The Forest Trees of Britain. By the late Rev. C. A. Johns. Tenth edition. Revised by G. S. Boulger. Pp. xiv+431. (London: S.P.C.K.) 6s. net.

University of London. Francis Galton Laboratory for National Eugenics. Eugenics Laboratory Memoirs. XV. Treasury of Human Inheritance. Parts vii. and viii. Section XV. A: Dwarfism, by Dr. H. Rischbieth and A. Barrington. Pp. xi + 355–573 + Plates li.–lviii. + O–Z + A.A.–W.W. (London: Dulau and Co., Ltd.) 15s. net.

The Migration of Birds. By T. A. Coward. Pp. ix+137. Prehistoric Man. By Dr. W. L. H. Duckworth.

Pp. viii+156. The Natural History of Clay. By A. B. Searle. Pp. viii+176. The Modern Locomotive. By C. E. Allen. Pp. ix+174. Earthworms and their Allies. By F. E. Beddard, F.R.S. Pp. vii+150. (Cambridge Manuals of Science and Literature.) (Cambridge: University Press.) 1s. net each.

Micropetrology for Beginners. By J. E. W. Rhodes. Pp. xv+126. (London: Longmans and Co.) 2s. 6d. net.

National Insurance. By A. S. Comyns Carr, W. H. S. Garnett, and J. H. Taylor, with a Preface by the Rt. Hon. D. Lloyd George, M.P. Pp. xxx+504. (London: Macmillan and Co., Ltd.) 6s. net.

Siam: a Handbook of Practical, Commercial, and Political Information. By A. W. Graham. Pp. xvi+637. (London: A. Moring, Ltd.) 10s. 6d. net.

Lessons in Geometry. By Dr. C. McLeod. Part i. Pp. xii+212. (Aberdeen: University Press.) 2s. 6d. net.

La Pila Elettrica. By A. Astolfoni. Pp. xv+297. (Milan: U. Hoepli.) 3 lira.

On the Mesozoic Rocks in some of the Coal Explorations in Kent (Memoirs of the Geological Survey, England and Wales). By G. W. Lamplugh, F.R.S., and Dr. F. L. Kitchin. Pp. vi+212. (London: H.M. Stationery Office; E. Stanford, and others.) 3s. 6d.

Wimbledon Common, its Geology, Antiquities, and Natural History. By W. Johnson. Pp. 304. (London: T. Fisher Unwin.) 5s. net.

Theorie und Praxis der Grossgasindustrie. By R. Mewes. i. Band, i. Hälfte. Pp. xx+403. (Leipzig: H. A. L. Degener; London: Williams and Norgate.) 18s. net.

The Natural History of the Bible. By the late Dr. H. B. Tristram. Tenth edition. Pp. viii+520. (London: S.P.C.K.) 5s.

Outlines of General Chemistry. By Prof. W. Ostwald. Translated, with the author's sanction, by Dr. W. W. Taylor. Third edition. Pp. vi+596. (London: Macmillan and Co., Ltd.) 17s. net.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 15.

ROYAL SOCIETY, at 4.30.—An Alleged Specific Instance of the Transmission of acquired Characters—Investigation and Criticism: Dr. T. G. Brown.—Further Experiments on the Cross-breeding of two Races of the Moth *Acidalia virgularia*: W. B. Alexander.—On the Effects of Castration and Ovariotomy upon Sheep: F. H. A. Marshall.—The Causes and Prevention of Miners' Nystagmus: Dr. T. L. Llewellyn.—The Stomatograph: W. L. Balls.—Composition of the Blood Gases during the Respiration of Oxygen: G. A. Buckmaster and J. A. Gardner.

ROYAL GEOGRAPHICAL SOCIETY, at 5.30.—Desert of North Africa: Captain H. G. Lyons, F.R.S.

INSTITUTION OF MINING AND METALLURGY, at 8.—On the Theory of Blast-Roasting of Galena: C. O. Bannister.—Quick Combination Methods in Smelter Assays: A. T. French.—A Graphic Method of Illustrating the Results of Extraction Tests: H. K. Picard.

LINNEAN SOCIETY, at 8.—An Investigation of the Seedling Structure in the Leguminosæ: R. H. Compton.

FRIDAY, FEBRUARY 16.

ROYAL INSTITUTION, at 9.—The Road: Past, Present and Future: Sir John H. A. Macdonald, K.C.B., F.R.S.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Annual General Meeting.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Works for the Prevention of Coast-erosion: W. T. Douglass.

GEOLOGICAL SOCIETY, at 8.—Anniversary Meeting.

MONDAY, FEBRUARY 19.

ROYAL SOCIETY OF ARTS, at 8.—The Meat Industry. The Pig and its Products: Loudon M. Douglas.

VICTORIA INSTITUTE, at 4.30.—The Real Personality or Transcendental Ego: S. T. Klein.

TUESDAY, FEBRUARY 20.

ROYAL INSTITUTION, at 3.—The Study of Genetics: Prof. W. Bateson, F.R.S.

ROYAL STATISTICAL SOCIETY, at 5.—The Rate of Discount and the Price of Consols: T. T. Williams.—The Rate of Interest since 1844: R. A. Macdonald.

ZOOLOGICAL SOCIETY, at 8.30.—Notes on Age-determination in Scales of Salmonoids, with special reference to Wye Salmon: Dr. A. T. Masterman.—Studies on Pearl Oysters. I. The Structure of the Shell and Pearls of the Ceylon Pearl Oyster (*Margaritifera vulgaris*, Schumacher), with an examination of the Cestode Theory of Pearl Production: Dr. H. Lyster Jameson.—Mimicry amongst the Blattidæ; with a Revision of the Genus *Prosoplecta*, Sauss: Robert Shelford.—Contributions to the Knowledge of the Spiders and other Arachnids of Switzerland: Rev. O. Pickard-Cambridge, F.R.S.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Further Cave Explorations in Gibraltar in September, 1911: Dr. W. L. H. Duckworth.—On Some Prehistoric Monuments in the Departments Gard and Bouches du Rhone: A. L. Lewis.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Some Features of the West African Government Railways: F. Shelford.

ILLUMINATING ENGINEERING SOCIETY, at 8.—Discussion on Shoplighting: Papers by N. W. Prangnell and A. E. Broadberry.

WEDNESDAY, FEBRUARY 21.

ROYAL SOCIETY OF ARTS, at 8.—The British Silk Industry and its Development since 1903: F. Warner.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Fourth List of New Species of Rotifera since 1889: C. F. Rousselet.—On the Colouring of Lantern Slides, with Illustrations on the Screen: E. J. Spitta.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—The Thunderstorms of May 31, 1911: J. Fairgrieve.—The Thunderstorms of July 29, 1911: R. G. K. Lempfert.—The Drosometer, or Measurer of Dew: Sidney Skinner.

THURSDAY, FEBRUARY 22.

ROYAL SOCIETY, at 4.30.—Bakerian Lecture: The Variation of the Specific Heat of Water investigated by the Continuous Mixture Method: Prof. H. L. Callendar, F.R.S.—*Probable Papers*: Index to Reports of Physical Observations—Electric, Magnetic, Meteorological, Seismological—made at Kew Observatory: Dr. C. Chree, F.R.S.—On the Velocities of Ions in Dried Gases: R. T. Lattey and H. T. Tizard.—The Observation by means of a String Electrometer of Fluctuations in the Ionisation produced by γ Rays: Prof. T. H. Laby and P. W. Burbidge.—The Wave Problem of Cauchy and Poisson for Liquid of Finite Depth and for Slightly Compressible Liquid: F. B. Pidduck.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Supply and Transmission of Power in Self-contained Road Vehicles and Locomotives: J. C. Macfarlane and H. Burge.

FRIDAY, FEBRUARY 23.

ROYAL INSTITUTION, at 9.—The Gyrostatic Compass and Practical Applications of Gyrostats: George K. B. Elphinstone.

PHYSICAL SOCIETY, at 5.—A Method of Accurate Comparison of Quantities of Radium: Prof. E. Rutherford, F.R.S., and Mr. Chadwick.—The Absorption of the γ-rays by Gases; Mr. Chadwick.—On Wave-form Sifters for Alternating Currents: A. Campbell.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Works for the Prevention of Coast-erosion: W. T. Douglass.

SATURDAY, FEBRUARY 24.

ROYAL INSTITUTION, at 3.—Molecular Physics: Sir J. J. Thomson, F.R.S

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