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ANCIENT HUNTERS.

Ancient Hunters and their Modern Representatives. By Prof. W. J. Sollas, F.R.S. Pp. xvi+416. (London: Macmillan and Co., Ltd., 1911.) Price 12*s.* net.

TO write a history of the early races of mankind is, at the present time, a most bold undertaking. A writer needs to bring to the task not only an expert knowledge of geology, an intimate acquaintance with the structure of man and beast, but also the long experience of those who have studied the culture—above all, the implements of primitive races. The difficulties of the task are increased by the extensive and technical literature which grows in volume year by year. Prof. Sollas has faced these difficulties with success, and under the rather inadequate title of "Ancient Hunters" produced a book which in reality aims at giving the early history of mankind.

"I believe," he says in the preface, "this is the first time that a general survey has been attempted—at least in the English tongue—of the vast store of facts which have rewarded the labours of investigators into the early history of man during the past half-century."

Those who are making a special study of ancient man are indebted to Prof. Sollas for the survey; it will prove no less acceptable to those who wish to make an acquaintance with this subject, for it is written in a simple and interesting style. The text is furnished with a plentiful supply of good and accurate illustrations.

We naturally turn first to see what Prof. Sollas has to say concerning the Pleistocene epoch, when his "ancient hunters" were living in Europe. The length of that period does not exceed, he believes, 300,000 to 400,000 years, and accepts Prof. Penck's four terraces on the valleys of alpine rivers as evidence that the Pleistocene epoch was divided by four periods of glaciation, each followed by a temperate interval, the fourth giving us our present moderate climate. Indeed, according to Prof. Sollas, we do not seem to have left the last glacial period far behind us. He takes the reader back 7000 years, and writes:—

"From this point—the beginning of the seventh millennium—we look backwards over the last glacial episode. The curve of temperature descends in a valley-like depression, the bottom of which corresponds with the period of intense glaciation."

The period which has elapsed since the last glacial period is estimated from the unsatisfactory data of Heim and of Baron de Geer to have been about 17,000 years.

The writer gives one the feeling of living on an earth with a very unstable climate, and yet in the last 7000 years there seems to have been no change. Prof. Sollas does not think that there is any satisfactory evidence of the existence of man before the beginning of the Pleistocene period. The eoliths attributed to man—Harrison's flints of the Kent Plateau, the sub-crag flints—are rejected as convincing evidence of man's existence. The earliest stone implements which carry a conviction to him of human workmanship are those found by M. Rutot in the Misvinian gravels of the valley of the Lys. The earliest remains of man himself—the Heidelberg jaw and the fossil remains from Java—he attributes to the first interglacial period, with the proviso that further evidence may place them at a later date. The Neanderthal race appeared before the last glacial episode, while the Cro-magnon race succeeded it. In these matters Prof. Sollas is in agreement with most of his Continental colleagues.

The civilisation of ancient and extinct races of mankind must be interpreted from our knowledge of the culture of surviving primitive races. Prof. Sollas has laid hold of that fact, and in many cases used it to excellent purpose. Yet in some cases his inferences are not well founded. He sees many points in common between the art of the modern Bushman of South Africa and the race who decorated the caves of Spain and France towards the close of the Pleistocene period. He also regards the Grimaldi human bones found in a cave near Mentone to be remains of that ancient artist race, and holds that the evidence "that Mentone was inhabited in Aurignacian times by a race allied to the Bushman amounts almost to positive proof." It is true that these Grimaldi people show negroid traits, and so do the Bushmen, but it would be difficult to find two negroid types which are more sharply differentiated in the characters of their skull and face than these ancient and modern negroid races. It is strange that Prof. Sollas does not allude to the best known of the Aurignacian men, the one discovered by Herr Hauser at Combe-Capelle in 1909, nor do the remains found at Furfooz, at Grenelle, and at Engis, come up for consideration; yet we may suppose them to belong to ancient hunters, and to be of importance because of the types which they represent. On the other hand, we find he accepts the peculiar and isolated skeleton discovered at Chancelade, in the south-west of France, as evidence that a race, very similar to modern Eskimos, lived in Europe about the same time as the Aurignacian and Cro-magnon men. Those who have studied the Chancelade skeleton in the Museum at Perigueux will hesitate to accept its identification by Prof. Sollas as Eskimo in character, and will find it difficult to follow him when he traces the dispersion of European Eskimo and other races in the continent of America.

This book has great merits; it will succeed, and it deserves success. Yet we do wish England had received some attention, were it only a fraction of what has been bestowed on France and neighbouring countries. Cresswell Crags, Kent's Hole, the Oban caves receive a passing notice, but the Thames Valley and its terraces—the very subjects on which Prof. Sollas can give an expert opinion—receive very scanty treatment. The human remains from the 100-foot terrace at Galley Hill and from the submerged strata at Tilbury are passed over in silence. Perhaps in another edition Prof. Sollas will make these omissions good.

STABILITY IN AVIATION.

Stability in Aviation: an Introduction to Dynamical Stability as Applied to the Motions of Aëroplanes. By Prof. G. H. Bryan, F.R.S. Pp. xi+192. (London: Macmillan and Co., Ltd., 1911.) Price 5*s.* net.

THIS book, in common with other published mathematical papers of Prof. Bryan, contains much original work. It is well worth study, not merely by mathematicians, but also by all interested in the practice of aviation and in the design of flying machines. In the preface and introduction the author indicates his reasons for undertaking this investigation, and his desire to make the book practically useful. It will be universally agreed, and the conclusion is confirmed by experience, that the greatest difficulties which must be surmounted in connection with aërial navigation arise from lack of exact knowledge of the principles of dynamical stability as applied to the motions of aëroplanes. Up to date it is probably correct to say that individual skill—often apparently almost instinctive—on the part of airmen, and their immediate readiness to act when sudden emergencies arise, play the greatest part in the safe conduct of aërial machines. In fact, having regard to endless possible variations in the conditions which are, and will be, encountered in aërial navigation, these personal qualities will always remain essential to success. On the other hand, there can be no dispute but that substantial advantages may be gained from the results of work done by mathematicians like Lord Rayleigh, Sir George Greenhill, and Prof. Bryan.

It is true that all mathematical investigations must be based on certain assumptions; and, because of our imperfect knowledge of atmospheric phenomena, errors have been, and will be, made in these assumptions, and important considerations may be omitted in framing equations. In consequence of these limitations mathematicians run a risk of claiming more for their conclusions than they are really worth. Prof. Bryan himself has not escaped entirely free from this danger in previous utterances on the subject of aviation; but in the book under review he puts the case for mathematical inquiry in a form to which no one will take exception. The passage is of sufficient interest to justify quotation, and the more so because it strikes the keynote of the book itself:—

"In this book attention is concentrated on the mathematical aspect of the problem for several reasons. In the first place, there is no obvious alternative between developing the mathematical theory fairly thoroughly and leaving it altogether alone; any attempt at a *via media* would probably lead to erroneous conclusions. In the second place, the formulæ arrived at, even in the simplest cases, are such that it is difficult to see how they could be established without a mathematical theory. In the third place, there is probably no lack of competent workers interested in the practical and experimental side of aviation, and, under these conditions, it is evident that the balance between theory and practice can be improved by throwing as much weight as possible on the mathematical side of the scale. Lastly, it is hoped to advocate the claims of aëroplane equilibrium and stability as an educational subject suitable for study in our universities alongside with such branches of applied mathematics and mathematical physics as hydrodynamics, and particle and rigid dynamics."

If it were necessary to choose between purely mathematical investigation and experimental research in connection with the development of aviation, the latter method would necessarily be preferred. No such choice has to be made, however, since progress can only be achieved if there is a close association of mathematical analysis with experimental methods.

Readers of Prof. Bryan's book will be impressed with the suggestiveness of many passages in which results of mathematical solutions of difficult problems are discussed. Even if all the mathematical processes in the book cannot be followed by practical men, their attention may well be turned to its pages, and they cannot fail to derive instruction and obtain guidance therefrom in determining directions in which further experimental research may most advantageously be undertaken.

Prof. Bryan anticipates "that the successful aëroplane of the future will possess inherent, not automatic, stability, movable parts being used only for the purposes of steering." He considers the use of gyrostats, pendulums, or other movable parts which are intended to provide automatic stability to be undesirable, because such parts are liable to get out of order, while "they increase the degree of freedom of the machines and add to the number of conditions which have to be satisfied for stability." There is sound common sense in this observation, and its force has been emphasised by experience in submarines. After many attempts to devise and apply means for automatic control of longitudinal stability, it has been universally agreed that manual control by competent steersmen is on the whole to be preferred. The case of the submarine is, of course, vastly simpler, and the conditions of service less complex and variable than are those to which aërial machines are exposed; but the principle holds good in both instances. The "human element" is all-important.

It is both unnecessary and undesirable to attempt any detailed description or criticism of the mathematical chapters of this book. They are marked both by an ability and a compactness which are not surprising to those who know the character of Prof. Bryan's mathematical papers. He has had the advantage of help from Mr. E. H. Harper and other gentlemen, to whom due acknowledgment is made, and by whom the whole of the formulæ have been checked. Prof. Bryan hopes that the formluæ are correct, but modestly adds:—"It is impossible to be too careful in a matter where a mere slip of a sign might change stability into instability." Readers are, therefore, invited to check the formulæ for themselves—an invitation which may have an attraction for mathematicians, but not for all who will study the results recorded in these pages.

The volume is admirably produced, and it constitutes a valuable addition to the series of "Science Monographs," to which it belongs.

Special interest now attaches to the subjects treated;

and, in addition, it may be hoped that the wish expressed by the author will be fulfilled, and that the book will be used as a text-book for students of mathematics and physical science in the universities.

W. H. W.

STAMMERING.

The Real Cause of Stammering and its Permanent Cure: a Treatise on Psycho-Analytical Lines. By A. Appelt. Pp. ix+234. (London: Methuen and Co., Ltd., 1911.) Price 3*s.* 6*d.* net.

MANY theories have been advanced to explain the distressing complaint known as stammering, and the modes of treatment have been equally numerous. The treatment has often fallen into the hands of quacks, who have pursued empirical methods without any insight into the real nature of the affliction. The author of this book suffered during his early youth and manhood; he put himself under the care of specialists, and he was an inmate of three institutions; but the result was only failure and relapse. He now considers himself to be completely cured by a method entirely different from that usually followed, and he gives the result of his investigations and experience in this interesting volume.

The subject is introduced by a concise historical account of the notions that prevailed for centuries as to the cause of stammering. The Jews, the Greeks, and the Romans paid much attention to impediments in speech, but it was not until the sixteenth century that a real beginning was made by special observations by some of the early physicians. From that time much has been written and many theories have been advanced. The articulating mechanism was held to be at fault; weakness of the soft palate; defective movements of the tongue; abnormal movements of the larynx; spasm of the glottis, all received blame. The discovery of reflex action, about 1841, led to the view that stammering was due to a reflex spasm caused by excito-motor spinal action predominating over cerebral activity. Cerebral congestion, spasms of the vessels in the brain, intense emotional excitement, insufficiency and irregularity of respiration, and abnormal nervous irritation were adduced as explanations. It is dreadful to realise that some of these erroneous theories led to severe surgical operations, such as cutting through the base of the tongue, and it was not until 1851 that surgical treatment was abandoned as worse than useless. The view that the impediment existed in the outer organs of speech was at last definitely abandoned, but it was only since the beginning of the present century that investigators have come to the conclusion that stammering is a psychical ailment, and that the special cause is a feeling of dread, "the dread of speaking," and that to effect a cure the psychic influences or impulses must be met by counteracting suggestions.

The author gives a very interesting account of the mechanism of speech, not in the ordinary sense, but of the origin of the art of speaking in the child. Nowhere have I read a better account of how baby is influenced in the production of vocal sounds by feelings of comfort or the reverse, of how he hears his own voice, and associates the sounds with those feelings; and so on, step by step, until the sounds express ideas which are associated with baby himself, or with his parents, or those about him. There is then a full account of the pathology of stammering, and it is shown how all the irregular movements are preceded by a feeling of dread. The stammerer dreads the effort, and the greater the dread the worse the stammering, until, in extreme cases, there is positive mental torture, which reacts on the psychological condition of the sufferer, and may even alter his character. It is remarkable that there is no spasm of the glottis: "the closure of the glottis ceases instantaneously when the stammerer gives up his intention to speak." In this otherwise excellent description the author uses the word "anelectrotonus," but as this word has a very definite meaning in electro-physiology, it would be better to avoid its use as applied to the phenomena described by the author. The author also often describes affections of "nerves" when he evidently means "nerve centres." Nerves are conductors; the intimate phenomena of nervous action take place in the collocations of nervous matter we call "centres," although it must be confessed we know very little about the phenomena occurring therein.

The author then comes to the essence of his theory, namely, that stammering is essentially a psychic disturbance. At the root of speech lie the emotions; the results of emotional states may remain long in a hidden condition, or are awakened only now and then. Such emotional conditions may be repressed, and from the days of infancy they are habitually repressed. Thus we may consider them to be in a state of tension, and this tension may disturb the centres for speech, if it is associated with feelings of dread. These feelings of dread may have first originated in childhood, and for years they may exist in the mind unconsciously. The author holds strongly the modern view of unconscious mental operations that develop into a second, and usually hidden, self. This implies that there may be *mental* operations without consciousness. With this modern view I cannot agree. It is not necessary for me, however, to state my objections here, but rather to give a fair account of the author's view, which he regards as the kernel of his theory. This unconscious mind is a psychic complex endowed with extremely intense emotions and inhibitions. The individual is under its influence, and "the physical and psychic symptoms of defective speech are merely projections of the conflicts piled up in the emotional complex." The unconscious psychic complex is often in conflict with the conscious ego, and a feeling of dread, of dread of the unknown and mysterious, more than simply a feeling of fear, precedes the articulatory disorder.

This psychological view leads to a rational therapeutics. Abandon exercises in elocution; give up the dreaded pronunciation of certain words; try the effect of auto-suggestions, such as "I shall get over this and soon be quite well"; submit to hetero-suggestions of the same kind originating in the teacher or trainer, in whom the

patient should strive to have confidence; cultivate mental ease; get into a stoical frame of mind, and speak slowly, even with a drawl, as if it did not matter in the least how or what was said. Finally, the teacher employs the methods of psycho-analysis by which the modern psychologist obtains an insight, as it were, into the work of the patient's faculties. Thus by the method of Jung of "stimulus words" awakening ideas, mental "blocks" may be discovered; there is loss of time in certain mental efforts, and the hidden cause of "dread" may be discovered, although the cause may have been repressed since childhood. When the dread is removed, and a feeling of calmness predominates, then stammering disappears, never to return. Such is Mr. Appelt's interesting tale. Some of it is hard to understand, more especially his view that ill-defined but repressed erotic elements originating in childhood enter into the condition, but one feels that inquiry is on the right road, and that psychologists, as well as those who endeavour to help the stammerer, are indebted to Mr. Appelt for a very valuable and suggestive book, bearing not only on stammering but on obsessions and neuroses of many kinds.

JOHN G. MCKENDRICK.

BLACK AND WHITE IN SOUTH-EAST AFRICA.

Black and White in South-East Africa: a Study in Sociology. By Maurice S. Evans, C.M.G., with a preface by Lieut.-Colonel Sir Matthew Nathan, G.C.M.G. Pp. xviii+341. (London: Longmans, Green and Co., 1911.) Price 6*s.* net.

THE title of this book is a little misleading, as it may induce the reader on the look-out for information to conclude that it describes the negroes and the white men of the province of Mozambique, or rather of all that portion of Portuguese Africa which lies to the south of the Zambezi and to the east of the British territories. As a matter of fact, it is concerned mainly with the people of Natal, and less closely with the natives of Basutoland, Cape Colony, and the Transvaal: with South Africa proper.

Reference has been made in other reviews by the present writer published in NATURE to the unauthorised variants of accepted names introduced by writers not at present entitled to an overriding authority. This trait reappears in Mr. Evans's book in one or two instances, but most notably in the tiresome form of Abantu, with which he replaces the widely used term Bantu, that for something like half a century has been employed to indicate the racial or linguistic type of all the negroes of South Africa except the Hottentot and Bushman. Apart from the fact that Bantu has been accepted in this corollary by all the civilised people of the world, and almost the entirety of writers on Africa in general, and South Africa in particular, the substitution of Abantu is foolish and unmeaning. It simply means, in native parlance, "*the* Bantu," the *a* before the *ba* prefix being merely the fragment of a definite article which is absent from many Bantu languages, and when present is employed or not, according to the needs of the syntax. Pedantic as it may seem, it is necessary to pounce on this misuse of Abantu, because not a few reviewers who have dealt with Mr. Evans's interesting book have regarded his version as being something new and singularly correct.

It is curious how nearly all writers on South African subjects have little or no acquaintance with the rest of Africa, and often entirely misunderstand the proper application of this term Bantu. It was devised by the late Dr. W. I. Bleek as a convenient word to indicate those tribes and nations of negroes who spoke prefix-governed languages, of which the very term Ba-ntu ("men") was an effective illustration. Subsequently a Bantu physical type was alluded to by many writers on Africa, but it has since been shown that in strict accuracy it is quite impossible to associate exclusively any one differentiated type of negro or negroid with the speaking of Bantu languages. These languages, undoubtedly due in their inception to some invasion or impulse of the white man in North Central Africa some thousands of years ago, may be, and are, spoken at the present day by negroid giants and ultra-negro pygmies and forest tribes, by people of semi-Bushman race, and by others with a strong infusion of the Nilote, the Hamite, or the Semite. In no sense whatever—language, physique, folklore, traditions, customs—are the negroes of South Africa—Kafirs, Zulus, Basuto, Mashona, &c., set apart or distinct from the negro tribes and peoples over the whole rest of Africa, and the sooner South African statesmen realise this—namely, the absolute oneness of the negroes south of the Zambezi with the negroes north of the Zambezi, the better for their shaping of an intelligent, a humane, and a practical native policy. If South Africa is Bantu, so are Uganda, the Congo Basin, Angola, Zanzibar.

All who are sincerely well disposed towards the South African negroes and yet at the same time not mere sentimentalists, but practical persons, neither undervaluing the white man nor his great importance in the future development and civilisation of Africa, will welcome this book by Mr. Evans. It seems to the reviewer an accurate and perfectly fair-minded statement of the black and white problem in British South Africa. The book teems with shrewd observations and snapshots in words (for example, chapter vi., on the wasted labour of the black man). The remarks on the supposed danger to white women, the causes of such danger as really exists, and the remedies, are well worthy of study by politicians and philanthropists; so are the remarks on the unrestricted supply of distilled alcohol, and on the diseases introduced by the white man. In general, it may be said that the reader rises from the perusal of this book with a feeling that of all the divisions of South Africa the one which has behaved best and most successfully in regard to the treatment of its large negro population is Cape Colony. A mistake which is frequently made by superficial writers on South African problems is to assume that Cape Colony is a white country as compared to the adjoining States of Natal, Basutoland, the Transvaal, and Bechuanaland. Such is not the case emphatically. The eastern half of Cape Colony has a very large Kafir population. At the present day there are something like 2,000,000 of negroes and 300,000 half-castes

in comparison to 700,000 pure-blood whites. So that if the Government of Cape Colony can conduct its native affairs with little or no difficulty, scandal, or injustice, the same thing ought to be possible for the Transvaal and Natal. H. H. JOHNSTON.

ENCYCLOPÆDIC PHOTOGRAPHY.

Cassell's Cyclopaedia of Photography. Edited by Bernard E. Jones. Pp. viii+572. (London: Cassell and Co., Ltd., 1911.) Price 10*s.* 6*d.* net.

THE encyclopædic arrangement has both advantages and disadvantages. One important advantage is the possibility of including out-of-the-way matters that could scarcely be referred to in a systematic treatise without devoting an unjustifiable amount of space to their consideration. The editor has made the very most of this possibility, for we find such headings as "Bicycle" and "Contact Breaks," the connection of which with photography is rather remote, and others, such as "Tea-tray Landscapes" and "Thought Photography," which must occur very rarely indeed in photographic or any other literature. Of the few headings that we have sought for to test the inclusive character of the volume, the only ones that we fail to find are "Metallography," a common enough word that stands for a very important branch of photography at the present time, and "Rainbow," to which the reader is specifically referred at the end of an article on "Cosmical Photography."

An advantage often claimed for the alphabetical arrangement is facility of reference, though this can scarcely be greater than in the case of a treatise with a good index. The editor appears to have been unduly anxious with regard to this matter, for in some cases he has, in our opinion, failed by reason of the excessive subdivision of the subjects. For example, some shutters are described under the heading "Shutters," where we expected to find the whole subject treated of. But other shutters are given under "Flap Shutter" and "Focal Plane Shutter," and before we get all that is given on this subject, we must read also the various sections, "Instantaneous Shutters," "Shutters, efficiency of," "Shutters, testing," and possibly others that we have not come across. And this is not exceptional, for spectroscopy appears to be distributed among nearly a dozen headings, and astronomical photography and the use of polarised light, among other subjects, are similarly subdivided.

The editor has been perhaps rather too ambitious, at least in his preface, for he refers to the volume as "surveying the whole field of photographic knowledge," and being "at once authoritative and complete." The work "is intended not only for the practical photographer, but also for the scientific student" who will find articles "valuable, because authoritative." "The manufacturer, too. . . ." The authoritative character of an article depends upon the author and upon him alone, and the real student always desires to know upon whose authority the statements that he reads depends. A very few articles are signed, but there are many and among them very excellent articles that are not only not signed, but to the authorship of which there is no clue, even in the list of chief contributors and the nature of the subjects with which they deal. The authorship in some cases is obvious enough to those acquainted with photographic literature, and some of the articles would have gained rather than lost by having their source clearly indicated.

When a volume is written by nineteen "chief contributors," and presumably other contributors in addition, it is impossible that its sections shall be equally "authoritative," and, as a matter of fact, they are of very various degrees of merit. Many are all that could be desired within their limits, giving a concise, clear, and inclusive summary of the subjects with which they deal. But in some the subject is evaded, as in "Shutters, testing," where, after a quarter of a page of information, we read that "there are numerous other methods, most of which, however, call for special apparatus," and the reader is left in the dark with regard to these "numerous other methods." Some are obscure, and we doubt whether Mr. Dallmeyer himself would have recognised the "Adon" lens that he invented from the description given of it. "Polarisation" is defined as "The splitting up or division of a ray of light into two distinct refracted parts," and here the student is left to ponder the matter with no diagram to help him, though there are "hundreds of line drawings in the text" (as stated on the title-page), and some, such as those of a "porcelain evaporating dish" and a "clamp for general use," might well have given place to others more helpful. As might be expected, the volume is not free from errors. Cedar-wood oil is not volatile; the Abbe two-lens condenser is not of low numerical aperture; and it is not correct to say that "the focal lengths of the microscope objectives in general use range from 3 in. to $1\frac{1}{2}$ in.," even if we add that "lenses of both lower and higher power are manufactured." We do not understand how a photograph taken on an isochromatic plate with a "six-times" yellow screen can be "over-corrected," nor how "beads of dried paste, made with magnesium powder and distilled water," could be used instead of limes for the limelight. But looking at the book as a whole we can safely say that the discriminating student will find in it a great fund of information, and that a reference to it will sometimes save him prolonged if not fruitless search among rare, little-known, and old records. C. J.

MATHEMATICS FOR TEACHERS.

Lectures on Fundamental Concepts of Algebra and Geometry. By Prof. J. W. Young. Prepared for publication with the cooperation of W. W. Denton. With a note on the Growth of Algebraic Symbolism by Prof. U. G. Mitchell. Pp. vii+247. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1911.) Price 7*s.* net.

THIS book contains a series of lectures on some of the fundamental principles of mathematics, treated from the most recent and scientific point of view; that is, mainly with reference to their consistency and the nature of the assumptions involved.

The reader is not supposed to have any advanced technical knowledge, and everything seems done to help him to appreciate the important notions which the last few years have developed.

Among the subjects treated are the meaning of definitions, axioms, and postulates; the elementary properties of classes, and of transfinite ordinal and cardinal numbers; negative and complex numbers; the three possible geometries in three-dimensional space; spaces of more than three dimensions; variable, function, and limit.

As an indication of the upper limit that is reached, it may be noted that we have Cantor's proofs that the numerical continuum is not denumerable, and that the class of algebraic numbers is; correspondence between points of a line segment and those of a square; and a brief account of quaternions.

In the more strictly geometrical part, Hilbert's axioms are discussed in considerable detail, an illustration is given (after Klein) of a system for which Archimedes' axiom is not satisfied, and an account is given of Pieri's kinematical theory. This last is comparatively novel, and will perhaps appeal to some more vividly than Hilbert's.

There are a few controversial points to which attention may be directed. On p. 43 we are told that "the only test for the consistency of a body of propositions is that which connects with the abstract theory a concrete representation of it." Even allowing the widest sense to the term "concrete," this does not seem justifiable. Weierstrass proved that ordinary complex algebra could *not* be consistently extended to a linear algebra of three or more dimensions, and his proof was as abstract as possible. The fact seems to be, as Prof. Young practically admits elsewhere, that there is no absolute test of consistency for any set of assumptions; all we can say is that, after applying them in myriads of ways, we have not found any inconsistency.

Then there is the question of the term, "the class of ordinary classes" (p. 219). Prof. Young takes the view, which seems the right one, that this term is intrinsically nonsensical, and involves a vicious circle.

On p. 81 the symbol ω is unfortunately used for the *cardinal* number of all denumerable sets. It is much better to keep it as the *ordinal* number of the natural scale, and use a for the corresponding cardinal.

Finally, with regard to the author's pedagogic attitude. He emphasises rightly, more than once, that with young pupils no attempt should be made to treat the subject with logical rigour. On the contrary, a large number of assumptions will be made, and everyday experience constantly appealed to. This is a sufficient answer to those who think that the "logicians," as a body, wish to reduce mathematics to dry bones. At the same time, a teacher ought to know something about these logical methods, just in order to avoid making dogmatic assertions which have been shown to be false, and also that he may answer inquiries without implanting erroneous ideas. For this purpose Prof. Young's book may be heartily recommended; it is one more of the many good educational works on mathematics produced in the United States. G. B. M.

OUR BOOK SHELF.

Contemporary Chemistry: a Survey of the Present State, Methods, and Tendencies of Chemical Science. By E. E. Fournier d'Albe. Pp. xvi+180. (London: Constable and Co., Ltd., 1911.) Price 4*s*. net.

IF the author of this book had been content to give it a more modest title, the task of the reviewer would have been a pleasanter one. Mr. Fournier d'Albe undoubtedly possesses a gift of expression, and his breezy style is attractive and interesting. Moreover, due praise must be given to him for his effort to popularise the fascinating phases of modern chemistry. Yet it is just here where the difficulty comes in. If the present book is intended for the general reader, the author's semi-journalistic "lightning sketches" assume too much, and are too lacking in coherence, to convey any definite impression. On the other hand, the serious student of chemistry will find the author's fare, if appetising, rather scrappy and unsatisfying.

The book indeed fails to give any rational and connected account of the main lines of contemporary chemical science. Let us take, for example, the chapter on "Affinity," where the author gives us little more than a couple of hazardous calculations on the attraction of electrical charges. Not a word is said about the real work of to-day, namely, the numerous experimental methods of measuring chemical affinity, and the collation and comparison of the vast amount of data already obtained. We cannot have our Newton before our Tycho Brahe and Kepler.

A closer examination of the book reveals in many cases the author's want of familiarity with chemistry, whereof a few instances may be noted. On pp. 21–22 we hear about de Broglie, but no hint is given of the work of Perrin, Svedberg, or Henri. On p. 36, it is stated that "a single phase has therefore two independent variabilities." On p. 38 there is a complete confusion between passivity to change and Le Chateliers's theorem. The calculation on p. 55 appears to the reviewer to be quite absurd. On p. 56 there occurs a misleading confusion between ordinary and electrolytic dissociation, whilst on p. 57 the use of the expression "specific conductivity" instead of molar conductivity leads to dire results. P. 59 opens with the sentence, "It might seem at first difficult to prove that metallic sodium and uncombined chlorine exist in a dilute solution of hydrochloric acid." Apart from the obvious misprint, this is truly a case of "save us from our friends." The cup is full when, on reaching p. 92, the author says, "Yet to-day we believe not only that metallic sodium exists in sea water," &c. One wonders what the author's theory of the metallic state would be like. Other slips of a similar nature might be quoted, but it would be ungracious to multiply instances.

As a survey of the present state, methods, and tendencies of contemporary chemistry, the book is indeed very inadequate. But as a crisply written and readable sketch of many interesting things it may stimulate interest where many a more ponderous and more accurate volume would fail. F. G. D.

Outlines of Biology. By Dr. P. Chalmers Mitchell, F.R.S. Revised and supplemented by George P. Mudge. Third edition, revised. Pp. xv+348. (London: Methuen and Co., Ltd., 1911.) Price 6*s*. net.

THIS is a book which, as its author and reviser say in their opening remarks, is intended to "cover the ground of the student working for the First Examination of the Conjoint Board of Surgeons and Physicians, London," and also as an elementary text-book for

"those who propose to devote themselves afterwards to more detailed study of zoology."

There has been for a considerable period a great need of a suitable text-book of biology for the First Conjoint Examination, as the authors of elementary text-books seem invariably to base the contents of their volumes on the syllabus of the examinations of the University of London. It is thus with considerable pleasure that we welcome a text-book that we can put into the hands of students, feeling confident that it will neither burden their minds with unnecessary matter, nor fail to deal with subjects coming within the range of their examination.

Almost the whole of the book deals with the types required by the Conjoint Board; the remaining chapters contain either accounts of a few other organisms, which the authors consider necessary for the proper comparison of the types, or else they set forth in an elementary manner some of the general principles of biology. In one or two matters the reviewer does not see eye to eye with the authors. In some minor theoretical points they adopt views divergent from his. For instance, they unequivocably describe bacteria as unicellular plants, while the extremely primitive organisation and their peculiar and equally primitive methods of nutrition justify, in our opinion, their classification as a group entirely apart from animals or plants, and certainly lower than the typical unicellular organism. Another point is the complete separation of blood from the other connective tissues in a group of its own. But, after all, these are matters of opinion and not of fact.

A more serious matter is the fact that all the figures, with the exception of the plates, have been ruthlessly diagrammatised. We feel that whatever these figures gain in clearness from this simplification they will lose far more in usefulness when the student attempts to apply them to the actual specimens. We hope, however, to see this remedied in future editions, and with this exception, and in spite of it, the book is one that should prove of value to the students to whom it is addressed. R. W. H. R.

The Boy Fancier: being a Complete Manual of all Matters Appertaining to Domestic Pets Suitable for the Youthful Fancier. By F. T. Barton. Pp. xx+435. (London: George Routledge and Sons, Ltd.; New York: E. P. Dutton and Co., n.d.) Price 5*s*.

FROM his professional training as a member of the Royal College of Veterinary Surgeons, the author of this well-illustrated volume is thoroughly qualified to give sound and trustworthy information with regard to the general care, feeding, and treatment in illness of animals kept as pets, or, like poultry and goats, reared for profit. And although the work before us is primarily intended for the benefit of young persons, it will be found equally valuable for those of more mature age, who, for purposes of pleasure or profit —or both combined—devote their attention to the keeping and rearing of dogs, cats, goats, guinea-pigs, rabbits, squirrels, poultry, pigeons, cage-birds, &c.

In the case of dogs Mr. Barton refers particularly to such as are best suited for boys, especially those adapted for ratting and rabbiting, and gives valuable advice to his young readers in the matter of proper training. Guinea-pigs he regards as specially suitable for children, since they require much less care and attention than rabbits. The sections on poultry and pigeons, as well as that on goats, will be found valuable to older readers, as most of the more important breeds are more or less fully mentioned. The book may be confidently recommended as one of the best of its kind, the only error that has come under our notice being that the habitat of the capuchin monkey is given as Guinea, instead of Guiana, which is obviously a mere misprint. R. L.

Methodical Nature Study. By W. J. Claxton. Pp. 195. (London: Blackie and Son, Ltd., 1911.) Price 6*s*.

THIS book is framed with the object of indicating a series of lessons on plants and animals, appropriate to each month in turn, so that the qualification "seasonable" would be more applicable than "methodical." The author has found it difficult to maintain the study of animals throughout the winter months, and in some instances reverts to lessons based on pictures or to instruction without observation. The botanical syllabus follows very ordinary lines, but there is a notable omission of physiological experiments. The author is not sufficiently careful in his use of technical terms, as will be evident from a reading of p. 16; nor can his reasonings be freely accepted. There are many excellent illustrations from photographs by Charles Reid, Henry Irving, and Douglas English, which, however, are shorn of their value in a book concerned with the study of nature by direct observation.

Geological and Topographical Maps: their Interpretation and Use. A Handbook for the Geologist and Civil Engineer. By Dr. A. R. Dwerryhouse. Pp. viii+133. (London: Edward Arnold, 1911.) Price 4*s*. 6*d*. net.

THE practical problems involved in the interpretation of geological and topographical maps are here dealt with in a manner likely to appeal to students of geology and civil engineering. Having worked his way through the book, a student should be able to draw sections of the country shown upon a map, to estimate the thickness of the strata of which the area is built, and to understand the relations of the strata to the surface of the ground and to each other.

The volume is illustrated by ninety clearly drawn figures, and tables are provided showing variation of dip and the natural sines, tangents, and cotangents. Some typical exercises to enable the student to test his knowledge would be a useful addition to the next edition.

Flora of the Upper Gangetic Plain, and of the Adjacent Siwalik and Sub-Himalayan Tracts. By J. F. Duthie. Vol. ii., Plumbaginaceæ to Plantaginaceæ. Pp. ii+266. (Calcutta: Superintendent, Government Printing, India, 1911.) Price 2 rupees (3*s*.).

THIS volume treats the second and third series of Hooker's Gamopetalæ. The order Ericales is wanting from the flora; otherwise twenty-six out of thirty families are represented. There are three large families, the Acanthaceæ, Labialæ, and Scrophulariaceæ; paucity of species is very noticeable, and many genera are unispecific; Ipomœa is the chief exception, as it supplies twelve indigenous and seven important cultivated species. Several changes are made in generic nomenclature from that followed in "The Flora of British India," such as the segregation of Ipomœa into four species; these changes are noted without the comment that one would have expected. Very few indigenous species in these series are of much economic importance. *Diospyros tomentosa* supplies the ebony of northern India; *Tectona grandis* is described as native; *Sesamum indicum* is cultivated, but not to any great extent.

Memories of a School Inspector. Thirty-five Years in Lancashire and Suffolk. By A. J. Swinburne. Pp. 274. (Snape Priory, Saxmundham: Published by the Author; London: M'Dougall, n.d.) Price 2*s.* 6*d.* net.

THIS story of thirty-five years' work as a Government inspector of elementary schools is concerned chiefly with anecdotes of encounters with a great variety of characters. Educational questions of importance are touched upon lightly here and there, but the object of the book appears to provide entertaining reading for leisure hours.

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.*]

Microscope Stands.

MICROSCOPISTS will have experienced a feeling of satisfaction that, what they might anticipate would be a carefully reasoned consideration of the respective merits of Continental and English microscopes, had been provided for them in the issue of NATURE of December 21 last, but their satisfaction must have been considerably modified when they had finished reading the article in question. The subject is admittedly one of considerable difficulty, but no good purpose is to be served by giving the opinions of those, if one may judge from the opinions expressed, who are only able to see from the point of view of the producer, the user not being considered. Apparently the intention is to state the matter from each side: the first and second sections, therefore, treat of the characteristics and advantages of the English and Continental types respectively, while the third and concluding section would presumably be a careful comparison of these two types. In point of fact, the latter is nothing but a eulogy of the productions of Continental houses, and, if the concluding sentence is to be accepted, there is nothing left for English producers but to retire from the field and leave them in undisputed possession.

The opening statement of the claims for superiority in the English stand is fairly set out; in fact, as no particular opinion is expressed on the merits or demerits of this type of instrument other than to indicate its good points, little can be urged against it. The controversial part is mainly confined to that in which the provision of sprung bearings and controlling screws is set forth as an advantage, but I shall have occasion to refer to this further when considering the claims of the Continental type.

The second part of the article is headed "A Defence of the Continental Form." The first point raised, that the short Continental microscopes are more convenient in use, applies only when the instrument is used in a vertical position: but it should have been pointed out that this shortness is dependent on the optical tube length, which is shorter than in the English type.

The mechanical stages on the best Continental stands are all that could be wished, and the claims made under that head are quite justifiable.

The substage arrangements might easily be the subject of criticism, as in most Continental types they are far too cramped, and there is not sufficient latitude to allow of the easy manipulation of the various substage fittings. At the same time it must be admitted that in all but a very few cases a fine adjustment motion to the substage fittings is not necessary. But this is not because the Continental types are of necessity better made, as the paragraph in question somewhat implies, but because, in general, an achromatic condenser, even of the finest optical construction, does not focus within such narrow limits that a fine adjustment motion is necessary. A well-made rackwork will, in fact, give a sufficient degree of accuracy.

As to the horseshoe foot, this has little to recommend it when compared with the English tripod. It is true that there are three points of support, but they are not sufficiently far apart, and are not in the position in relation to the centre of gravity to ensure rigidity and firmness in any position. For photomicrography no well-designed stand should require clamping to its base at all, and the best of Continental microscopes, even those especially designed for the purpose, are so unstable that they will not stand alone when horizontal, much less retain any degree of stability in that position. The method of clamping down is usually such that the instrument is under considerable strain and tension, and certainly should any vibration be set up it will feel the effects of this to the utmost. The statement that clamping down is necessary with the larger stands of English make is not in accordance with the facts; I have recently had a microscope made by a leading English maker which is even more stable in the horizontal than the vertical position, and I should certainly consider that any clamp when using this instrument would be superfluous.

The large body tube of the Continental stands is a point distinctly in their favour, and one which some English makers have wisely thought fit to imitate.

As to the sensitiveness of the fine adjustment, this is perhaps a controversial point, the degree of sensitiveness required depending to a large extent on the user. As one becomes more expert, it is realised that such extreme slowness of movement is not required, but that it is necessary for the movement to be absolutely precise. Slowness of the fine adjustment motion which is claimed as a characteristic of the Continental type has at least been equalled for many years by an English maker. One well-known English fine adjustment moves the body tube 1/25,000th of an inch per division of the milled head, and this is practically the same as that provided in one of the newest of Continental instruments.

As to the relative merits of ground-in as compared with sprung motions, there is no doubt, from the point of view of the ordinary microscope user, that the ground-in fittings are preferable, but this does not of necessity apply to those who use their instruments with great care and who are quite capable of making the necessary adjustments which the sprung fittings provide. When once a ground-in fitting has become loose from wear there is nothing to do but to return it to the maker for replacement, whereas with the sprung fittings, by careful use, they can be adjusted from time to time and the instrument kept in perfect working order. However, this point has been more or less settled in favour of the ground-in method, as leading English makers are now providing (and some of them have done so for several years) instruments in which all their fittings are ground. So far, the respective claims of the English and Continental stands are fairly well set out, although much of the information given is to be found in makers' catalogues; but it is when we come to that part of the article headed "English and Continental Microscopes," and in which, therefore, we look for a careful comparison of the merits and demerits of the two types, that astonishing claims are made. While it is scarcely possible to consider fully the question of the evolution of the microscope, it must at once be said that the statements made are not strictly in accordance with the real facts.

The modern Continental microscope, whatever its advantages or disadvantages, has been evolved largely as the result of a consideration of the English model. Here we are told that the present-day English microscope is a degenerate form of what was originally a complicated and massive piece of mechanism, the multiplicity of racks and screws of which were a source of delight to *dilettanti*, while the modern Continental instrument is an evolution from an exceedingly simple, and by inference highly satisfactory, design. To put it plainly, this is not the fact; the refinements on a modern Continental stand have almost entirely been borrowed or copied from more perfect English models. We are told that the serious worker in science has not the time to play with the large variety of fittings in the English stand, while the *dilettante* is content to manipulate these, with the result that he is both "physically and mentally exhausted." In any case, if the user of a microscope requires an instrument that will deal with a large number of objects in a given time, it would be quite easy to devise some mechanical arrangement. Fortunately, there are still

workers who would be content to observe one preparation per day if such observation resulted in their seeing something that otherwise would pass unnoticed. The multiplicity of screws and racks which are scoffed at may each perform its function, and one has yet to learn that even the most complicated English microscope that has yet been produced cannot be manipulated, and all its adjustments made use of, in as many minutes as the writer would seem to imply hours are needed for the task.

The English tripod is, however, treated with a little more fairness, and it is even admitted that this has so modified the intentions of Continental makers that they have altered their microscope base in recent years, so that it has at least some of the advantages of the English tripod form. But the statement is here again made that in photomicrography the Continental horseshoe is the equal in stability of the English type if the former is clamped down. As a photomicrographer, one can only say that it is entirely in opposition to experience, and that the horseshoe foot, in which the centre of gravity of the instrument is not in its proper position for stability, is never the equal of the English tripod, neither can it with fairness be urged that the English tripod results in less freedom of access to the substage arrangements than does the Continental type.

We come next to the paragraph in which the superiority of a centring arrangement to the objective over the method of centration of the substage is claimed, and we are told that in photomicrography the absence of centring screws in the substage means "a considerable saving of time," &c. One always understood as a question of practical optics that considerable trouble is taken by opticians to ensure that the objective and ocular are in optical alignment. We know that there is always some difference of centration between objectives even by the same maker, which is no doubt unavoidable in the course of manufacture, but these differences are but slight. In good microscopes very great care is taken to ensure that the nose-piece of the instrument is made to take an objective which, when screwed home, is as nearly as practicable in perfect optical alignment with the eyepiece. But the same cannot be said for the substage condenser. This is an independent optical system carried on a separate part of the instrument, and it is extremely difficult to ensure accurate alignment, and still more difficult to maintain this, even if it were so at the start. English microscopes are therefore provided with centring screws to the substage, and it would be interesting to hear on what optical grounds it can be proved that a method of centring the objective, in relation to an eyepiece and substage which are themselves not in alignment, can be justified. We are also told that objective changers which have centring screws provided on them are to be used and manipulated in the course of work for centration purposes. The avowed object of centring screws on these carriers has always been to provide against the slight want of centration between different objectives already referred to; but that these small fittings should be used for purposes of centration in the ordinary course of manipulation of the instrument is a purpose which has never before been assigned to them. One wonders what would be the condition of these little screws with their short bearings after a few months' regular laboratory work!

We are entitled to infer, therefore, that these Continental microscopes are so extraordinarily well and accurately made that perfect collimation of the substage condenser with the magnifying system is perpetual, which can only be described as unlikely.

As to the mechanical draw-tube (*i.e.* one with rackwork focussing), this is a feature, as stated, that is only provided in a few Continental models, whereas the English instrument of any elaboration is provided with such. But we are told that, *instead* of this mechanical draw-tube, the Continental makers provide the objective with correction collars, from which it may be inferred that correction collars are unknown in English objectives. Perhaps the writer is not aware that Messrs. Powell and Lealand fitted correction collars to their objectives some seventy years ago, and have continued to do so, and that every English house is at the present time making objectives which are provided with correction collars. As the writer evidently regards mechanical draw-tubes (and, presumably, any draw-tube at all) as an unnecessary elaboration, it would be interesting to know how he would provide against variations in thickness of cover-glass when using an objective such as a 12 mm. Zeiss apochromatic, an objective which is, rightly, not provided with collar adjustment, although its magnificent corrections are substantially affected by differences in cover-glass thickness.

As to the want of uniformity in the Royal Microscopical Society standards, the writer here has a fair cause for complaint. The society has been for some time considering the question of these standards, a subcommittee is at present dealing with the matter, and it is to be hoped that something like finality will be reached as the result of their deliberations. At the same time, it must be pointed out that the chief cause of variability is not that the society's standards are wrong, but that makers, whether English or Continental, have failed to conform to them. There is not the least doubt that the society would welcome the cooperation or the assistance of the National Physical Laboratory in this matter, as it is one not without difficulty, and the greater the weight of opinion that can be brought to bear on the subject the better.

There are still many points outstanding that one feels require further elucidation, but it is feared that the ordinary limits of a letter have been much exceeded. It is to be hoped that other microscope users will give their opinions and help to arrive at some sort of conclusion as to the respective merits of the English and Continental microscope.

J. E. BARNARD.
King's College (University of London), Strand, W.C.

The Teaching of Electricity in Schools.

IT will be seen from Mr. Daniell's report of the meeting, held on January 12, of the Association of Science Masters in Public Schools (NATURE, January 18) that the headmaster of the Royal Naval College at Dartmouth has made himself responsible for the advocacy of a complete reversal of the historical order in teaching electricity to boys. He would begin with electricity in motion, and only incidentally throw in a little parenthetic information as to the phenomena of the electrostatic field.

I gathered from Mr. Ashford's address that it is for the sake of helping young boys to a pleasing and perhaps useful familiarity with the working of such things as electric bells, lamps, telephones, dynamos, and motors that he is willing to begin the subject at the wrong end, to omit the consideration of some of the most fundamental facts of the science, to introduce terms and units of measure which must appear extraordinarily arbitrary, and the exact significance of which cannot possibly be understood, and in general to make the best he can of what is logically a very bad job. He thinks that the gain overbalances the loss. I am very strongly of the opposite opinion.

Leaving out of consideration the very special training that may be required for a naval officer, I would refer to the boys who come for a good general education to a public school, where the science teaching will be only a part of a general scheme of education. It is important that the development of a boy's intellectual powers shall proceed happily and harmoniously, that every part of the teaching shall, if possible, assist every other part. If the science teaching is less methodical, less logical, less sincere than that of other subjects, the boys will soon find it out, and the other teachers of classics and mathematics will soon find it out, with the result that the science teaching will fall into just disrepute.

I think I should prefer for a boy of my own no teaching of electricity at all rather than such illogical teaching as that advocated by Mr. Ashford.

A science master who is not developing a subject step by step in a thoroughly orderly and logical manner, proceeding from the simple to the complex, insisting on the accurate definition of every term used and on its use in that sense only, is not in my opinion taking his share in the educational scheme of which his teaching should form part.

It is, however, my experience that, provided a boy has

already a fair knowledge of magnetism, of heat, and of chemistry, he can very profitably begin the study of statical electricity, which can be made quickly to lead on by well-understood steps to the study of electric currents.

Clifton, January 22. A. M. WORTHINGTON.

Glazed Frost.

A REMARKABLY good instance of glazed frost occurred in the London suburbs on Thursday morning, January 18, and evidently the same phenomenon was observed over a wide area in the south of England. A touch of real winter had spread rapidly over the country, and a strong and cold easterly wind was blowing, associated with the European anticyclone where the barometer was 31 inches, and with an area of low barometer readings over the Atlantic in fair proximity to our coasts. These conditions occasioned a heavy fall of snow over the northern and Midland portions of England, but there was copious rain in the south of England, with the air temperature at or slightly below the freezing point.

The trees and shrubs, as well as all ornamental work, in the garden were coated with clear ice varying in thickness from a tenth to two-tenths of an inch.

I plucked a twig with its ice coating on Streatham Hill and carried it with me to Fleet Street, where on arrival an hour later the twig remained encrusted with ice.

The shrubs and wire arches, &c., were exceedingly beautiful, but there was no ice coating within 2 feet of the ground—my lowest screen temperature was 31°.

The following description of the phenomenon is taken from "The Observer's Handbook," published by the Meteorological Office, London, 1910:—

"GLAZED FROST. (German *Glatteis*, French *Verglas*.)

"A transparent *smooth* coating of ice covering trees, buildings, &c. The phenomenon is usually caused by rain which freezes as it reaches the ground, and thus covers all objects with a coating of smooth transparent ice. It is very rare in our climate, but on the Continent or in America it is more common. The weight of the ice which collects is frequently sufficient to cause damage to telegraph wires, trees, &c. It is probable that the rain in these cases consists of supercooled drops of water."

Scott's "Elementary Meteorology," p. 116, has an excellent reference to a remarkable instance of glazed frost which occurred in France on January 22–24, 1879, taken from the *Comptes rendus* of the Paris Academy of Sciences. CHAS. HARDING.

The Isothermal Layer of the Atmosphere.

MAY I be permitted through the medium of your columns to suggest briefly what appears to me a possible explanation of the isothermal layer of the atmosphere, or stratosphere?

It is, I believe, generally admitted by astronomers that the swarm of small cosmical bodies reflecting light from the sun, known as the Zodiacal Light, extends beyond the earth's orbit, but lies outside the earth's atmosphere. My proposition is that heat received by these bodies from the sun is reflected, some of the heat reaching our atmosphere and penetrating its layers as far as the outer limits of the cloud layer. The heat thus supplied from above would be supplemented by heat received through the agency of terrestrial radiation, a larger supply being accumulated above the land than above the ocean. The greater height of the isothermal above the latter might be accounted for in this manner.

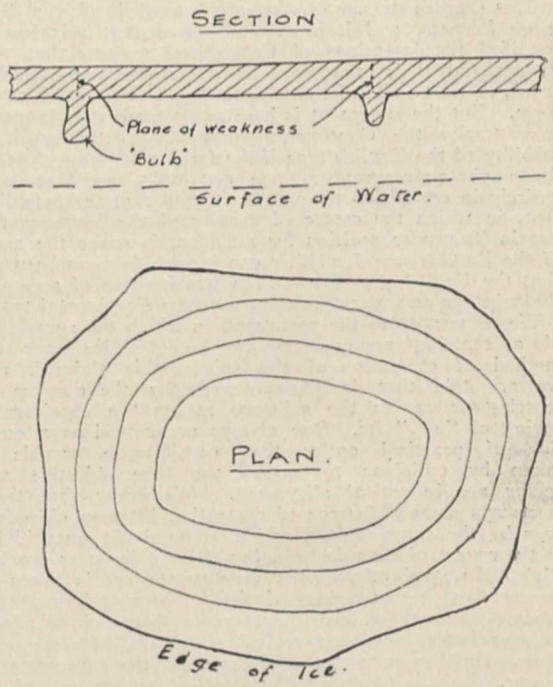
This suggestion is thrown out for the purpose of eliciting criticism, and in the hope of gaining information.

CAMPBELL HEPWORTH.

2 Amherst Road, Ealing, W., January 15.

Concentric Joints in Ice.

IN walking over a piece of water-logged ground, I noticed several small shallow pools which had frozen over. A number of rings, more or less parallel to the edges, were visible as in the plan. The water was found to be a couple of inches below the top of the ice, and the rings were vertical planes, along which the ice could be readily broken. Beneath each of these concentric "joints" the bulb formation indicated in the section (roughly to scale) was found in various stages of development, the bulbs nearest the centre being, as a rule, the most perfectly developed. The full bulb projected about three-quarters of



an inch below the ice-sheet, which did not vary much from five-eighths of an inch or so in thickness.

I should be interested to hear if any of your readers can explain the somewhat peculiar formation described above.

HAROLD J. F. GOURLEY.

St. Stephen's House, Victoria Embankment, Westminster, S.W., January 15.

The Late M. Radau.

IN the obituary notice of M. Radau printed in the "Notes" columns of NATURE (January 11, p. 354) I notice the statement: "At no time does he seem to have held an official post as a practical astronomer." These words fail to do complete justice to this distinguished man of science. On M. Loewy's death M. Radau was appointed to succeed him as "le Membre du Bureau des Longitudes chargé de la rédaction de la Connaissance des Temps," and in this capacity he signed the "avertissements" to the volumes of the Connaissance des Temps for the years 1911, 1912, and 1913 as the official responsible for their contents.

January 20. A. M. W. DOWNING.

The Luminosity of Cats' Eyes.

I HAVE repeatedly observed the brilliancy of cats' eyes in the dark in particularly favourable circumstances. I have a brilliant incandescent light in my hall, and several cats on the premises. The entrance drive is in a line with the door and the hall lamp. When I call a cat in the chances are that if there she simply sits and looks at me, presenting the spectacle of two small incandescent lights glowing out of the darkness. Light, observer, and cat are all three in line, as observed by Colonel Herschel.

A. R. HUNT.

Southwood, Torquay, January 23

GROWTH AND SHRINKAGE OF GLACIERS.[1] THE volume referred to below deals with certain glaciers in Savoy; four of them in the *massif* of Mont Blanc, the same number in the Maurienne, and one in the Tarentaise. It is well known that, during the last few centuries, the Alpine glaciers have been increasing and decreasing in volume, though the extent and duration of these oscillations have been less certain, and observers in different parts of the chain are now watching and recording the amount of changes. The glaciers near Chamonix are particularly well adapted for study, because that place has been frequented by travellers for a longer time than other Alpine centres. Hence more information can be obtained, and this in some cases is supplemented by drawings, which, however open to criticism as works of art, are valuable records of facts.

FIG. 1.—Glacier du Tour, October, 1891.

These Savoy glaciers attained one maximum, according to a curious contemporary record, in 1643; they had greatly dwindled in 1770, but during the next ten years they again increased. Early in the next century came another advance, which culminated in 1819, and was followed by another retreat. They again advanced in 1826, and oscillated considerably during the next ten years. In the latter part of this century the Chamonix glaciers apparently did not diminish so much as those in most other parts of the Alps; for they are said to have ceased shrinking in 1875, and to have reached another maximum (though smaller than on some previous occasions) in 1892.

The French surveyors have worked on a definite and comprehensive plan, making maps, fixing points for measurement and observation, and taking photographs, so that a precise register, from year to year, can be kept of the changes in these ice-streams. Some old illustrations have been reproduced, which, though artists might justly criticise, give us a good notion of the state of certain glaciers about the maximum of 1832, and photographs show some of the changes during the last twenty years. Those, for instance, of the Glacier du Tour in 1891 and 1898 (Figs. 1 and 2) indicate a considerable alteration in the volume of the ice; for an ice fall has shrunk enough to disclose a large part of the cliff by which it has been produced, while a third view, taken in 1907, exhibits a still larger amount of bare rock. It is also worth observing, though we must not enlarge upon so controversial a subject, that these illustrations have a bearing on the question of the erosive power of ice. They indicate (and this is corroborated in other parts of the Alps) that a glacier in passing over a well-marked step of rock often neither smooths it away nor digs for itself anything like a deep channel.

The position of the glaciers treated in this work has been, so far as possible, ascertained and recorded, the method of studying them being described and worked out in a typical case, so that students of glaciology receive a valuable addition to the facts at their command, and their successors, in another half-century, will be in a far better position to ascertain the precise causes of these ebbs and flows in the ice-streams of the Alps. A sentence on the title-page of this book is significant, "Service des grandes Forces hydrauliques," for it shows that the French Government (the work is undertaken by the Ministerial Department of Agriculture) recognises the value

FIG. 2.—Glacier du Tour, October, 1898.

[1] "Études Glaciologiques en Savoie." Tome ii. (Ministère de l'Agriculture. Direction de l'Hydraulique et des Améliorations Agricoles. Service des Grandes Forces hydrauliques, Région des Alpes.) Pp. vii+140+19 plates. (1910.)

of Alpine rivers as inexhaustible stores of energy. Had we the same in Britain we could contemplate with equanimity the exhaustion of our coalfields.

T. G. BONNEY.

CELESTIAL SPECTROSCOPY.[1]

THE publication referred to below contains an account of six separate and distinct investigations, which have been grouped together under the above heading. In part i. are given the results of a comparative study of the sun (Fraunhoferic), chromosphere, and lower type star spectra in relation to the sun-spot spectrum. Part ii. contains an account of an investigation into the spectrum of ε Ursæ Majoris as compared with the normal Sirian spectrum. Under part iii. is found a discussion of the occurrence of nitrogen lines in the stellar spectra, and under part iv. lists of the enhanced lines of certain metals, which have not previously been published. The wave-lengths of certain well-defined lines of simple and definite origin, which are peculiarly suitable for radial velocity measurements, are given in part v., while under part vi. are grouped the wave-lengths of those well-marked lines occurring in celestial spectra for which no terrestrial equivalents have yet been found.

It may be said at once that the two last sections of this book should prove of great value. It is manifestly impossible to obtain accurate results in any radial velocity measurements unless the selected spectrum lines are at once simple in structure and of known origin. The publication of a list of such lines occurring in the spectra of nine different types (Kensington) must certainly aid those engaged in this particular branch of stellar spectroscopy.

The first part of the book is devoted to a comparison between the sun spectra and those of Capella and Arcturus, considered especially in reference to the spectrum of sun-spots. Certain of the Fraunhofer lines are found to be considerably modified in intensity in the Arcturus spectrum, and it has been definitely established by Hale and Adams that the same lines are affected in sun-spots. A close comparison of the Kensington measurements with those taken at Mount Wilson is given as far as they overlap, and though there are present in each certain lines not common to both, the two sets of observations are strikingly concordant. It has always been held by Sir Norman Lockyer and his co-workers that the comparison between the spectra indicate that the temperature of Arcturus and that of the sun-spots are comparable and lower than that of the rest of the solar reversing layer. Although other theories have been advanced, the latest observations go to show that the Kensington theory is the right one.

The second chapter deals entirely with the spectrum of ε Ursæ Majoris, the lines of which have been measured and as far as possible traced to their origin. The differences between this spectrum and those of Sirius and α Cygni are given, and the general conclusion is drawn that ε Ursæ Majoris must be placed between the Sirian and the Procyonian group on the Kensington temperature scale.

It is impossible in a short notice to enter into the details of this work, so many branches of which have been grouped together. Suffice it to say that the whole investigation stands on the same high plane as all those carried out in the Solar Physics Observatory, and the author is to be congratulated on bringing a laborious research to a successful conclusion.

1 "Researches on the Chemical Origin of Various Lines in Solar and Stellar Spectra; being the Results of Investigations made at the Solar Physics Observatory, South Kensington, after discussion." By F. E. Baxandall. Pp. vii+77. (London: H.M. Stationery Office, 1910.) Price 4s. 6d. (Solar Physics Committee, under the Direction of Sir Norman Lockyer, K.C.B., F.R.S.)]

"YELLOW JACK."

A MELANCHOLY interest attaches to this volume inasmuch as it was the last work penned by its gifted author before his premature decease, and serves to emphasise the loss to tropical medicine sustained thereby.

The book is a complete treatise on yellow fever—the "yellow jack" of the earlier navigators, that dread disease which so often broke out with appalling suddenness and severity on ships voyaging to the west coast of Africa, the West Indies, and Central America, and parts adjacent thereto. Its distribution is somewhat peculiar in that it is practically confined to that part of the globe between the parallels of latitude 40° north and south, and of longitude 20° east and 100° west. It is true that outbreaks of the disease have occurred somewhat outside these limits, *e.g.* in North Italy, French seaports, Swansea, and Southampton in this country (a few cases only), and at times severely in New York and Philadelphia, but in these districts it has never obtained a foothold. The reason for this geographical distribution is associated partly with the endemic areas which naturally exist in West Africa and Central America, and partly by reason of the fact that the disease is transmitted by a species of mosquito, the *Stegomyia fasciata* (*calopus*), the distribution of which is practically world-wide *between* the parallels of latitude 40° north and south. Thus in Europe, the Stegomyia is found in southern Spain, Italy, Malta, and Greece, and it

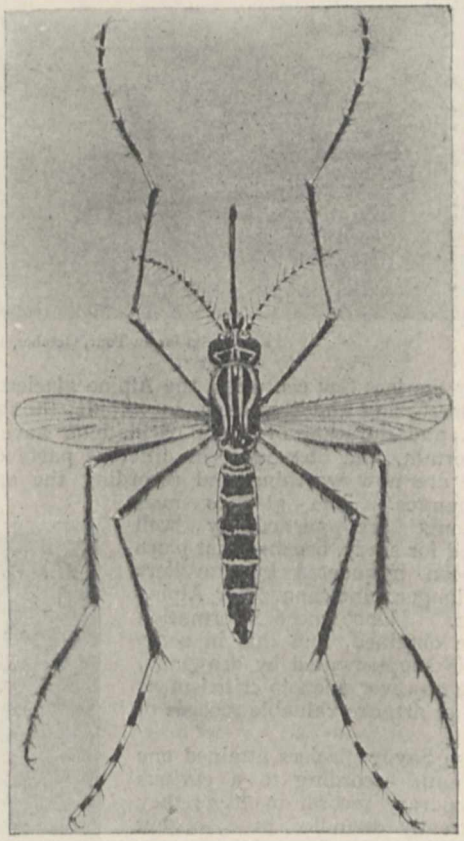


FIG. 1.—*Stegomyia fasciata*, F. (=*Calopus*, Mg.), ♀, the mosquito which carries yellow fever. From "Yellow Fever and its Prevention."

1 "Yellow Fever and its Prevention: a Manual for Medical Students and Practitioners." By Sir Rubert W. Boyce, F.R.S. Pp. xv+380. (London: John Murray, 1911.) Price 10s. 6d. net.

occurs outside the epidemic and endemic areas of yellow fever in East Africa, Arabia, India, Indo-China, China, Japan, the East Indies, Australia, and some of the Pacific Islands. It may be asked, how is it that yellow fever is not a disease of the last-named countries? The reply is because the disease has never been introduced into them, and epidemiologists are keenly alive to the fact that the conditions existing therein are probably just as favourable for its spread there as in the localities in which it exists. Should the disease ever be introduced into the East, and increasing facilities and rapidity of travel are favourable for such an event, the consequences probably would be disastrous. The impending opening of the Panama Canal, for instance, is recognised as a menace to China so far as the introduction of yellow fever is concerned, and efficient precautions will doubtless be taken to prevent such an occurrence.

The various subdivisions of the book deal respectively with the history and geographical distribution of yellow fever, its symptomatology and treatment, pathology, epidemiology, entomology, and prophylaxis. While forming a treatise for the use of the medical and sanitary office, its style is such that it can be understood by any educated individual, and should thus be of service to Colonial governors and members of legislative assemblies and municipalities of localities where the disease may occur. The author considers that yellow fever is an endemic and indigenous disease of Central, and the northern part of South, America, of the West Indies, and of West Africa, and a record is given of the principal outbreaks occurring there and in other parts during the past two centuries.

The portion of the book which will probably appeal most to the general reader is that dealing with prophylaxis, the prevention of the disease. The epidemiology of yellow fever was a mystery to the older observers, and they were divided into two camps, the "contagionists" and the "non-contagionists," who considered it a "place disease," and in different outbreaks the facts seemed equally favourable to either; this, of course, was due to the transmission of the disease by the mosquito. The first to direct attention to this fact was Beauperthuy (1850–60), who taught in no uncertain manner that the agent which propagated yellow fever was the "house-haunting mosquito." Finlay, of Havanna, came to the same conclusion in 1881, and undertook direct experiments to substantiate his views, with a certain amount of success, but it was only after years of bitter controversy and Ross's discovery of the part played by mosquitoes in the transmission of malaria that the American Commission in 1899 definitely established the *rôle* of Stegomyia in the transmission of the disease. The prevention of yellow fever therefore resolves itself into (*a*) the destruction of Stegomyia by removal of breeding places, "screening" of water receptacles, fumigation of dwellings, oiling of ponds, &c.; (*b*) prevention of mosquito bites by wire-gauze screening of windows and doors so far as possible, and the use of the mosquito net; and (*c*) segregation and careful screening of the sick, so as to prevent access and infection of the mosquitoes. Fortunately, in one sense, the Stegomyia mosquito is largely a domestic species, and its breeding places are almost exclusively *artificial* collections of stagnant water, including all receptacles in which, by accident or design, water is caught, stored, and not repeatedly renewed, such as old pots and tins, flower-pots, tanks, tubs, broken crockery, bottles, &c. Boyce says he has never found it breeding more than 50 to 100 yards from the abode of man. This fact renders the extermination of this species of mosquito a far easier matter than in the case of the anophelines which convey malaria. The practical outcome of such anti-mosquito measures may be realised when it is stated that by their adoption yellow fever has been completely stamped out in Havanna, which up to 1909 always suffered severely from the disease. The book is admirably illustrated, and concludes with a summary on quarantine administration.

R. T. H.

FIG. 2.—A row of upturned bottles used to make an edge to a flower-bed in Freetown, Sierra Leone. Favourite receptacles for Stegomyia larvæ. From "Yellow Fever and its Prevention."

THE JOURNALS OF THE FIRST SURVEYOR-GENERAL OF INDIA.[1]

IN 1906 Sir Rennell Rodd, G.C.V.O., now British Ambassador at Rome, presented to the Victoria Memorial Collection at Calcutta a small quarto volume containing the journal of his great-grandfather, Major James Rennell, F.R.S., which covered a portion of the period which he spent in India. The present editor, Mr. T. H. D. La Touche, was desired by the Director of the Geological Survey of India to see whether it contained anything of geological interest, but though such information is wanting except in so far as striking and important changes have taken place in the courses of rivers in Bengal since Rennell's

1 "The Journals of Major James Rennell, First Surveyor-General of India." Edited by T. H. D. La Touche. Memoirs of the Asiatic Society of Bengal, vol. iii., pp. 95–248.

surveys, the journal is of the highest interest for its careful and precise account of the physical aspects of the country, its climate, crops, communications, &c.

The period covered by the journal is from May, 1764, to March, 1767. Rennell had just received a commission as probationer engineer in the fort then being erected at Calcutta, near Fort William, and was ordered on May 6 to make a survey of the Ganges eastward of Jelenghee, in order to find out the nearest passage from the Ganges to Calcutta in the dry season, and to report fully on the appearance and products of the country passed through to Mr. Vansittart, the Governor of Bengal. This journal was then kept in pursuance of the Governor's orders, and in it we find daily notes on the weather, the width and depth of the river at high and low water, with many notes on the navigability of the channels traversed, until August 4, when the expedition came to an end.

Six weeks later he started on a second expedition to survey the Ganges from the point reached in the former expedition as far as Dacca, where he was taken ill. As soon as he had recovered he carried his survey to the junction of the Meghna and the Ganges, which his observations show to have then been about a degree farther north than it now is. This expedition ended in May, 1765, and besides carrying out his own surveys, we see from the "Journal" that he was also occupied in collecting from others all such material as would be of service in compiling a general map of Bengal. After two months engaged in surveying on the Meghna and Brahmaputra Rivers the "Journal" passes to the fourth expedition undertaken at Lord Clive's orders in order to form a general map of Bengal, for which distances were to be taken in a cursory manner, only latitudes being used to correct them. In February he was seriously wounded in a fight with a body of Sanashi fakirs, and incapacitated from work until June, but so effectively had he pushed on his survey that on Lord Clive's sudden departure at the end of January, 1767, Rennell was able to supply him with a map of Bengal and a part of Bahar, and another of the Ganges from Patna to Kananj, on the scale of 10 miles to one inch. On January 1, 1767, he notes that he was appointed Surveyor-General, and mentions the four officers who were appointed as his assistants, among whom he apportioned the country to be surveyed.

A large collection of itineraries, latitudes, observations for magnetic variation, and various memoranda complete the volume, which gives a vivid picture of the conditions under which the first surveys in India were carried out. At this time few instruments of precision were available, and his surveys were made with a compass and the chain, while he employed a Hadley's quadrant for the determination of latitudes. Even with such simple equipment he worked with remarkable accuracy, and many places fixed by him are found by subsequent measurement to agree closely with their true positions, though his instruments left much to be desired, as errors of 6 and 8·5 inches in his chain length, which are recorded among the memoranda of his "Journal," show. It was no doubt his own skill in carrying out route surveys and controlling them by astronomical observations that prejudiced Rennell at first against Major Lambton's procedure of triangulation.

The "Journal" is a record of the highest interest, and geographers are much indebted to the editor for his labours, and to the Asiatic Society of Bengal for publishing it, together with a map of Bengal and Bahar from Rennell's "Bengal Atlas" to illustrate it.

H. G. L.

NOTES.

A STONE has recently been put up in Teddington Church in memory of Stephen Hales, who, in addition to being a distinguished man of science, was for fifty-one years the faithful vicar of that parish. He died in 1761, and was buried under the tower in what now serves as the entrance to the church. The fact that Hales was so buried was perfectly well known, and it is hard to say why a morning paper should assert that a number of learned men have hitherto sought for his tomb in vain. It was also known that the gravestone was being worn by the feet of Teddington congregations, and this it was that suggested the erection of a mural tablet on which the epitaph might be permanently preserved. The necessary funds were raised by subscriptions from a number of leading botanists. The students attending a course of lectures on the history of botany at University College, London, also materially helped with contributions. The Vicar of Teddington, the Rev. A. Cazalet, has taken a kindly interest in the scheme, and has been good enough to put up the tablet on the wall close to the burial place of Hales. The inscription is as follows:—"Beneath is the grave of Stephen Hales. The epitaph, now partly obliterated but recovered from a record of 1795, is here inscribed by the piety of certain botanists. A.D. 1911. 'Here is interr'd the body of Stephen Hales, D.D., Clerk of the Closet to the Princess of Wales, who was Minister of this Parish 51 years. He died the 4th of January, 1761, in the 84th year of his age.'"

MR. W. LEO BULLER has presented to the Dominion Museum, Wellington, New Zealand, an extremely valuable collection of about 700 Maori ethnological specimens which had been collected by his illustrious father, Sir Walter Buller, the well-known authority on the birds of New Zealand. The benefaction includes a large and representative collection of valuable historical greenstones, including both personal ornaments and weapons; a number of house carvings; a large pataka; a large carved war canoe with all its ornamental fittings, and a small, beautifully modelled light canoe; a collection of stone tools, adzes, &c., including the largest and finest stone adze at present known; a specially valuable collection of Maori garments, two being dog-skin cloaks in a perfect state of preservation, which were acquired in 1838; a number of other objects of Maori workmanship, many of which are of historic interest. In addition to these specimens, the collection will be completed by sending out to New Zealand the objects now in the Imperial Institute collected by Sir Walter Buller. It is difficult to overestimate the value of this donation, and when the gift was announced in the New Zealand Parliament by the Prime Minister it was received by members with expressions of very warm appreciation. We may now anticipate with confidence that the Dominion Government will at last build a museum to house its natural history and ethnological specimens, the value of which cannot be reckoned in money, but which are contained in an inflammable "old shed of a museum." It is satisfactory to know that the new specimens will be under the care of Mr. Hamilton, the director of the Dominion Museum, who has himself made valuable contributions to our knowledge of the arts and crafts of the Maoris.

NEWS has just reached us of the death, on January 12, of M. T. Durand, member of the Royal Academy of Belgium, director of the State Botanic Garden, and general secretary of the Royal Botanic Society of Belgium.

THE Academy of Natural Sciences of Philadelphia has awarded the Hayden medal in gold for distinguished work in geology to Prof. J. C. Branner, of Leland Stanford Jr. University, U.S.A.

THE Royal Geographical Society has arranged for a course of three lectures on "The Desert of North Africa," to be given by Captain H. G. Lyons, F.R.S., in the Theatre, Burlington Gardens, on February 9, 13, and 15.

AN official intimation from the Musée National d'Histoire Naturelle de Buenos Aires informs us that Dr. Angel Gallardo has been appointed director of that institution in succession to Dr. Florentino Ameghino, who died on August 6, 1911, at fifty-six years of age.

AT the ordinary scientific meeting of the Chemical Society held on Thursday, January 18, the president, Prof. Percy F. Frankland, F.R.S., announced that the Moissan memorial lecture will be delivered in the rooms of the society by Sir William Ramsay, K.C.B., F.R.S., on Thursday, February 29, at 8.30 p.m.

SO much interest has been aroused by the exhibition of bird tables and nesting-boxes in the offices of the Selborne Society at 42 Bloomsbury Square, W.C., that it has been decided to allow the collection to remain on view until January 31. The hours are from 11 a.m. to 5 p.m. on weekdays, except Saturday, when the exhibition closes at 3 p.m.

IT will be remembered that M. Maurice Maeterlinck last year received the Nobel prize for literature. The prize amounted to 7772*l*. We learn from the *Revue Scientifique* that M. Maeterlinck proposes to raise the sum to 8000*l*., and to employ it to establish a biennial prize of 640*l*. to be awarded to the author of the most remarkable work—whether on literature, art, or science—published in the French language.

IN December last one of the massive sarsen stones still remaining of what is known as Longstone Cove, or Longstones, standing in the ploughed field to the right of the road from Avebury to Beckhampton, which, according to Stukely, formed an adjunct to the Beckhampton Avenue leading to Avebury, fell down. Its weight is estimated to be more than 30 tons. The Wiltshire Archæological Society, through its secretary, the Rev. E. H. Goddard, Clyffe Vicarage, Swindon, now appeals for assistance in raising the sum of about 50*l*. required to re-erect the stone and support it by a concrete foundation, the funds of the society being inadequate to undertake such a work.

WE regret to see the announcement of the death, on January 21, in his eighty-second year, of Dr. David Christison, one of the foremost antiquaries in Scotland. From an obituary notice in *The Times* we learn that he was secretary of the Society of Antiquaries of Scotland for sixteen years, from 1888 to 1904. He travelled over a great part of Scotland planning the prehistoric forts and minutely examining them, and the results of his investigations he contributed in many interesting papers to the Society of Antiquaries. About twenty years ago he was Rhind lecturer, and chose as the subject of his course "The Prehistoric Forts of Scotland." These lectures were published in book form. "Early Fortifications in Scotland" was another of his works. In 1867, for the benefit of his health, Dr. Cristison visited Argentina, on which he wrote a number of papers. A keen student of botany, he was a member of the Botanical Society, to which he made several communications, particularly on the growth of trees.

ON Thursday, February 1, Prof. A. M. Worthington will begin a course of two experimentally illustrated lectures at the Royal Institution on "The Phenomena of Splashes," and on Saturday, February 3, Sir Alexander C. Mackenzie will deliver the first of a course of lectures, with musical illustrations, on (1) "Russian Music of To-day," and (2 and 3) "Franz Liszt (Centenary)." The Friday evening discourse on February 2 will be delivered by Sir James Mackenzie Davidson on "Vital Effects of Radium and other Rays," and on February 9 by Dr. J. A. Harker on "Very High Temperatures."

THE Liverpool excavations at Meroë, under the direction of Prof. Garstang, assisted by Mr. Schliephack, are making great progress. The palace of the Ethiopian kings, near the temple of Amon, proves to contain more than forty chambers and a large court. On the foundation-walls are reliefs of the usual Ethiopian pattern. Three hundred Sudani natives are now employed, with a staff of trained Egyptian diggers, chiefly fellâḥîn from Ḳuft. A light man-tramway, of the kind commonly utilised in excavations elsewhere (*e.g.* at Abusir and Deir el-Bahari) to facilitate the removal of the excavated material, has been installed, and to this Mr. Garstang has added a small aërial cableway. A telegram from Khartûm describing the progress of the work appeared in *The Times* of January 17; from this the above account is partly taken.

AT the annual general meeting of the Royal Meteorological Society on January 17 the president, Dr. H. N. Dickson, presented to Prof. Cleveland Abbe, of the U.S. Weather Bureau, Washington, the Symons gold medal for 1912, which had been awarded to him in consideration of his distinguished work in connection with instrumental, statistical, and dynamical meteorology and forecasting. The following officers and members of council for the ensuing year were elected at the meeting:—*President*, Dr. H. N. Dickson; *vice-presidents*, R. H. Hooker, R. G. K. Lempfert, H. Mellish, Colonel H. E. Rawson, C.B.; *treasurer*, Dr. C. T. Williams; *secretaries*, F. C. Bayard, Commander W. F. Caborne, C.B.; *foreign secretary*, Dr. R. H. Scott, F.R.S.; *councillors*, W. W. Bryant, C. J. P. Cave, Dr. C. Chree, F.R.S., F. Druce, F. W. Dyson, F.R.S., E. Gold, Commander M. W. C. Hepworth, C.B., R. Inwards, Captain H. G. Lyons, F.R.S., M. de C. S. Salter, Captain A. Simpson, and Sir J. W. Towse.

A MEMORANDUM of revised arrangements between the Board of Agriculture and Fisheries and the Board of Education in regard to agricultural education in England and Wales has been issued. It is pointed out that in view of the large additional sums which have become available since 1909 for the purposes of agricultural education and research under the Development and Road Improvement Funds Act, 1909, the arrangements made in 1909 now require some modification. It no longer appears possible to delimit the spheres of work of the two Boards by assigning to the Board of Agriculture the responsibility for the universities and colleges in which advanced work is being done, and to the Board of Education the responsibility for farm schools and such other provision for agricultural education as is on a lower plane than that of agricultural colleges. It has therefore been decided that, in future, the responsibility for farm institutes, as well as for the agricultural work of universities and colleges, shall be transferred to the Board of Agriculture, and that this Board shall be regarded as the Government department concerned with this branch of educational work for the purposes of the Development Fund. The application for an advance from the Development Fund in aid of farm

institutes, which has been made by the Board of Education, will therefore be withdrawn by them. A fresh application for an advance in aid of farm institutes will in due course be put forward by the Board of Agriculture.

A MEETING of the London Section of the Association of Chemical Technologists will be held at St. Bride's Institute, Bride Lane, Fleet Street, E.C., on Friday, January 26, when a paper will be read by Mr. J. W. Hinchley on the technologist and the factory. The association was inaugurated about a year ago, and its constitution was decided at a general meeting held on December 11 last. Among the objects of the association are the following:—(1) to extend the study and practice of applied chemistry so as to enable this country to compete industrially on equal terms with the most commercially progressive countries abroad; (2) to promote a wider appreciation of the value to the country of applied chemistry, and to obtain for it the active support and encouragement which, from its great economic importance, it deserves; (3) to promote the growth of a distinct profession of applied chemistry, and thus to place this profession upon such a basis that the applied chemist may be at no disadvantage in comparison with his fellows in allied professions; (4) to effect the cooperation of applied chemists for all matters which may promote their interests; (5) to raise a fund to furnish grants for assisting persons approved by the council to obtain training in applied chemistry at approved institutions or chemical works, either in this country or abroad, and to furnish grants for the prosecution of technical research; (6) to assist members of the association to obtain advice in patent matters. Any further information may be obtained from the secretary, 30 Victoria Street, Westminster, London, S.W.

THE Decimal Association has recently made special efforts to bring the advantages of the metric system more fully before the public. The association is now prepared to find a lecturer and to pay his expenses wherever a good audience can be assured, and it suggests that chambers of commerce, education committees, and trade protection societies will do well to take advantage of this offer. A meeting is to be held on January 26, when Mr. Alexander Siemens will address the London Teachers' Association. A pamphlet circulated by the association shows that in Malta the compulsory adoption of the metric system began on January 1 last. The Central American Republics of Nicaragua, Honduras, Costa Rica, San Salvador, and Guatemala have passed the necessary measures to enforce the metric system as from January 1, 1912. China has decided to adopt the metric system. An Act rendering the metric system compulsory in Bosnia-Herzegovina has been passed by the Government of that country, and will come into force on September 1, 1912. The Danish Weights and Measures Act was passed in 1907, and will come into force in April, 1912. The pamphlet points out that the metre and the kilogram are gaining ground in every direction, and that the number of non-metric countries is being reduced steadily; it continues, "the metric system is gradually closing in upon these islands, and it only requires the adoption of the system by one of our great colonies to cause very much more serious attention being given to the subject by the Government of this country."

THE Smithsonian Biological Survey of the Panama Canal zone, begun in December, 1910, and continued through the major part of 1911, is being pushed to completion before the opening of the canal in 1913. The second expedition sailed on January 9 to take up the work for another season, the botanist, Prof. Pittier, being the only naturalist who remained in the field since the beginning of the survey. Although much interesting information has been collected, and a great many specimens secured, nothing like a complete report is ready. The party includes Dr. Seth E. Meek, formerly of the Bureau of Fisheries, but now representing the Field Museum of Natural History; Mr. S. F. Hildebrand, of the Bureau of Fisheries, who will collect fishes, reptiles, and amphibians; Mr. E. A. Goldman, of the Biological Survey, Department of Agriculture, who will collect birds and mammals; and Prof. Charles D. Marsh, of the Bureau of Plant Industry, Department of Agriculture, who will collect and study the microscopic plant and animal life of the fresh waters of the zone. As can readily be imagined, the life-areas on the zone will become confused as soon as the canal is opened and the waters of the Pacific and Atlantic watersheds are intermingled. It is particularly important on that account that the present geographical distribution of animals and plants be recorded prior to that time, and this is especially true as regards the life of the fresh waters and the sea-coasts. The work of the survey is being carried on through the united efforts of the Smithsonian Institution, several of the U.S. Government departments, and the Field Museum of Natural History of Chicago, and the hearty cooperation of the Panama Canal Commission has been an important factor in the success of the undertaking.

THE U.S. Bureau of American Ethnology is preparing a new work which will form a handbook of aboriginal remains in the United States, and will have to do with the ancient abodes, camps, mounds, workshops, quarries, burial places, and so on of the Indian tribes. Letters of inquiry are being sent to all persons, institutions, and societies thought to have any knowledge of American archæology and ethnology. In 1891 a catalogue of prehistoric works east of the Rocky Mountains was published, but that work is both out of date and out of print. The parts of the United States most densely populated by the aborigines must have been the basins of the Mississippi and Ohio Rivers and the southern shores of the Great Lakes, although there are indications of many settlements on the Atlantic coast, especially in Florida. The history of the American Indians forms an attractive subject of inquiry, but the data available are rapidly decreasing. The fact that the customs, folk-lore, and traditions of these people are being lost through advancing civilisation, and that the older Indian authorities and characters are rapidly passing away, makes it more and more difficult to preserve the history of the Indians for future generations. Through the thorough methods of the Bureau of American Ethnology, devoted to the recording of the habits, customs, and history of the American Indians, many valuable data are, however, constantly being compiled.

ANTI-TYPHOID vaccination by means of a vaccine prepared with killed cultures of the typhoid bacillus, as a preventive of typhoid fever, has of late been extensively practised. Last year a French commission reviewed the results obtained, and recommended its adoption in certain circumstances. In the "Report on the Health of the Army for 1910," recently issued, it is stated that on December 31, 1910, out of 71,623 European troops in India, no fewer than 58,481, or 81·7 per cent., had been vaccinated, some once, some twice, some more than twice. Of 335 cases of typhoid occurring in the Indian Army in 1910, 187 were inoculated men and 148 were not inoculated

men. Twenty-two deaths occurred among those inoculated and twenty-four deaths among those not inoculated. The ratio per 1000 of strength of admissions for enteric fever among the inoculated was 3·19, and the corresponding ratio of deaths was 0·37. Among the not inoculated the admission ratio per 1000 of strength was 12·72, and that for deaths was 2·06. As regards case mortality, the percentage figures are 11·23 for the inoculated and 16·89 for the not inoculated. There thus seems to be a very strong case in favour of anti-typhoid vaccination.

In *The Field* of December 30, 1911, Mr. Lydekker suggests that the so-called unicorn rams of Nepal, of which living examples were exhibited a few years ago in the Zoological Gardens, are an artificial product. Mr. Lydekker's views are, however, disputed by Mr. Pocock in the same journal of January 13. In *The Scottish Naturalist* for January Mr. H. J. Elwes gives the first instalment of notes on the primitive sheep of the Scottish islands, dealing in this instance mainly with those of the Shetlands. The paper includes illustrations of a ram and a ewe of the short-tailed Soay, or Soa, breed, which is perhaps the most primitive of all.

Palæobotanists are well served by the publication "Die Palaeobotanische Literatur," of which the second volume, compiled, as was the first, by Dr. W. J. Jongmans, has been published by Gustav Fischer, Jena (price 18 marks). This volume catalogues contributions issued in 1909, and contains also a few papers of the previous year. The first section provides a bibliography; the second section, forming the main portion of the work, presents an alphabetical list of references for families, genera, and species.

Two important contributions to the flora of Siam were published last year. A systematic catalogue, appearing in the *Beihefte zum Botanischen Centralblatt* (vol. xxviii., part ii.), deals with the plants collected by Dr. C. C. Hosseus in 1906. It amplifies the list communicated by the author to the preceding volume by the incorporation of new identifications; among the latter, the family Orchidaceæ attracts attention on account of numerous new species and the large number of species of Dendrobium. A more comprehensive list is that provided by Mr. W. G. Craib, who has worked out the collections of Dr. Kerr and officers of the Siam Forest Service, and has embodied his determinations of the dicotyledonous plants in the first and last numbers of *The Kew Bulletin* (1911). This enumeration indicates a preponderance of species in the families Leguminosæ, Euphorbiaceæ, Rubiaceæ, and Acanthaceæ; the Cupuliferæ consists of twelve species of Quercus and four of Castanopsis; new species are abundant.

The experimental trials of different varieties of sugar cane that have been maintained in the Leeward Islands for eleven successive seasons furnish each year new facts or premises. The latest report, for 1909–10, bears testimony to the value in Antigua of the established variety, Sealy Seedling, and a seedling introduced recently from Barbados; similarly, an older and a new variety, different from the two former, have yielded the best returns in St. Kitts. It has been recognised that the results of the experimental trials must not be too hastily followed up on the sugar estates; there has certainly been no precipitate change in Antigua, where White Transparent still occupies two-thirds of the total acreage; in St. Kitts, however, a seedling introduced in the earlier trials has displaced that standard variety from the premier position. An increase in the amount of root disease caused by the fungus *Marasmius sacchari* is noted, for which rotation with cotton is suggested as a remedy. The manurial experiments recorded in a separate part are now confined to ratoon canes; the new fertilisers, nitrolim and nitrate of lime, were introduced for the first time.

A copy of the report for the year 1911 of the Philosophical Institute of Canterbury, N.Z., has been received. During the year the membership reached its highest for many years, and the financial position of the institute is very satisfactory. The report points out that the council of the institute has considered it a duty constantly to urge the importance of preserving the native fauna and flora of New Zealand, and when it was suggested recently that Kapiti Island, one of the Dominion's sanctuaries, could with advantage be used as a holiday resort for Wellington, representations were made to the Government as to the retrograde nature of the proposed step, and the council has had the satisfaction of eliciting from the acting Minister of Lands a statement that it is not intended to interfere with the position of the island as a sanctuary. The council has also urged on the Government the desirability of using the s.y. *Terra Nova* in investigating the biological and hydrographical problems of the New Zealand continental shelf. Its representations have not been accepted, but it is to be hoped that the work which has been done by the *Terra Nova* in the waters immediately to the north of New Zealand may result in substantial additions to scientific knowledge of the marine fauna of that area, as well as conduce to the safety of shipping between Australia and this country. The president of the institute for the present year is Dr. L. Cockayne, and the honorary secretary Dr. C. Coleridge Farr.

The summary of the weather for the week ending January 20, issued by the Meteorological Office, shows that the conditions were generally unsettled throughout the period. Heavy falls of rain, sleet, or snow occurred in every part of Great Britain. The aggregate rainfall was in excess of the average over the entire kingdom, except in the north of Scotland and the north of Ireland, the excess being large in most parts of England and in the west of Scotland. In the northern and Midland counties the precipitation was chiefly snow. At Southport the depth of snow on the morning of January 17 was 7 inches, whilst a similar quantity was reported next morning at Cirencester, and a depth of 8 inches at Bath. In the south and south-east of England the fall of snow was very slight. There was a decided rise of temperature towards the close of the week, and the snow rapidly disappeared. The melted snow, combined with the copious rains, occasioned floods in many parts of the country. At the end of the week the large European anticyclonic system, which had extended from Siberia to Norway, and at the centre of which the barometer was above 31 inches, had decreased considerably in intensity. For the time the threatened cold spell had disappeared, and damp and mild weather had again set in.

In a memorandum dated Simla, December 11, 1911, referring to the probable character of the rains from December, 1911, to February, 1912, in northern India, the officiating director-general of observatories explains that the falls during the winter season occur during the passage of disturbances which have been shown to reside in the upper and middle strata of the atmosphere. When these depressions show themselves, their line of travel varies considerably from year to year, and it is chiefly

owing to this fact that the rains at that season are so variable and erratic. The present knowledge of the upper air currents is scanty, and it follows that forecasts of the winter rains are considerably more tentative than those for the monsoons. On the basis of the history of past years which have shown a general similarity with 1911 in respect of meteorological statistics during October and November, it is estimated that the geographical average of the rains in question is not likely to be in defect in northern India; an excess is probable in the Punjab and the west of the United Provinces, but there may be a defect in Gujarat and Sind. The amount of snowfall in the west Himalayas may be expected to be above the normal.

POURING oil on troubled waters as a proverb is well known. The actual use of oil at sea for preventing waves from breaking is known, but not so universally. Messrs. Loveridge, Ltd., of The Docks, Cardiff, are supplying a convenient device for utilising oil economically. This is Couves's automatic "wave subduer." A cylindrical vessel containing a heavy piston is fixed in the ship near the bow, and a little above the water-line. Two narrow pipes pass from the bottom of this through the plating, one on either side of the stem, and these pipes are normally closed by taps. The vessel is filled with oil, and the piston is raised by a central screw. It is then ready at any moment to drive the oil through one pipe or both when the proper taps are opened. The amount of oil used per hour appears from a letter by a user to have been in his case about half a gallon only. Being only applied at the bow, the oil does not have time to do much to the waves that break over the bows, but, even so, it appears to have a marked effect further aft, that is, when meeting a heavy sea. With a following wind, however, the trail of oil would seem to be much more efficacious, and the great risk of being pooped at such times is no doubt greatly diminished.

THE application of "flashlight" photography to living microscopical organisms is discussed by Mr. Walter Bagshaw in the Journal of the Royal Microscopical Society for December, 1911, who points out the advantage, especially in photographing pond life, of using living instead of mounted specimens. Mr. Bagshaw has experimented on *Lophobus crystallinus*, caddis flies, water shrimps, &c., though he has not yet succeeded in photographing darting or rapidly moving objects. The "flashlight" powders give a total exposure of one-thirtieth of a second, irrespective of the quantity used. The best instant for exposure was determined by illuminating the object with a faint side-light and observing it through a hand magnifying glass. Should the method be brought into general use, there appears no reason why an apparatus should not be constructed which would enable the object to be viewed through the microscope and focussed up to the instant of exposure, as in the reflex camera. The same number of the Journal contains two interesting papers dealing with the optical resolution of minute structures, one by Mr. T. W. Butcher on the structural details of *Coscinodiscus asteromphalus*, the other by Mr. James Strachan on the scales of *Thermobia domestica*, an ally of the well-known *Lepisma saccharina*.

THE first number has been received of the Journal of the Association of Teachers of Mathematics for the South-eastern Part of England, which is to be published three times a year. It contains the presidential address delivered at the inaugural meeting at Tonbridge on November 24, 1911, by Dr. A. N. Whitehead, F.R.S., on "The Place of Mathematics in a Liberal Education." The new association consists of nearly fifty members, more than half of whom are women engaged in school teaching in the district in question, the secretary being Mr. G. St. L. Carson. It is intended to promote common action and unity of purpose among school teachers of all grades, including those only engaged in teaching arithmetic. The question may be asked, why is it not affiliated to the Mathematical Association? Mr. Carson, however, points out that England is almost alone in preserving an unnatural separation between the professed mathematician and the teacher of elementary mathematics, and he hopes the association may help towards bridging this chasm. In Dr. Whitehead's address we note several interesting suggestions, in particular he emphasises the view that modern education should be based more on a study of modern civilisation and less on that of the civilisation of the Greeks and Romans. In order to effect this object Dr. Whitehead would include in elementary mathematics exercises based on the statistics of modern commerce and politics. If this proposal should do anything to convince a future generation that modern politics ought to be treated as a science and made the subject of qualifying tests similar to those required for admission to learned professions, a useful purpose would be served.

ACCORDING to a reprint from the November (1911) number of the Proceedings of the American Academy of Arts and Sciences, Mr. E. L. Chaffee, of the Jefferson Physical Laboratory of Harvard, has devised a system which produces undamped electrical oscillations of extremely high frequency with greater regularity than any of the systems at present in use in wireless telegraphy or telephony. In principle, the method stands intermediate between the methods of Poulsen and of Wien. A direct-current generator of 530 volts is connected through variable resistances and inductances, and through the primary coil of a closely coupled oscillation transformer, to the oscillation gap. This consists of two parallel plates of one or two square centimetres area 0·07 millimetre apart, the anode being of copper or silver and the kathode of aluminium. Both anode and kathode are water or air-cooled, and are surrounded by moist hydrogen at atmospheric pressure. The primary of the transformer and the spark-gap are shunted by an air condenser, and another is placed in series with the secondary of the transformer. Both admit of variation to secure syntony. A thorough examination of the secondary oscillations has been made by means of the Braun tube oscillograph.

So much of the recent work on the properties of electrons depends on Stokes's law of resistance to the motion of a sphere in a viscous fluid, that careful tests of the validity of the law have become essential. According to a reprint from vol. xxxvi. of the *Annalen der Physik*, Prof. Knudsen and Dr. Weber, of the University of Copenhagen, find the law requires modification for small spheres moving through a gas, especially if the pressure of the gas is low. Their method depends on the observation of the logarithmic decrement of the torsional oscillations of a light rod 16 centimetres long with or without light glass spheres of a few millimetres diameter at its ends. The oscillating system was placed in an enclosure which could be evacuated, and observations were taken in air at pressures from 0·14 to 1 million dynes per square centimetre. The resistance to a sphere of radius r moving with velocity v through a gas of viscosity η is equal to

$$6\pi\eta rv/(1+0{\cdot}68l+0{\cdot}35le^{-1{\cdot}84/l}),$$

where l is the mean free path of the molecules of the gas divided by the radius of the sphere. It will be seen that the result involves an exponential term not given by the theoretical investigation of Cunningham or the experimental work of McKeehan, although the authors show that there is some indication of its effect even in the observations made by the latter.

A LECTURE, under the auspices of the Graham Lecture Fund was delivered on Tuesday, January 16, in the hall of the Technical College, Glasgow, by Prof. H. E. Armstrong, F.R.S. The lecture was arranged by the Royal Philosophical Society, and the subject selected was "Some Consequences of Graham's Work." The lecturer was dealing with a subject on which he was specially qualified to speak when he described the way in which Graham's work on diffusion had been developed in recent years. The effects produced by non-electrolytes, which are able to penetrate the membranes of living cells, and so to set going important physiological processes, are now recognised as factors of vital importance in the life and development of plants and animals; it was therefore a happy inspiration on the part of the trustees of the Graham Fund to secure from Prof. Armstrong himself a description of the experiments which have done so much to bring home to the physiologist, as well as to the chemist, the important results which have followed upon the pioneer work of Graham.

AN interesting study of the localisation and function of potassium in plants, by Dr. Th. Weevers, is contained in the *Recueil des Travaux botaniques Néerlandais* (vol. viii., p. 289), use being made of Macallum's very delicate microchemical test, based on the precipitation of potassium cobalt nitrite and subsequent conversion of this into black cobalt sulphide by treatment with ammonium sulphide. In a very large number of plant tissues tested, potassium was found always to be present, save in the Cyanophyceæ. In all cases the cell nucleus, however, contained no trace of this element, even in cases when the cytoplasm contained this element in abundance. Special experiments showed that this result was due neither to potash salts diffusing out of the nucleus under the treatment, nor to inability of the reagent to penetrate therein. The larger portion of the potassium is contained in the vacuoles of the cells, the chromatophores being free from it; chlorophyll also contains no potassium. In all cases tested the potassium was present in a form soluble in water, and can be extracted practically completely from the cell by water or 50 per cent. alcohol, but it seems to be insoluble in ether. In phanerogamous plants the potassium is most abundant in the parenchyma, especially in the growing points and reserve organs. In the secondary tissues potassium predominates in the living elements of the wood and bark, especially in the cambium and medullary rays; the latter seem to act as potash reserves for the growth of new shoots. In discussing the physiological significance of potassium in the plant, it is considered that this element plays little or no part in carbon assimilation, but probably is concerned more in building up protoplasm at growing points. In the leaf it probably functions in synthesis and degradation of the protein.

MESSRS. WITHERBY AND CO. are about to publish "The Game-birds of South Africa." The book is by Major Boyd Horsbrugh, and will be illustrated by nearly seventy coloured plates reproduced in facsimile from the drawings of Sergeant C. G. Davies. The work will be in small quarto, and will be issued in four quarterly parts.

OUR ASTRONOMICAL COLUMN.

SCHAUMASSE'S COMET, 1911*h*.—In the *Comptes rendus* for January 8 (No. 2) M. G. Fayet announces his tentative conclusion that the comet discovered by M. Schaumasse at Nice on November 30, 1911, is a periodic comet with a period of about seven years. A parabolic orbit first calculated showed such digressions from the observed places that an elliptic orbit was tried which gave satisfactory O–C differences for intermediate positions. The preliminary elements, determined from positions observed at Nice on December 1, 11, 16, and 21, 1911, are as follows:—

$$\left.\begin{aligned} \pi &= 136^\circ\ 33'\ 37'' \\ \Omega &= 93^\circ\ 14'\ 32'' \\ i &= 17^\circ\ 40'\ 46'' \end{aligned}\right\} 1911{\cdot}0$$

$$T = 1911 \text{ November } 12{\cdot}2440 \text{ M.T. Paris.}$$
$$\log q = 0{\cdot}084487$$
$$e = 0{\cdot}675480$$
$$\mu = 489{\cdot}938''$$

The data are, of course, too meagre for any certainty to be claimed for these elements, but it is worthy of notice that on December 28 the departure of the observed place from M. Fayet's ellipse was only 15″.

THE DISTRIBUTION OF BRIGHTNESS IN THE TAIL OF HALLEY'S COMET.—Some important results concerning the nature of the particles in the tail of Halley's comet, and of their illumination, are obtained by Drs. Schwarzschild and Kron in a paper of which a translation is printed in No. 5, vol. xxxiv., of *The Astrophysical Journal*. The material for the discussion was provided by plates secured by the Potsdam Observatory expedition to Teneriffe to observe the comet.

The photographs were secured in pairs, and photometric standards for comparing the density of the image were produced simultaneously; the photographs show that the apparent intensity of the tail diminishes continuously from the head outward. This diminution might be produced by two causes, first the decrease in density of the tail matter, secondly by a decrease in the actual luminosity of the individual particles; decrease in density would be produced by increase in cross-section of the tail as units further from the head were considered, and by the greater velocity of the particles through each section produced by the solar acceleration.

The density effect was very carefully calculated by the authors, and, to their surprise, was found to account, in the most part, for the decrease of brightness. It should be remembered, however, that several unknown quantities enter into the conditions discussed. This result, if legitimate, can be explained by assuming that the light of a comet's tail is a kind of fluorescent or resonant radiation excited by the solar radiation. On this basis they calculate the amount of matter passing through a unit section, and also the density, and find that, exposed for a whole day to the conditions obtaining at the time of its passage through the tail, the earth would not collect more than 250,000 kilograms of cometary matter, a relatively insignificant amount.

OBSERVATIONS OF PLANETS.—In No. 4548 of the *Astronomische Nachrichten* is published a telegram, received from Prof. Lowell on January 12, announcing that since the last presentation the canal Titan on Mars has doubled.

M. Jarry-Desloges reports that the south polar cap reappeared, as two distinct masses, on January 3, and that the abnormal white streak at the north pole going south between Propontis and Palus Mæotis, had completely disappeared on that date.

The latter also states that on December 29, 1911, at 23h. 30m., the south polar regions of Saturn were covered by a well-defined dark area having an equally well-defined greyish area at its centre; taking the equatorial diameter of the planet as unity, the respective diameters of these patches were 0·31 and 0·11. At 23h. 15m. the same evening the eastern anterior portion of the rings appeared very notably darkened, but the phenomenon did not endure more than twenty-four hours. The farther eastern section of the exterior ring, as compared with the Cassini division, was also darkened. At this time the inner transparent

ring was rather difficult, but on December 30 it was easily seen and its granular structure detected.

THE "ANNUAIRE" OF THE BUREAU DES LONGITUDES, 1912.—This year's issue of the "Annuaire" contains the usual astronomical information, ephemerides, and tables, and deals with chemistry and physics similarly. It also contains the complete list of minor planets, for 714 of which it gives the orbital elements. Among the "notes" there appear an interesting *résumé* of solar physics by M. Deslandres, a long discussion on the various calendars, an article by M. Bigourdan on seismology, a brief description of the physical constitution of the moon by M. Puiseux, and a discussion of the mean temperature in various parts of France by M. Bigourdan. All the times in this "Annuaire" are given in accordance with the new law of March last. The price of the "Annuaire" is 1.50 francs net.

THE RADIAL VELOCITIES AND SPECTRAL TYPES OF STARS.

ALTHOUGH the determination of radial velocities is, as a practical proposition, a development of comparatively recent years, the data already secured by the several observatories doing line-of-sight work promises to be of inestimable value in the study of cosmological problems. It is no longer merely a question of "approach" or "recede"—a far greater vista has been opened up as the work has proceeded. Combined with the researches of Kapteyn, Eddington, Dyson, and others on the streaming tendencies disclosed by the discussion of "proper motions," it promises a rich mine of as yet undisclosed facts concerning the evolution of enormous sidereal systems.

A glance through Prof. Campbell's second catalogue of spectroscopic binaries [1] tells of much work already accomplished, and the discussion discloses how much there is still to be done.

One outstanding result of this discussion of more than 300 binary systems, so far as it applied to the comparative few for which the periods of revolution and other orbital elements have been determined, was the fact that the motions of the stars are intimately related to the spectral types which may be taken as indices of stellar ages. Briefly, it appears that the older a binary system becomes the greater becomes the eccentricity of the orbit and the longer grows the period of revolution.

The existence of the relation between radial velocities and stellar types was also brought out in a later paper [2] dealing with some peculiarities in the motions of the stars, where the following table was given, the spectral types being given under the Harvard designations :—

Spectral types	No. of stars	Average radial velocities
O and B	141	8·99 km.
A	133	9·94 ,,
F	159	13·90 ,,
G and K	529	15·15 ,,
M	72	16·55 ,,

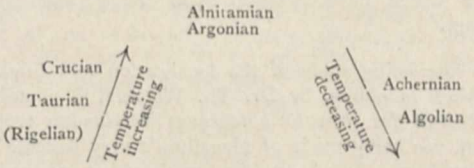
In the general discussion it was found that the B-type ("helium") stars called for special treatment, and Prof. Campbell discussed the motions of the brighter stars of this type in a further paper.[3]

The main conclusion to which we wish to direct attention here is that "An error, of obscure source, causes the radial velocities of Class B stars to be observed too great by a quantity, K, amounting to several kilometres. For stars of Class B–B_5 the value of this error is approximately K = +4·7 km. per second. The value obtained for Class B–B_9 stars is +4·1 km. It is therefore probable that K is less than +4 km. for stars of Class B_8–B_9."

The result was based on the consideration of 225 Class B stars, K being an assumed, unavoidable, but systematic error inherent to the observed velocities, and disclosed in calculating from these the velocity of the solar system in space. This systematic difference, peculiar to the B-type stars, has led to some very interesting and important suggestions as to the characteristics of the stars themselves; Prof. Campbell makes several tentative suggestions as to its source. Of these, we would direct attention to that in which it is suggested that in these stars the absorption takes place in the lower layers of the atmospheres, and therefore under greater pressure, thus modifying the effective wave-length and producing the error when the measures of wave-length are compared with terrestrial standards. Another suggestion points out that the helium lines frequently used in the measures are double, with the red component, in the laboratory, much the fainter. If the conditions in the star increase the relative intensity of these red components, the wave-length of the centre of gravity of the whole line would be shifted, and the observed difference be thus produced.

A most interesting contribution to the discussion of the motions of this type of star is published by Dr. Ludendorff [4] in the form of some remarks on the classification of helium stars. He takes from Campbell's list of 224 stars all those which have an absolute radial velocity, V_2, $\geq$ 8·0 km., and shows that there is a distinct differentiation of their velocities if they are arranged according to Lockyer's classification [5] of the helium stars.

As is generally known, this classification is unique in that it aims at arranging the classes of stars in an evolutional order, difference in the chemical characteristics, accompanying differences in age and temperature, being the criterion. It also essentially takes into account the idea that stars probably increase before decreasing in temperature, and on these lines arranges the helium stars at the top of the temperature curve thus :—



In the Lockyer classification the Rigelian class is not given as essentially a helium class, although helium is mentioned as one of the prominent elements; for this latter reason Dr. Ludendorff includes it in his discussion.

Of the sixty-three stars selected from Campbell's list, he finds eighteen classified in the South Kensington catalogue, and tabulates them as follows, the velocities being given in round numbers :—

Ascending branch of Curve			Descending branch of Curve		
Star	Type	V_2	Star	Type	V_2
		km.			km.
ζ Persei	Crucian	+ 9	π Andromedæ	Algolian	+ 8
η Orionis	,,	+14	ν ,,	Achernian	−24
β Canis Maj.	,,	+10	19 Tauri	Algolian	−10
σ^2 ,,	Taurian	+25	γ Corvi	,,	−13
η ,,	,,	+17	ι Aquilæ	Achernian	−14
δ Crucis	Crucian	+13	ε Delphini	,,	−10
χ Centauri	,,	+ 8	α ,,	Algolian	−10
ε Lupi	,,	+12	o Andromedæ	Achernian	−10
ν Scorpii	,,	+21			
67 Ophiuchi	Rigelian	+10			

From this table evolves the striking fact that, without exception, those stars placed by Lockyer on the ascending arm of the temperature curve all have + velocities, and, with one exception, those on the descending side have − absolute radial velocities. It would appear extremely unlikely that this remarkable division is due to chance; but Dr. Ludendorff seeks further evidence by taking from Campbell's catalogue all (seventy-one) those stars classified at South Kensington as helium stars—including the Rigelian class—and arranges them as follows, giving the mean absolute radial velocities V_2 of each class :—

[1] Lick Observatory Bulletins, No. 181. [2] *Ibid.*, No. 196. [3] *Ibid.*, No. 195.

[4] *Astronomische Nachrichten*, No. 4547, vol. cxc., p. 193.

[5] Catalogue of 470 of the Brighter Stars Classified according to their Chemistry.

α. Ascending arm of Lockyer's curve.

1. Rigelian stars	$V_2^0 = +2{\cdot}3$ km.	3 stars
2. Taurian ,,	$= +8{\cdot}8$,,	4 ,,
3. Crucian ,,	$= +3{\cdot}7$,,	38 ,,

β. Maximum of Lockyer's curve.

1. Alnitamian stars	$V_2^0 = -0{\cdot}4$ km.	5 stars
2. Argonian ,,	—	0 ,,

γ. Descending arm of Lockyer's curve.

1. Achernian stars	$V_2^0 = -5{\cdot}4$ km.	11 stars
2. Algolian ,,	$= -3{\cdot}7$,,	10 ,,

Grouping them further, and taking general means for each of the groups α, β, and γ, we get:—

α. $V_2^0 = +4{\cdot}1$ km.	45 stars	mean error	$\pm 1{\cdot}03$ km.
β. $V_2^0 = -0{\cdot}4$,,	5 ,,	,,	$\pm 1{\cdot}29$,,
γ. $V_2^0 = -4{\cdot}6$,,	21 ,,	,,	$\pm 1{\cdot}72$,,

It is obvious that the β group is so small, and its mean error so much greater than the mean value of the velocities, that it is negligible, and Dr. Ludendorff considers only the α and γ groups; the difference between these is +8·7 km., with a mean error of ±2·0 km.

Further analysis shows that, of the forty-five stars in group α, thirty-one have V_2 positive, with a maximum of +25 km., and fourteen negative, with a maximum negative value −7 km., while the mean of the + values is +7·2, and that of the negative values −2·8.

Analysing similarly the γ group, the mean $-V_2$ is 8·8 km., and the mean $+V_2$ is +3·9 km., so there can remain no reasonable doubt as to the reality of the connection between + values and "ascending" stars and − values and "descending" stars.

Taking these same seventy-one stars and arranging them under the Harvard equivalents of the Lockyer classes is rather a hazardous proceeding on account of the generical differences of the two classifications with their consequent overlappings; but Dr. Ludendorff has done it systematically, and finds that the mean velocity difference between the analogues of the α and γ groups employed above is +3·6 km., with a probable error of ±2·41 km. It is evident that the systematic difference so obvious in the previous tables is somewhat obscured, and it becomes more so when the whole of Campbell's 224 stars are arranged under the Harvard equivalents of the Lockyer classes. Dr. Ludendorff therefore concludes the comparisons with the statement that when one arranges the helium stars of Campbell's catalogue under the Lockyer classification, there appears in the mean values of the absolute radial velocities of the several classes a distinct systematic difference. When one arranges the stars under the Harvard, or the Miss Maury, classifications, this systematic difference is not so clear as under the Lockyer arrangement.

Arising out of the question as to the reality of the observed difference, several suggestions as to its origin are made. The question of systematic error in the actual measuring is dismissed, and the evidence of streaming, disclosed by arranging the stars in four R.A. groups, is very small.

Dr. Ludendorff concludes with the suggestion that the wave-lengths in the spectra of helium stars vary with the condition of the star, and that this variation of condition may also be a function of Lockyer's arrangement of the stellar classes. Further, he makes the important suggestion that, as the Lockyer classification discloses this systematic difference, while the Harvard classifications do not show it so clearly, in the future discussion of a definite classification of the stars the classification which discloses this difference, possibly dependent upon spectral evolution, should receive most careful consideration. The elements of the spectral change, as shown in this discussion of the helium stars, are already incorporated in the classification, which by further natural development, and maybe slight modifications, may be made still more to portray the development of a star as it grows older.

WILLIAM E. ROLSTON.

EDUCATIONAL CONFERENCES CONSIDERED IN RELATION TO SCIENCE IN PUBLIC SCHOOLS.[1]

II.

Laboratory Work in Schools and in Examinations.

IN our previous article we gave an account of those discussions at the annual meeting of the Public School Science Masters' Association which dealt with the sequence of studies. The remaining discussions were concerned with the position of qualitative analysis and the relation between laboratory work in schools and the practical examinations of public examining bodies. Dr. E. B. Ludlam (Clifton) found the position of the teacher difficult, as he thought that modern methods were better than those in which qualitative analysis had figured so largely, but was obliged by the scholarship examinations and those for the higher certificate to retain too much of the older methods. At the same time, he found that boys were stimulated by exercises in the identification of substances, a process which enlarged a boy's chemical experience and gave scope to his individuality. He therefore advocated a study of "comparative chemistry," with early attention to metals and the periodic classification; in connection therewith, the boys should work out their own methods of identification. From the discussion on examinations, opened by Mr. G. F. Daniell, it appeared that there was a desire for more alternative questions, *i.e.* more options, in the practical tests, and Mr. H. Richardson suggested a number of useful variants from the ordinary type of question. In practical chemistry, the use of the blow-pipe and some work with unknown substances should be retained; but there had been too much refinement of analytical work, both qualitative and volumetric. Problems, accompanied by fairly full working instructions, would bring the examination work more into line with the work in the school laboratory. The opener, and several subsequent speakers, advocated closer relations between teachers and examiners, and agreed that it was important that the examiner should be present during the laboratory examination.

Mathematical Teaching.

It is usually unprofitable to deal with papers on mathematical subjects by means of short abstracts. We therefore give the programme of the meeting of the Mathematical Association, and attempt to review the present position in the light of the discussions.

The president's address, by Prof. E. W. Hobson, appeared in NATURE of January 18. Mr. C. Godfrey gave some account of the work of the International Commission on Mathematical Teaching. Mr. G. St. L. Carson read a paper on some unrealised possibilities in mathematical education, and there was a discussion on the introduction of the calculus, in which Mr. C. V. Durell, Mr. A. W. Siddons, Dr. T. P. Nunn, and others took part.

Broadly stated, the papers threw light upon (1) the democratisation of mathematics; (2) the relation between the instrumental and the philosophical elements in mathematical teaching. Prof. Hobson's address makes clear what we wish to convey by (1), and we observed that the idea influenced most of the speakers. Prof. Perry and the Board of Education use the term "practical mathematics" in the sense of vocational mathematics, and Prof. Hobson had apparently the same idea in his references to "practical life." Where the president spoke of the "practical side" being overdeveloped he had in view laboratory exercises. By "instrumental" mathematics we mean the method of teaching which uses the utilitarian motive in order to lead the pupil to mathematical concepts. We put it that Prof. Hobson recognises the democratisation of mathematics as a welcome fact, believes that this justifies some, but not exclusive, use of the instrumental method, and lays stress on the necessity for combining with the latter considerable philosophical and deductive training. Mr. Godfrey told us that Italy had, more than any other country, continued to demand a philosophical treatment of geometry from young beginners, employing methods more rigorous than those of Euclid. Germany, on the other hand, had gone farther than any other nation in develop-

[1] Continued from p. 394.

ing the instrumental aspect. The Italians did not seem to be satisfied with their own results. The discussion on the calculus showed methods which had been successful in introducing this subject into schools (cf. Sir Joseph Thomson's laudatory remarks). The requirements of the physicist and engineer had been in view from beginning to end, but attention had been paid to the concepts of limits, differential coefficient, differential equation. In fact, mathematical masters in the larger schools were prepared to follow Prof. Perry in many of his reforms and extensions of their curricula, but part company with him when he asks them to eliminate philosophical considerations, as unsuited to boys. Mr. Carson went a stage further. He advocated a more philosophical treatment from the beginning of arithmetic, geometry, and algebra, in the order named, and would introduce pure mathematics—in the sense in which Bertrand Russell uses the term—to the older pupils. This he did because he believed that the modern theories of pure mathematics were destined to illumine our understanding of psychology, history, sociology, and economics, just as the older mathematics had thrown light on electricity, heat, light, and other physical sciences. He would teach mathematical philosophy as instrumental to human thought and social development, in that it shows the true relation between thought and experience.

Progress of the Societies.

At the business meeting it was reported that nearly all public schools are represented in the Science Masters' Association. The committee had been invited to assist the Army Council in connection with science examinations, and their advice had been utilised. The Oxford and Cambridge Joint Board had agreed to the request of the committee for extended time for practical chemistry. The General Medical Council had altered their regulations so as to admit a public school, under certain conditions, to "recognition as an institution where medical study may be begun."

The Mathematical Association has grown during the year, and now has 675 members and 200 associates, the increase of branch activity being worthy of remark. *The Mathematical Gazette* has been enlarged and made more useful to teachers, and the library is being made more accessible to members.

Exhibition of Apparatus.

There was a large and instructive display of apparatus in the common rooms of the London Day Training College, of which we are only able to give a few instances. Mr. D. Berridge provided a cheap, serviceable optical bench with vertical adjustments to the stands, while another felt want is supplied by the very handy electrolytic cell of the Rev. W. Burton. Mr. G. H. Martin's model volcanoes will be widely copied, and his dissociation model would be a useful adjunct to the college lecture-room. A carbon rheostat made by the Loretto boys appeared to be a serviceable instrument. We should like to see more evidence of boys' ingenuity and handicraft; its rarity suggests a weak point in the teaching, which it is quite possible is more apparent than real. A simple method of finding the surface-tension of a soap-film, shown by the Rev. S. A. McDowall, gave promise of considerable accuracy. Among the exhibits of business firms we noted more improvements and additions to apparatus of established repute than absolute novelties. Useful instruments for electrical and magnetic instruments, strong but cheap, were shown by Griffin and Sons, Philip Harris and Co., Becker and Co., Gambrell Bros., and others. We noticed a very good "wireless" set by Becker at ten guineas. Nalder Bros. have improved that originally excellent instrument the Ayrton-Mather universal shunt. Watson and Sons had a good display of microscopes, and their "H" stand offers more conveniences, combined with precision, than we have found in an extensive experience of Continental instruments. The laboratory fittings by Baird and Tatlock, the stills and ovens by Brown and Son, the lanterns by Reynolds and Branson, are well known, and are being constantly improved. Some gas-generators shown by Townson and Mercer are well suited to school use, and the foot-bellows, *without rubber*, supplied by Gallenkamp and Co. will appeal to many. The requirements for laboratory mathematics are admirably met by G. Cussons, Ltd., and we believe that the school apparatus of the future will follow the lead given by this firm in making use of sets of apparatus with interchangeable parts attached to truly-made substantial standards. They show a hand-microtome which is really efficient and easy to use. As many science masters work in remote districts, they took the opportunity to inspect the well-chosen books exhibited by Messrs. Arnold, Bell, Cambridge University Press, Macmillan, Methuen, Oxford University Press, and University Tutorial Press.

G. F. DANIELL.

BIRD-NOTES.

IN the second part of vol. ix. of the Transactions of the Norfolk and Norwich Naturalists' Society, Mr. J. H. Gurney records what is known with regard to the history of the stuffed specimen and egg of the great auk in the Norwich Museum. The egg, which is noteworthy on account of the well-preserved colouring of the markings, was presented to the museum in 1910 by Mr. James Reeve on his retirement from the curatorship. It was bought by Mr. Reeve from Mr. J. H. Walter, by whose father it was purchased about 1850 from Dr. Pitman. Beyond this its history cannot be definitely traced, although the suggestion has been made that it originally came from the Hamburg dealer J. G. Brandt. The stuffed bird was presented to the museum in 1873 by Mrs. E. P. Clarke, daughter of Mr. Edward Lombe, of Melton, near Norwich, to whom it previously belonged. Mr. Lombe bought it from Benjamin Leadbeater, the taxidermist, of Brewer Street, Golden Square, W.C., some time previous to 1822; but here its history ends. In spite of having probably been stuffed about seventy years ago, the plumage is still in fine condition.

In *The Emu* for October, 1911, the well-known ornithologist Mr. Sergius A. Buturlin gives a list of species of Australian birds which visit Siberia. The list includes no fewer than forty-eight species, of which, however, three are only occasional stragglers to the Far North. Of these some ten or eleven breed not only in Siberia, but likewise, although perhaps in slightly different forms, in Australia.

The Transactions of the Edinburgh Field Naturalists' and Microscopical Society for 1910–11 (vol. vi., part iv.) contains a paper on bird-migration in the Solway district, communicated by the late Mr. Robert Service six months before his death. In one passage the author emphasised the fact that every British bird, except the grouse and perhaps one other species, is, to some extent at any rate, migratory. "All the individuals of such a species as, for example, the robin, shift their quarters a few degrees north or south at the migration seasons. It will thus happen that at the northernmost limit of the distribution of such a species no birds of that species will be found in winter, while similarly, at the southern limits of its range, no birds of the species will be found in winter."

Later, the opinion is expressed, on several grounds, that the returns from lighthouses relating to bird-migrations are based on misleading data, as birds are never low enough to strike the stations except when the weather is very dark or thick, or when they are driven down by strong gales.

The feature of the December (1911) number of Witherby's *British Birds* is formed by three superb photographs of the black-throated diver, taken by Mr. O. G. Pike in the Outer Hebrides. The photographs were taken from a stone hut, built, with special precautions, near the nest. "The bird before me," writes the artist, "was absolutely unconscious of any danger, and it was really beautiful to watch her as she settled down upon her two eggs. At first she could not get comfortable, and I exposed a good many plates, but when she eventually settled it seemed impossible to move her."

The damage inflicted on trees and timber by woodpeckers forms the subject of Bulletin No. 39 of the Biological Division of the U.S. Department of Agriculture. From an economic point of view the author, Mr. W. L. McAtee, divides the group into true woodpeckers, which are mainly beneficial, and sap-suckers, which are very injurious.

Although some of the former do considerable damage to trees, and even to telegraph poles, they more than compensate these injuries by the destruction of insects, some of which belong to species eaten by no other birds. For the typical sap-suckers little or no defence is possible, as they feed largely on the juices and tissues of trees, and do not prey upon any specially harmful insects. In extracting the growing, or cambium, layer beneath the bark they frequently so damage the trees that they are weakened and crippled, or even killed, while the timber is in many cases rendered more or less useless. Two species of sap-sucker (*Sphyrapicus varius* and *S. ruber*) are so mischievous that their destruction is considered justifiable. It is added, however, that "as there are twenty species of woodpeckers in the United States, and only two of them are under indictment, great care should be exercised to distinguish the real offenders. When it is necessary to destroy sap-suckers, poison should be used, because of the small risk to other birds."

The "casual list" of British birds has been further augmented by the capture on October 30, 1911, at Fair Isle, of a male of the pine-bunting (*Emberiza leucocephala*). Mr. Eagle Clarke, who records the occurrence in the January number of *The Scottish Naturalist*, states that at the time of capture the characteristic chestnut of the head, neck, and throat was obscured by white tips to the features, which are worn off during winter. The colouring of the remainder of the upper parts is very similar to that of the yellow-hammer. The species is a native of Siberia, from the Ural to Amurland, but it winters in northern China, Mongolia, Turkestan, and the Himalaya, straggling to Turkey, Austria, Italy, and the south of France.

In the same communication Mr. Clarke records a sprosser, or thrush-nightingale (*Luscinia*, or *Daulias luscinia*) at Fair Isle in the spring of 1911. The species ranges from Denmark to S.W. Siberia, visiting E. Africa in winter. The upper parts are darker and more olive than in the nightingale, the tail is dark brown with only a tinge of rufous, and the feathers of the breast are darker, with a spotted appearance. The only other British occurrence was at Smeath, Kent, in October, 1904, but this has been regarded as doubtful.

Mr. Clarke likewise records Baird's sandpiper (*Tringa bairdi*), of which two previous British occurrences are known, at St. Kilda on September 28, 1911; while in a separate note in the same issue the woodchat-shrike is also added for the first time to the Scottish list.

Nor does this exhaust the tale of rare stragglers to Great Britain, for in the January number of Witherby's *British Birds* are recorded, for the first time, two examples of the American peregrine (*Falco peregrinus anatum*), the one taken in Leicestershire on June 14, 1891, and the other in Lincolnshire on September 28, 1910. They are the first British records for this race, which is characterised by its large size and dark plumage.

To the Journal of the South African Ornithologists' Union for December, 1911, Mr. Alwin Haagner contributes a second note on the presence of a deciduous hook at the extremity of each half of the beak in nestling honey-guides. The occurrence of these curious hooks in a second specimen, and that belonging to a different species, renders it certain that the first example was not a "sport."

To the January number of *The Zoologist* Messrs. F. J. Stubbs and A. J. Rowe contribute an article entitled "The Prehistoric Origin of the Common Fowl"—certainly a somewhat curious designation for a communication of which the pith is based on historical data. In place of the domesticated fowl having been evolved from the wild *Gallus bankiva* in or near India, and reaching Europe by way of Persia, whence it was carried first to Athens and then to Rome, the authors cite pictorial and other evidence to show that the bird was known to the Mesopotamians and Egyptians so early as about 4600 B.C., and from this and other evidence they arrive at the conclusion that its original home was probably in Central Asia. Finally, they state that "the evidence appears to indicate that the bird [*i.e.* the wild *Gallus bankiva*] was introduced to India by invaders—a race known as Dravidians—from the north-west at an unknown date, and that the species is now feral there." Such a suggestion is altogether unreasonable. It may be added that when alluding to the sheep of ancient Egypt, the authors make no reference to the work of Messrs. Lortet and Guillard on the mummified fauna of that country published in the Archives of the Lyons Museum.

Dr. Van Oort has favoured us with a reprint of an article from vol. xxxiv. of Notes from the Leyden Museum on bird-marking in the Netherlands, which was commenced in the spring of 1911. It is believed that 1165 birds, representing thirty-one species, were ringed during the year, out of which twenty-two had been recovered at the beginning of November last.

In *The Victorian Naturalist* of December, 1911, Mr. E. B. Nicholls records the marvellous mimicking power of the lyre-bird, as heard in the Bass Valley. The sounds imitated comprised the cry of the koala, or native bear, the notes or calls of seventeen different species of birds (including the alarm notes and whirring of the wings of a flock of startled parraquets), the creaking of the boughs of trees in the wind, and the "puffing" of locomotive engines.

R. L.

THE INSTITUTE OF METALS.

THE annual meeting was held in London on January 16 and 17. Owing to sudden illness, the president-designate, Prof. W. Gowland, F.R.S., could not attend, and his address on "Copper and its Alloys in Early Times" (of which we hope to give an account later) was read by the secretary, Mr. G. Shaw Scott. Sir Henry J. Oram, K.C.B., Engineer-in-Chief to the Royal Navy, occupied the chair.

Among the papers read the following may be mentioned:—

Mr. G. D. Bengough, in a paper on a study of the properties of alloys at high temperatures, described a series of tensile tests on selected metals and alloys. The tests were carried out at temperatures varying from the ordinary temperature to the neighbourhood of the melting points of the materials used. Unexpected results have been obtained. The curves showing the variation of mechanical properties with temperature show certain "mechanical critical points" in the neighbourhood of which the direction of the curves alters rapidly, and this phenomenon occurs even in the case of commercially pure metals, such as copper and aluminium.

In a paper by Mr. R. H. Greaves on the influence of oxygen on copper containing arsenic or antimony, experiments were described which were made to determine the influence of oxygen on certain mechanical and physical properties of copper containing either arsenic or antimony in quantities up to 0·5 per cent. With increasing arsenic the metal may take up more and more oxygen without suffering deterioration in its capacity for rolling. The action of oxygen on copper containing antimony is similar. The ductility was similarly affected by oxygen. Increase in oxygen from 0·15 to 0·4 per cent. causes a rapid diminution in elongation. Oxygen has little effect on the hardness until a limit is passed; above this the hardness increases rapidly. Measurements of electrical resistance show that oxygen diminishes the conductivity of copper containing arsenic, but increases that of copper containing antimony.

Mr. Philip's paper, on contributions to the history of corrosion: the corrosion of condenser tubes by contact with electronegative substances, was devoted to an examination of the relatively small number of cases experienced by the Royal Navy in which localised corrosion occurs in condenser tubes made of Admiralty composition. The causes of 90 per cent. of the cases of corrosion observed in the establishments of the Royal Navy have long been known. The main problems which remain to be solved are the explanation of the causes of rather less than 10 per cent. of the cases which are now observed, and, secondly, the devising of means of preventing these and all other cases of corrosion superior to the method of protector bars, as at present employed.

In a note on the nomenclature of alloys, Dr. W. Rosenhain raised the question of the nomenclature of non-ferrous alloys, and put forward some tentative suggestions to serve as a basis for discussion. Confusion in nomenclature

exists at the present time, particularly as regards such terms as "brass" and "bronze." A system of nomenclature was put forward in which alloys are classified according to the system of binary alloys to which they approximate most closely, and class names for such binary systems were advocated.

Prof. T. Turner dealt with the behaviour of certain alloys when heated *in vacuo*. It was observed, a year ago, that on melting brass *in vacuo* the whole of the zinc volatilises, leaving the copper. This separation is quantitative if the heating is not too prolonged and the temperature not above 1200° C. The behaviour of other copper-zinc alloys was therefore investigated. A sample of "poisoned" brass—*i.e.* brass containing iron, lead, tin, arsenic, and other impurities—was heated *in vacuo* at 1200° C., and the residue examined. All the zinc, lead, and arsenic, and a little of the tin, volatilised, leaving a residue of copper, iron, and most of the tin. It is suggested that heating *in vacuo* might be advantageously applied for the refining of crude copper, brass scrap, &c. "Hard" zinc may be refined by heating *in vacuo* to 500° C., *i.e.* to a scarcely visible red heat. Zinc distils readily in glass vessels *in vacuo*, the vapour being colourless and transparent. The zinc condenses in globules, having the appearance of mercury.

Prof. H. C. H. Carpenter described further experiments on the critical point at 470° C. in copper-zinc alloys. The so-called β constituent in copper-zinc alloys is to be regarded below 470° C. as a minute and uniform complex of α and γ particles. Even after six weeks annealing at 445° C. no coalescence of the particles has been observed in an alloy of exactly the eutectoid composition. When, however, a few crystallites either of α or γ are initially present in an otherwise pure eutectoid alloy, then, on annealing at 445° C., this stability is easily destroyed. The structural stability of the pure eutectoid alloy can be explained by supposing that, at the inversion temperature on cooling, the resolution of β into α plus γ takes place throughout the entire alloy almost, if not quite, simultaneously.

Mr. F. Johnson, in his paper on the effect of tin and lead on the micro-structure of brass, records the results of experiments made with the object of ascertaining the structural relations which exist between lead and tin when present in brass where the ratio of copper to zinc is 2 : 1. He strongly advocates a very thorough annealing of all cast material of the 70/29/1 and 62/37/1 compositions (Admiralty and Naval brass respectively) before subjecting it to rolling or drawing.

OXFORD METEOROLOGICAL OBSERVATIONS.[1]

WE are glad to see the appearance of the volume referred to below, containing as it does the meteorological observations made at the Radcliffe Observatory, Oxford, for the years 1900 to 1905 inclusive, because there has been difficulty in obtaining the necessary funds for printing. Fortunately the Radcliffe Trustees, by means of a grant of a special character, have been able to overcome this difficulty; and not only will the arrears of printing be made good, but, as the director remarks, "we hope before many months are past to be able to clear those off and in future to publish the results of our meteorological observations promptly in a regular annual form." This is really good news, because meteorologists—and there are now many of them—who discuss meteorological observations desire to include the most recent data, and in a great number of cases these are impossible owing to the values not being published. The meteorological observations made at the Radcliffe Observatory, some of which date from the year 1850, form a most valuable, continuous, and homogeneous series, so that it is most important that this series should be published as soon as possible. Even now the present volume goes only so far as the year 1905, so that the observations for the years 1906 to 1911 are still missing in a published form.

In recent years attention has been directed to the peculiar position the Radcliffe observations hold with regard to the large question of the Thames flow. It was found by Sir Norman and Dr. Lockyer that the rainfall at Oxford represented variations from year to year which corresponded closely with the variations determined from a large number of combined stations, and these corresponded in nearly every feature with the variations of the level of the Thames as recorded at the numerous gauges on the river. This fact showed that by simply taking the Oxford rainfall records alone a good approximation to the subsequent flow of the Thames could be gathered, because the natural flow of the Thames has a lag of four to five months on the rainfall. It is noticed in this report that weekly values of rainfall are communicated directly to the Thames Conservancy Board, no doubt in consequence of this relationship.

The volume is arranged on the same lines as that previously issued for the period 1892 to 1899, with the following important differences:—First, that the readings of the fine underground platinum thermometers, which were commenced in the year 1898 (October), and continued daily throughout the six years dealt with in this volume, have been omitted, as it is intended to publish them later in a separate form, with a full discussion of the results; secondly, that the tabulated daily results and monthly means derived from the photographic and self-recording instruments have been included; thirdly and lastly, that the results of the hourly readings of the barograph, thermograph, and hygrograph have also been incorporated in the volume, with a discussion of the mean diurnal inequalities in the readings of the three instruments for the period under consideration, and a comparison of these inequalities with similar quantities deduced for the period 1880 to 1887.

[1] "Results of Meteorological Observations made at the Radcliffe Observatory, Oxford, in the Six Years 1900–5." Under the direction of Dr. A. A. Rambaut, F.R.S. Vol. xlix. Pp. xx+304. (Oxford: Henry Frowde; London: Oxford University Press, 1911.)

AMERICAN ARCHÆOLOGICAL PROBLEMS.

MR. ALFRED P. MAUDSLAY delivered his presidential address at the annual general meeting of the Royal Anthropological Institute on Tuesday, January 23. Mr. Maudslay said that even at the present day the idea that the origin of man does not form a fit subject for scientific inquiry has not yet entirely died out, and this feeling has militated against anthropology becoming a popular study. Meanwhile, the immediate and energetic prosecution of anthropological studies is of vital necessity, since the material with which this science deals is becoming rarer every year, as primitive customs yield to civilisation. The fact that man's physique is less subject to alteration gives a permanent value to the study of physical anthropology. An example of the far-reaching effects of a change in culture is, let us say, the introduction of writing, which has a democratic tendency, since it places the tribal law, formerly preserved in the memories of the elders, at the disposal of the younger members of the tribe. Upon the present occasion attention may be confined to certain points of the archæology of America, where there are traces of many extinct civilisations. The word civilisation is used for want of a better; such a people as the Aztecs, though civilised in some respects, were barbarous, or even savage, in others. In fact, our terminology requires revision, for the existence of a savage custom, such as cannibalism, does not necessarily imply a low stage of culture. Want of recognition of this fact has caused many misunderstandings between Europeans and the "barbarous" races. Such misunderstandings might be avoided by a knowledge of elementary anthropology, and this institute has not ceased to press upon the Government the advisability of establishing in this country an Anthropological Bureau, which would be of material assistance to colonial administration.

There is no better test of the antiquity of American culture than the fact that maize and other vegetable foods had been gradually evolved by patient cultivation from obscure wild plants. The indigenous nature of that culture is shown by the fact that they were unknown in other continents before the discovery, though their value to man led to their introduction all over the world immediately afterwards. The languages of America, moreover, bear a closer resemblance to one another than to those of the rest of the world.

In solving the many problems presented by America,

where race has overrun race and culture succeeded culture, archæology is not self-sufficient, but it may often point the way to further research. For instance, at Ixkum, in northern Guatemala, a stone relief shows two typical Maya standing on two individuals of a totally different type. The latter probably represent a conquered race. Near the city of Guatemala stone figures have been discovered closely resembling this non-Maya people. Ruins in the neighbourhood bear an interesting resemblance in plan to those at the famous site of Teotihuacan in Mexico, but the site still awaits proper investigation.

Another point from which the antiquity of American culture may be argued is the distinctive nature of American art; but while general similarities exist all over Central and South America, local developments occur, *e.g.* at Mitla, which are not only *sui generis*, but are, apparently, accompanied by no remains which indicate how they were evolved. Certain motives appear to be almost universal, such as the serpent, and the *quetzal*-bird, which occur in various combinations, and also the water-plant, which is interesting as being the only vegetable form in American art. A few instances such as these show what a vast field for investigation is offered by America, the study of which has been rather neglected in this country. This year, in May, we shall be welcoming the International Congress of Americanists to London, and though we possess in England more pre-Columbian objects of interest than any other European country, it is the first time that we have acted as hosts to the leaders of American research.

THE USE OF PHOSPHATIC FERTILISERS IN FRANCE.

SOME years ago M. Risler took an inventory of the soils of France, classing them as complete if they contained sufficient food material to yield fair crops, and incomplete if they were markedly deficient in any particular food constituent. Out of a total agricultural area of 49,000,000 hectares, no fewer than 36,000,000 were deficient in phosphates, and could not be made to yield profitable crops without liberal dressings of phosphatic fertilisers—a state of affairs that was not the result of previous bad cropping, but of lack of phosphorus in the original rock material.

In order to make good this deficiency, French agriculturists use both basic slag and superphosphates, but very little of the rock phosphates so popular in America. More than a quarter of a million tons of basic slag are used annually on the grass land, especially where the soil is derived from granite and schists, while about one and a half million tons of superphosphate are used annually on the arable land, and a good deal of phosphate is also contained in the guano applied as fertiliser.

But, vast as these quantities are, they are insufficient, and consequently there has been a marked increase in the price of phosphatic fertilisers during recent years. The various factors coming into play have been recently analysed in an article by M. Hitier in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* (No. 6, vol. cxv.).

Superphosphate, as is well known, is made by treating rock phosphate—an impure tri-calcic phosphate—with sulphuric acid, and in order to overcome transport and other difficulties, the sulphuric acid is usually made on the spot at the factory itself. Both the raw phosphate and the pyrites from which the sulphuric acid is made have increased in price; the world's consumption of phosphates, which was four and a half million tons in 1898, had in 1908 increased to ten million tons. The price of superphosphates in France has usually been lower than in England, but now that the French deposits of rock phosphate are giving out, it has been necessary to look elsewhere. At present nearly half of the world's supply comes from North America, North Africa, however, also furnishing a great deal. Other supplies come from the Pacific Islands and the north of France and Belgium.

Investigations have shown that dressings of phosphates not only raise the quantity of the crop, but also improve the quality. Müntz showed that dairy produce, particularly butter, of the finest quality was obtained only from pastures exceptionally rich in phosphates. More recently M. Paturel has traced a clear connection between the quality of wine and the supply of phosphates. Analyses of numerous samples during the last ten years show that the best wines are richest in phosphoric acid, of which they contain about 0·3 gram per litre, whilst the second, third, and fourth classes are successively poorer. Further, if the vintages for different seasons are arranged in order of their phosphoric acid content, the list thus obtained is almost identical with the order of merit assigned by the wine merchants.

THE CARBONISATION OF COAL.[1]

II.

HAVING gained an idea of the results desired in the manufacture of illuminating gas and furnace coke, we can pass on to the thermal conditions existing during carbonisation, and at the outset we are met by the difficulty that little is known as to the heat of formation of coal, and that a variety of opinions exists on this point.

It is evident that, as the composition of coal in a mine will vary not only in different seams, but even in the same seam, there is no definite composition, and that nothing can be known as to the heat of formation except by direct determination, which necessitates experimental estimations of so complicated a character that the introduction of errors is extremely likely to vitiate the results.

Probably the most valuable work done in this direction is to be found in a report presented by M. Euchêne on the thermic reactions which occur during the distillation of coal, which is in the Transactions of the International Gas Congress in Paris, 1900, in which he determines the thermo-chemical data coming into play during the distillation of coal in the manufacture of gas, with careful estimations of the heat of formation of the products of the distillation as compared with the heat developed by the fuel needed for the distillation; that is to say, a balance is struck, showing on the one side the heat generated, and on the other the heat expended, the difference found representing the heat of the decomposition of coal.

Mahler also determined the calorific value of a coal and of the products obtained on carbonising it, and both these observers found that the calorific value of the coal exceeded that of the products—that is, that coal is endothermic, and that its decomposition evolves heat—but it is quite clear that in the determination of a factor of this kind, which is dependent upon the difference between two figures obtained from a highly complicated set of determinations, each with its own source of error, and all tending in the same direction, these will be borne by the resultant, and it is not surprising, therefore, to find that with a coal of the same type Mahler found the heat of decomposition to be +254·83 calories, whilst Euchêne found it to be +63·51 calories.

In Mahler's work the result was arrived at by deducting the heat of combustion of the products from the heat of combustion of the coal, whilst Euchêne's determinations were obtained by taking the difference between the heat supplied and the heat consumed during distillation, so that the difference between the two would be likely to be increased by errors leading in opposite directions.

M. Euchêne has determined in this way the heat liberated during the distillation of three types of coal, these results showing in a striking way that the heat liberated increases in nearly regular ratio with the amount of volatile matter in the coal, and that the more oxygen the coal contains, the more endothermic its reaction, a fact which points clearly to its being the oxygen-bearing compounds in the coal which give it its endothermic character.

It seems likely that when the oxygen in the coal falls below 3 per cent., all endothermicity will disappear, or at any rate become negligible, whilst with gas coals of the type most used in England, containing about 32 per cent. of volatile matter and 7 to 8 per cent. of oxygen, it will approximate to 250 calories or 450 B.Th.U. per pound of coal, but all the evidence as to this property in coal is of an unsatisfactory character.

When a coal is carbonised, it decomposes into gases

[1] From a course of Cantor lectures given at the Royal Society of Arts in November and December, 1911, by Prof. Vivian B. Lewes. Continued from p. 368.

and vapours, leaving behind the solid coke, and heat is used up in bringing about the change of state. When 1 lb. of coal is decomposed in the retort, the heat used up in the decomposition and distillation amounts to 462 B.Th.U. over and above the heat due to endothermic reactions. The heat withdrawn from the retort by the hot gas and vapours amounts to 324 B.Th.U., and the heat in the red-hot coke when it is drawn accounts for another 442 B.Th.U., so that the heat that has to be actually supplied for the carbonisation is 462+324+442=1228 B.Th.U.

The losses in the setting, however, exceed this, and in an ordinary horizontal bench would be 1463 B.Th.U. escaping with the flue gases, 398 B.Th.U. lost to the air by radiation and convection, and 23 B.Th.U. in the ash, making in all 1884 B.Th.U.

The thermal value of the reactions in the retort will remain the same whether the distillation be carried out in a horizontal, vertical, or inclined retort, in a coke oven or a chamber, and it is chiefly in the setting that the economies have been made which have reduced the carbonising fuel to the figures attained in modern practice.

In the horizontal retort setting quoted above, the total heat used would be 1228+1884=3112; now, 1 lb. of gas coke gives an average of 14,200 B.Th.U. in its combustion, so would give enough heat to carbonise 4·5 lb. of coal, or, in other words, the coal would require 21·9 per cent. of its weight of coke to carbonise it, whilst if the whole of the heat of combustion could be used in the retort, 8·6 per cent. would be sufficient.

A fair idea of the economies that are possible can be obtained by stating the heat used in the setting and retort in percentages :—

		B.Th.U. per lb	Per cent. of heat used	
Used in retort	1. Decomposition and distillation ...	462	15·7	39·3
	2. Escaping in gas and vapours	324	10·4	
	3. In hot coke ...	442	13·2	
Used in setting	1. Flue gases ...	1463	47·2	60·7
	2. Radiation and convection	398	12·8	
	3. Ash	23	0·7	

so that 39·3 per cent. of the heat is used in the retort, and 60·7 in the setting, the item which overshadows all others being the 47·2 per cent. which escapes up the chimney in the hot flue gases.

It is evident that the first step towards economy is to be found in a better utilisation of the heat in the setting, so as to abstract so far as possible the heat from the products of combustion, and this is done by regeneration, which reduces the flue gases by more than 300° C. in temperature, and brings down the loss due to this item from 47·2 to 25·2 per cent., whilst feeding the producers with red-hot coke from the retort effects a further economy, with the result that the fuel used falls from 21·9 to 14·8 per cent. and even lower.

Under these conditions the percentage of heat used in doing the work of carbonisation would be largely increased, and the chart would be as follows :—

Used in retort	1. Decomposition and distillation	21·4	54·1
	2. Escaping in gas and vapours...	13·8	
	3. In hot coke	18·9	
Used in setting	1. Flue gases	25·2	45·9
	2. Radiation and convection ...	19·9	
	3. Ash	0·8	

so that more than one-half the heat is utilised in work.

In the most modern practice results as low as 10·24 per cent. of the weight of the coal carbonised have been quoted, whilst in vertical retorts and chamber carbonisation 12 to 15 per cent. is the usual figure, these advances being made by utilising hot coke in the producers, more perfect regeneration, and reduction of the radiation.

The factor which endows all carbonisation problems with especial difficulty is that we are dealing with a body of such varying composition that no two samples are alike, whilst the conditions under which we are decomposing them vary from minute to minute.

The conduction of heat through a substance like the walls of a fireclay retort is a determination fraught with many troubles, as the conditions existing in a retort heated in a bench are totally different from those that can be obtained in making experimental determinations in a laboratory. In any calorimetric determination the one side of the test-piece is continuously cooled by the calorimeter, whilst the heat poured into the other side is very different in effect to the mass of heated material existing in the flues surrounding the working retort.

The rate at which heat is transmitted under working conditions depends upon the degree of heat in the flue and outer walls of the retort, the higher the temperature the more rapid being the transmission, whilst the difference between the temperature of the outer and inner skin of the retort is a factor of the greatest importance; the greater the difference, *i.e.*, the cooler the inner skin and the mass in contact with it, and the hotter the outer skin in the flue, the more rapidly will the heat pass. Again, the rapidity of transmission varies with the character of the fireclay, with its porosity, and with the temperature and length of time for which it has been baked, so that it is impossible to give any definite figure as to the rate of conductivity or transmission which shall hold good in all cases. Determinations based upon the rate of transmission at comparatively low temperatures may be discarded at once as valueless, but Mr. G. Beilby determined the conducting power of firebrick, and came to the conclusion that one square foot of firebrick, one inch thick, passed 6·59 centigrade pound units, or 11·86 B.Th.U. per hour for each degree centigrade of difference between the sides of the brick, when these differences were of the magnitude of 200–300° C.

My own opinion is that at the ordinary working temperature of a retort under gasworks conditions the amount of heat transmitted approximates to 25 B.Th.U. per square foot of surface for each 1° C. difference in the temperature of the outer and inner surface of the retort, and that this is not seriously affected by the thickness of the fireclay, as conduction is so slow with a retort 3 inches thick that it is probably only the internal portion that is cooled to any great degree when a fresh charge is fed into a properly heated retort, and the mass of fireclay acts as a store of heat, so that the heat has only a short travel.

In a horizontal retort ready for charging, the temperature of the inner walls will approximate to 1000° C. (1832° F.), and the flue temperature to 1100° C. (2012° F.), and the fireclay walls of the retort will conduct the heat at a rate which approaches to 25 B.Th.U. per square foot per hour for each degree centigrade difference in the two surfaces, so that during the first two hours, when the average temperature of the inner side of the retort walls, cooled by the charge and by the retort having been opened, will not be more than 800° C. (1472° F.), the amount of heat passing through the walls into the charge will be 25×(1100−800)=7500 B.Th.U. per square foot of surface, whilst by the fifth hour, when the inner side of the wall of the retort has risen to 950° C. (1742° F.), the amount passing will be—

$$25\times(1100-950)=3750 \text{ B.Th.U.},$$

or only half the amount passed in the earlier period, the average being approximately 5625 B.Th.U. per hour, which, taking the heat units needed for the actions taking place in the retort as 1228 B.Th.U. per lb., gives a carbonising value for a six-hour charge of 12 tons per 1000 square feet of retort surface.

The diminution in the quantity of heat passing through the walls of the retort during the last stages of carbonisation does not affect the rate at which the still uncarbonised core of coal is being heated, as the envelope of coke surrounding it has reached nearly the same temperature as the walls of the retort, and forms a store of heat, whilst in the carbonising mass during the first part of the distillation the volume of gas evolved is so large that it carries off from the contents of the retort a large proportion of the heat, and so keeps down the temperature of the mass until the later stages of the carbonisation.

It has become the custom to speak of the temperature of carbonisation being high merely because the temperatures in the flues and in contact with the walls of the retort are high, and to speak of the products of high

temperature distillation as if the coal had been carbonised at the temperature existing on the retort surface.

It is quite clear, however, that, coal being a bad conductor of heat, and coke a worse one, it is only the layer of probably less than an inch thick that is carbonised at anything like the retort temperature, and that the remainder of the charge is distilled at a slowly rising temperature, which attains its maximum only after the volatile products have been practically all driven off.

The real distinction between high heats and lower flue temperatures is that the higher the temperatures employed, the thicker and hotter will be the layers of coke which the gases and vapours have to traverse in their escape from the inner portions of the charge, and the greater will be their exposure to radiant heat and contact with the highly heated surfaces of the retort in their outward passage from the carbonising mass; the products of the primary action are, in fact, being subjected to secondary decomposition under conditions we neither know nor can control, and this is one of the weakest points in our methods of carbonising for the production of illuminating gas.

We make elaborate tables of the composition of gases and tars produced at various distillation temperatures, but the only information that they give us is what is left undecomposed under unknown and varying conditions, the only certain factor being that the heat was nowhere above that which we are pleased to call the temperature of distillation.

It is evident that if these variations exist in the temperature at which the coal is distilling in the comparatively small charge in the gas retort, they must be accentuated when one comes to deal with carbonisation in bulk as practised in oven and chamber settings, as not only is the travel of the gases and vapours through the red-hot coke much longer, but the rate at which the heat is conducted through the carbonising mass becomes slower as the bulk of the charge increases, whilst the temperature in the crown of the oven during the first half of the time is higher than is found in the gas retort, and this also applies to the temperature in the top layer of the coke.

If the coal is carbonised in a 6-inch diameter tube filled so that the heat shall be penetrating from every side, there is an almost immediate rise in temperature throughout the mass, owing to the hot gases and vapours passing through the interstices between the pieces of coal, and the coke attains its maximum temperature at the rate of about one inch per hour, so that in three hours, with a wall temperature of 1000° C., the centre of the mass would be at about 950° C., and the carbonisation would be finished; if, however, the tube be increased to 12 inches in diameter, the rate of conduction is reduced to 0·5 inch per hour, and the same thing takes place with a flat chamber retort heated from the sides, so that it would take about twelve hours to complete the carbonisation; whilst with further increase in the width of the chamber the rate of travel of the heat grows still less, the passage of the heat being still slower as the distance between the walls of the chamber gets greater.

The result of this is that in by-product recovery coke ovens and large chamber retorts the period of carbonisation becomes very long, and the gas has to pass through so much hot coke that the illuminating power is reduced to nine or ten candles.

These rates of passage of heat apply only to vertical retorts or chambers, the sides of which are heated, as bottom heat penetrates the mass rather more quickly owing to convection coming to the aid of conduction, and the upward flow of heated gases raising the temperature in advance of the conducted heat.

Moreover, the rate at which the heat travels in the carbonising mass depends to a great extent on the initial temperature employed, the figures given being attained only when the flues and outer walls of the retort or chamber are heated to about 1100° C. (2012° F.), but if the flue temperature is lowered, the transmission of the heat becomes lower, and a longer period, therefore, is required for the complete carbonisation, the time taken being nearly inversely proportional to the temperature; so that if in a 6-inch tube with a wall temperature of 1000° C. (1832° F.) it takes three hours to complete carbonisation, it would take six hours to do the same work with a wall temperature of 500° C. (932° F.). Consequently, in making low-temperature coke, such as coalite, in tubular retorts 5½ to 6½ inches diameter, it takes four hours to drive off two-thirds of the volatile matter that is in the coal.

The temperature of the coke or coal through which the gas and tar vapours have to pass, and the length of travel they have in reaching the exit from the retort or chamber in which carbonisation is proceeding, are two of the most important factors in determining their decomposition, as it is these which give rise to the secondary reactions that largely determine the final composition of the gas and tar.

Valuable pyrometric observations on the temperatures existing in charges of varying size have been made by Mr. Bond, of Southport, and other observers, from whose work we can deduce the following results as typical:—

If an ordinary D-shaped horizontal retort, 18 to 20 inches wide and 15 inches high, has a 6-inch charge fed into it, the space from the apex of the crown to the top of the charge will be 9 inches deep. If now thermo-couples properly protected are placed (1) at the bottom of the charge, (2) in the centre, and (3) at the top of the charge, we can gain a good idea of the way in which the heat is acting on the coal.

With full heats the coal at the bottom of the retort rapidly heats up, and in fifteen minutes has reached 700° C. (1292° F.), after which its rise in temperature slows down, and it takes two hours to reach 800° C. (1472° F.); after this it heats more rapidly, and attains 1000° C. (1832° F.) at the end of four hours, and then there is practically no rise in the last two hours of carbonisation. The temperature at the top of the charge rises more slowly, and by the end of the second hour is only 740° C. (1364° F.), or 60° cooler than the bottom, and remains at a lower temperature throughout the whole carbonisation. This is not to be wondered at, as although the top flue of the setting is 1150° C. (2102° F.), and the bottom flue barely 1100° C. (2012° F.), the coal at the top of the charge is being heated largely by radiant heat acting across a considerable gas space, whilst the bottom of the charge is in direct contact with the heated bottom, and is taking in heat by conduction.

The thermo-couple in the centre of the charge throws most light upon the course the distillation is taking, and we discover that so great is the heating effect of the gases and vapours passing up from the hot zone at the bottom of the retort that at the end of the first hour the temperature is only 30° below that of the bottom, 730° C. (1346° F.), whilst in two hours it is at the same temperature, and then falls slightly below it for the rest of the time, the rush of hot gases from the bottom having ceased, and the temperature of the top of the charge equals the centre only after the fourth hour.

Now the fact that differences in temperature are so small throughout the mass, and that during the whole of the period when the bulk of the gas is being evolved the centre of the charge is hotter than the top, points to the gas forcing its way through the pasty mass of distilling coke upwards into the space below the crown of the retort, where it is baked by radiant heat from the mass of fire-clay at 1050° C. (1922° F.), and the retort walls at 1050° C. and the coke at from 700° to 1000° C. (1292° to 1832° F.) are also in surface contact with it.

The passage of the gas through the pasty coke causes considerable swelling during the first hours of distillation, and when the shrinkage in the charge of coke takes place during the last two hours, the top portion, presumably carbonised by radiant heat from the top of the retort, shrinks over a smaller depth than the bottom and large portion, so that when the charge comes to be drawn there is found to be a fissure running horizontally between the upper and lower portions, but nearer to the top, from which vertical cracks branch to the top and bottom of the charge.

We are at present dealing only with the thermal conditions existing during carbonisation; but when we come to study the more chemical side of the actions taking place we shall see that such methods are the most brutal form of distillation—high heats and small charges certainly mean

high makes of gas, but got at the expense of all the other by-products, and bringing in their train all the troubles of stopped ascension pipes, carbonised retorts, ruined tar, and poor coke. If instead of using a 6-inch charge in such a retort it be filled with coal as nearly as a horizontal retort can be filled, that is, to within 2 or 3 inches of the apex of the crown of the retort, and the same temperatures as before are used in the setting, you approach to the same conditions that obtain in vertical retorts, which are entirely filled, and quite different results are obtained.

The improved results are by most observers ascribed to the doing away with the baking chamber above the charge, radiant heat being credited with the formation of free carbon and naphthalene, which have been the chief curses that have accompanied the raising of temperatures with small charges to increase the gas volume obtained.

The determination of temperatures as before in the charge shows that filling the retort does a deal more than this, however; in the first place, in order properly to carbonise the charge, the heating has to continue from eight to twelve hours instead of six, and the heat is poured into the charge in a much more even manner, the rise in temperature at both top and bottom being equal throughout the distillation, and with the top temperature always about 100° C. more than the bottom, truly reflecting the difference in temperature between the top and bottom flues of the setting. Owing to the thickness of the charge having been doubled, the heat advances more slowly into the mass, rendering the coal semi-fluid and pasty in front of it, and so forming the whole centre of the charge into a tube, through which a large proportion of the gas finds its way down to the mouth of the retort without having been overheated in the crown.

That this is the true explanation is shown by the thermo-couple in the centre of the charge, which during the first 5½ hours of the distillation rises slowly in temperature at about the same rate as the outer portions, but on a plane 500° C. (932° F.) below them, whilst after this period the central heat rises rapidly, and the same temperature as exists at the bottom of the charge is attained in the eighth hour.

The gas is improved because only a small portion has to run the gauntlet of overheating; the tar is improved because a considerable proportion is made at a lower temperature; the coke is improved because in the earlier half of the distillation a good deal of tar has condensed in the cool zone, and as the temperature rises the more volatile portions redistil, but the least volatile remain and get decomposed only in the last hour of carbonisation, increasing the gas yield, the factor for which the gas manager at the present time seems prepared to make any sacrifice.

It must be clearly borne in mind that the possibility of filling a horizontal retort to within 3 inches of the crown, although suggested by Kunath in 1885, is a comparatively new condition, which could be achieved only by the introduction of discharging machinery that would push the charge of coke out of the retort, and that, so long as we were dependent upon hand labour to draw the charge, it was impossible; now, however, the introduction of vertical settings allows a more complete filling of the retort by gravity and easy discharge, so that the question of the route taken by the gas in its escape from the carbonising mass is receiving its full share of attention; and opinions on the subject are by no means unanimous.

Dr. Bueb, to whom we owe the inception of the Dessau vertical retorts, is strongly of opinion that the largest bulk of the escaping gas finds its way through a cool core in the same way as it undoubtedly does in a well-filled horizontal retort; others favour the theory that the major portion passes up the sides, whilst Dr. Harold Colman and many others agree that, as the pasty area of the decomposing coal works its way inwards from the walls of the retort to the centre, gas escapes on both sides of it, so that a portion goes up the centre and the remainder through the hot coke or up the walls of the retort. What proportions exist between the gas that takes the cool route and that which is forced to pass through the hot coke cannot be exactly determined, and would vary with every kind of coal; but what we do know, beyond doubt, is that a large volume of the richest gas comes off from all coals when first heated, so that a large evolution of primary gas will be on the inside of the tube of semi-fused coal, whilst another factor which would tend to make the gas take the inner route is that any passing back into the hot zone would be expanded by the temperature, whilst the still pasty coke would offer more resistance to the passage of the gas than the coal, so that pressure would be highest on the hot side and lower on the cool, the probabilities therefore being that, so long as the central passage is unimpeded, the major portion of the gas passes up the centre. The analyses of the gases, however, all show that far too much cracking of the rich hydrocarbons has taken place.

If we distil coal at a fixed temperature, as has been pointed out, we know that in the distillates we have the volatile products yielded at all temperatures below the one employed, and such secondary products as have been formed by further decompositions or by interactions between the primary products at or below that temperature, so that if we distil coal in bulk at the lowest temperature at which volatile matter can be driven out from the coal, the analyses of the products will give us the maximum of primary products with the minimum of secondary, and we shall obtain the best possible data for forming an opinion as to the composition of coal, on the one hand, and the course taken by the interactions and decompositions in the secondary actions.

In the experiments that led to the introduction of coalite it was found that 420° C. (800° F.) was the lowest temperature that could be employed successfully, and many thousand tons of coal have been distilled at about this point, say, from 400° to 500° C.

Under these conditions a fair gas coal containing 30 to 33 per cent. of volatile matter will yield 68 to 70 per cent. of low-temperature coke containing 10 to 14 per cent. of volatile matter, and a volume of gas varying from 3000 to 5000 cubic feet, according to the coal used, having a composition approximating to—

Hydrogen			27·5
Saturated hydrocarbons—methane ...	48		
higher members	10·1		
		——	58·1
Unsaturated hydrocarbons...			3·0
Carbon monoxide			7·3
Carbon dioxide			2·5
Nitrogen			1·6

The gas before iron purification contains about 1·8 per cent. of sulphuretted hydrogen.

The low-temperature gas, of course, varies with the coal used, and the hydrogen is often below 18 per cent., and the saturated hydrocarbons up to 68 per cent.; but the marked feature of the gas is that it contains hardly any benzene vapour, and owes its illuminating power to a small percentage of ethylene, and chiefly to the gaseous members of the paraffin series (mostly ethane), and also that the percentage of hydrogen is low, very rarely reaching the amount present in the above sample, whilst bisulphide of carbon likewise is very low.

This I pointed out in the last course of Cantor lectures which I gave in March, 1908, and it has since been confirmed by the work of Porter and Ovitz, White Park and Dunkley, and Burgess and Wheeler.

The tar also varies with the coal used, and is sometimes as high as 23 gallons per ton, and in most cases averages 20 gallons.

The low-temperature tar is as distinctive in its characteristics as the gas. It has a specific gravity of about 1·075, is very liquid, and contains an abundance of light solvent oils, very low aromatic hydrocarbons, very little phenol, but large quantities of cresol, no naphthalene and very little anthracene, whilst the free carbon is, as a rule, below 2 per cent.

The very low percentage of benzene in the light oils is made up for by the presence of paraffins, such as hexane, heptane, and octane, whilst there are also present considerable quantities of that curious group of hydrocarbons known as naphthenes or hexahydrobenzenes, which play so important a part in Russian petroleum.

As before mentioned, carbolic acid occurs in very small quantities, but its higher homologues, such as cresylic

acid, &c., occur in much larger quantities than in coal tar, and there are also present quantities of polyhydric phenols or other esters of the type met with in coal tar, which form resinous masses difficult to investigate. The pitch left as a residue amounts to about 40 per cent. of the tar, and is of very fine quality, owing to the practical absence of free carbon.

When low-temperature coke that has been formed with the evolution of 5000 cubic feet of 22 candle-power gas, as measured by the No. 2 Argand, is further heated to a high temperature, it evolves nearly as much gas as it did before, and the composition of this gas is approximately—

Hydrogen	71·13
Saturated hydrocarbons	18·26
Unsaturated hydrocarbons	0·52
Carbon monoxide	6·30
Carbon dioxide	2·09
Nitrogen	1·70

The gas is practically non-luminous when burnt alone, but has a heating value of 447 B.Th.U. gross.

It seems clear from these experiments that in the distillation of coal for gas there are three distinct sources which give the final product :—

(1) The primary gases evolved from the coal, and distilled out as the advancing temperature travels through the mass.

(2) The gas evolved by the decomposition of the heavy tar or pitch left in the coking mass.

(3) The gas produced by secondary actions, and contact of the primary gases and vapours with the hot coke and walls of the retort.

It now becomes possible to trace, roughly, the actions taking place in the destructive distillation of a gas coal. Up to about 450° C. the products are chiefly primary :—

Humus bodies		Resin bodies and hydrocarbons
Carbon—		
Water, Carbon monoxide, Carbon dioxide, Hydrogen, Methane	Gases	Methane, Ethane, Propane, Butane
Coke and pitch—		
Watery tar	Liquids	Pentane, Hexane, Heptane, Octane, Nonane, Hexahydrides, Oxygenated hydrocarbons like cresylic acid and more complex bodies

About 400° to 450° C. the secondary actions start, the saturated hydrocarbons split up into unsaturated and simpler members of the saturated series, the hexahydrides shed hydrogen and give aromatic hydrocarbons, the tar thickens and alters in character, and synthetic actions start, cresol and hydrogen form more toluene, carbolic acid and carbon yield carbon monoxide and benzene. About 900° C. the degradation of all the hydrocarbons and other oxygenated bodies is proceeding, and finally the mixture of the results of endless actions and reactions yields us the high-temperature gas and tar, the mixture being diluted with the carbon monoxide, hydrogen, and methane yielded by the decomposition of the pitch residues in the soft coke, which leaves the hard coke behind.

With a good Durham coal, capable of yielding 11,000 cubic feet of gas and 10 gallons of tar per ton when distilled under ordinary conditions at a temperature of about 1000° C., it is found that on carbonising at 600° C. it yields only 5000 cubic feet of gas, but 22 gallons of tar per ton, and the residue, on continuing the distillation at 1000° C., yields a further volume of 4500 cubic feet of gas, but no tar, so that removing the gas first formed and the tar vapour from the secondary reactions induced by high temperature has reduced the gas yield by some 1500 cubic feet per ton, and increased the tar yield by 12 gallons; and an examination of the tar shows that the 12 gallons gasified by direct distillation at high temperature consist of the lighter portions of the whole of the tar, which at this temperature is capable of producing 1200 cubic feet of gas, leaving 300 cubic feet to represent the volume gained by degradation of gaseous hydrocarbons and deposition of free carbon, of which the high-temperature tar contains 25 to 35 per cent.

It may be taken, in round numbers, that when 11,000 cubic feet of gas are obtained per ton of such a coal, 45 per cent. of the volume is from the low-temperature distillation, 42 per cent. from the residues left in the low-temperature coke distilled at a high temperature, and 13 per cent. from the various secondary actions and tar.

When tested by the No. 2 Argand, the low-temperature gas has a candle-power of 22; the gas from the pitch in the coke is nearly non-luminous, giving not more than 2½ to 3 candles, but when mixed with the rich gas in the proportions of 45 of the latter to 41 of the former gives a 16 to 17-candle gas; whilst the gas from the tar and the secondary actions is 10-candle gas when tested alone, and when mixed with the others brings down the total candle-power to 14 to 15.

In the new methods of carbonisation, where the makes approximate to 13,000 cubic feet, the improvement found is entirely due to the free escape without over-heating of the products from the first two-thirds of the coal carbonised, whilst the extra volume is obtained from the complete degradation of the products from the remaining third, and that this is so is shown by the methane in the gas. In all fair coal gas in which there has been no over-degradation, even if you have been getting 11,500 cubic feet per ton from light charges, the methane will be about 34 to 35 per cent. of the gas; but notice the products of the new carbonisation, and you will find plenty of samples with only 28 per cent., and some even lower.

In considering the ultimate effect of pushing temperatures to the highest possible extent, it is as well to consider the amount and value of the gas and coke that could possibly be obtained from an ordinary coal.

If we took a coal of the composition—

Carbon	80
Hydrogen	5
Oxygen	10
Nitrogen and ash	5

and were to carbonise it in an inverted vertical retort with the coal fed in by a ram at the bottom, so that the gas and vapours had to traverse a column of 10 feet of coke at 1000° C., contact would decompose all the gaseous and volatile compounds to hydrogen and carbon monoxide, and we should obtain—

Coke	15·27 cwt.
Hydrogen	22,400 cubic feet = 77·87 per cent.
Carbon monoxide	6,366 cubic feet = 22·13 per cent.
	28,766 cubic feet

that is, you would rather more than double the volume of gas; but it is a non-luminous gas of the same thermal value (gross) as water gas, and not worth more than the 3½*d.* to 4*d.* a thousand that you could make water gas at by one of the newer processes.

Now this is exactly what is done in all the new processes directly the cool passage for escape of the primary gas gets tar-logged, and the gas from the remaining coal is driven through the red-hot coke and along the sides of the retort. Under these conditions some 3500 cubic feet of 22-candle gas are obtained, whilst there is a free, cool passage for its escape; and after that is closed the remaining coal yields by complete degradation of the tar and hydrocarbons 9500 cubic feet of hydrogen and carbon monoxide.

The limit of volume in gas-making, if not already reached, is fast being approached; economies are day by day getting more difficult to make; coal is not likely to cheapen; and all this means that the chance of considerable reduction in the price of gas is getting less and less. If the price of gas could be reduced in our large cities to the price charged at Widnes, the consumption of gas could be economically increased, and for power and heat gas would hold an unassailable position; but this can never be done in existing circumstances, because even if the gas could be made at the necessary price, the increased output of coke would outrun the demand. If, however, the companies would only live up to their titles of "Gas Light and Coke Companies," and bestow as much care on the

coke as on the gas, and cater for the supply of a good domestic fuel at the price of coal, instead of treating coke purely as a by-product, the demand for it would soon reach a point that would enable the desired reductions in the price of gas to be made. There is no need to fear as to the other by-products; the output of sulphate of ammonia could be doubled without affecting the market, and a good tar will look after itself; it was high heats that ruined the tar market, and with the demand for tar increasing for road work, no flooding of the market need be feared.

During the last few years the statement has several times been put forward that "as the gas manager's end and aim is gas, it is his duty to obtain the greatest volume of gas possible per ton of coal"; but with this I venture to disagree. The gas manager's duty is to obtain the greatest possible value per ton of coal, and until every industry dealing with coal recognises that in this respect its aim is the same, little economy will be possible in our rapidly diminishing store of coal.

The pressing of temperatures in carbonisation to higher and higher degrees with the old conditions of lightly charged retorts has given larger yields of gas, but it has loaded the gas with carbon bisulphide, depreciated the coke, and ruined the tar; and one of the chief claims for the adoption of the full-charge horizontals and intermittent vertical retorts for carbonisation is that they have improved the character of both coke and tar.

As I have shown, this is due to a certain proportion of the gas and tar vapour coming off through the cool core and so escaping over-cracking, but it can be only a partial improvement; whilst, so far as the coke goes, the nearer it approaches metallurgical coke the less it is fitted for a domestic fuel. True it is, that where the coke has been made harder and brighter the gas manager's market has improved; but it has been for use in furnaces, manufacturing processes, and for producers that the increased demand has been felt, and not for domestic use.

Even for the heating of furnaces the coke made at extreme temperatures is not so good as when the heats were slightly lower; and in Germany this is beginning to be recognised, and Körting, in a paper read this summer (1911), points out that the inclined settings, which used to work with 12 per cent. of fuel, now require fully 16 per cent., an increase due partly to higher temperatures, but largely to more highly carbonised coke.

Already the strides forward which gas has made as a domestic fuel are telling the tale in our atmosphere, and the yellow fogs of the last century are getting rarer; and if coke could be made a domestic fuel by leaving in it 6 to 8 per cent. of volatile matter to facilitate ignition and give a flame, the gasworks of the country could command the fuel market.

Remember that the sale of gas cannot be pushed beyond a certain point without overstocking with coke; the sale of both *pro rata* must be pushed, and if only you could be persuaded that this is the right road, you would be backed up by the smoke reformers and the public, and find yourselves able to sell a fuel coke at the price of the best coals.

I have shown that the factor for which you ruin your coke as a domestic fuel is about 3000 cubic feet of gas of the same value as blue water gas; the 3000 cubic feet of gas left in the coke would be worth four or five shillings a ton on the selling price, and the cost of replacing it by water gas would be about one shilling, whilst the creation of a large domestic market would enable a reduction in the price of gas to be made that would still further increase its use as a fuel.

Now I am sure in my own mind that these are the lines the gas industry should consider seriously, and that the advances in the next ten years must be an endeavour to get nearer to the ideal of carbonisation and to improve both gas and coke.

In a course of lectures such as these, four seems an ample allowance at the commencement—and probably to the audience more than ample at the end—but I realise only now how miserably inadequate the time has been for the expression of the matter I desired to bring before you, and can only hope that some of the points, controversial though they may be, will prove helpful in considering the carbonisation of coal.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE committee formed to promote a scheme for providing a college of university rank at Brighton has resolved that the scheme shall be one for establishing a constituent college of London University for the county of Sussex, the subjects to be arts, sciences, engineering, and pedagogy in the first instance, but medicine and law to be undertaken later.

THE Old Students' Association of the Central Technical College is organising a dinner to celebrate the election of Prof. W. C. Unwin, F.R.S., as president of the Institution of Civil Engineers. The dinner, which will be held at the Criterion Restaurant on Saturday, February 10, is intended to be a gathering of old students of the Central Technical College and Prof. Unwin's students at Coopers Hill. The chair will be taken by Mr. W. Duddell, F.R.S., president of the Central Old Students' Association. Tickets may be obtained from Mr. G. W. Tripp, 4 Fairfield Road, Charlton, Kent.

SEVERAL gifts to American universities are announced in the issue of *Science* for January 12. Mr. Jacob H. Schiff has given 20,000*l.* to Cornell University to promote studies in German culture; the 200,000*l.* fund for the further endowment of the medical school of Western Reserve University has been completed; and De Pauw University has just brought to a successful close the campaign to raise 80,000*l.* to meet the conditional gift of 20,000*l.* from the Rockefeller Educational Board. The subscriptions amount to a little more than 88,000*l.* This will make the productive endowment of the University something above 200,000*l.*

THE late Dr. R. D. Roberts, whose death occurred on November 14 last, left estate of the gross value of 10,024*l.*, of which the net personalty has been sworn at 6021*l.* He bequeathed the ultimate residue of his property "to the University College of Wales, at Aberystwyth, to form the nucleus of a fund to be formed and administered in accordance with a scheme to be prepared by the said University College, and approved by my trustees, to enable professors, after a certain number of years of service—say, not less than ten—to be released from the professorial duties for a period of about a year, and, at any rate, not less than six months on full salary, a substitute being paid out of the income of the fund, the purpose of this release from college duties being to enable the professor to refresh his mind by travel or research or visits to other universities, and so gain fresh stimulus and equipment for his work."

IT has been announced that the ordinance for the institution of degrees in veterinary science promoted by the University of Edinburgh has been passed by the Privy Council, and has received his Majesty's sanction. The ordinance will come into operation at the beginning of the next summer session, and by it the University is empowered to confer the degrees of Bachelor of Science and Doctor of Science in veterinary science. The Edinburgh veterinary student will now be in a position to obtain an academic distinction in addition to the diploma of membership of the Royal College of Veterinary Surgeons. The present time marks a distinct epoch in the history of veterinary science in Scotland. The Royal (Dick) Veterinary College—the original Scottish veterinary school—is about to enter upon a fresh era, inasmuch as it has been decided to erect new and up-to-date buildings on a scale which will do credit to the important educational centre in which it is located. At the same time, the students of the college are being afforded the means of entering the ranks of university graduates. These developments cannot fail to exert an important effect upon veterinary teaching in Edinburgh and upon the veterinary profession in Scotland.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 18. — Sir Archibald Geikie, K.C.B., president, followed by Sir A. B. Kempe, vice-president, in the chair.—Dr. J. S. **Haldane**, C. Gordon **Douglas**, Dr. Y. **Henderson**, and Dr. E. C. **Schneider**: The physiological effects of low atmospheric pressures, as observed on Pike's Peak, Colorado. The

following is a short preliminary account of a series of observations made in the summer of 1911 on the summit of Pike's Peak, Colorado. Pike's Peak is 14,107 feet above sea-level, the barometric pressure on the summit being about 18 inches (457 mm.). There is an excellent stone house close to the summit, in which the authors were accommodated during their stay of five weeks. The main object of the expedition was to discover to what extent, and by what means, adaptation takes place to low barometric pressure, and consequent deficiency in the partial pressure of oxygen in the air. The authors' chief conclusions are as follows:—(1) After two or three days on the summit of Pike's Peak very distinct signs of acclimatisation began to appear. (2) Before acclimatisation occurred, blueness of the lips and face, nausea, intestinal disturbance, headache, fainting in some persons, and periodic breathing were observed, besides great hyperpnœa on exertion or holding the breath for a few seconds. (3) All these symptoms are referable, directly or indirectly, to want of oxygen produced by the diminished partial pressure of oxygen in the air. The authors did not observe, either in themselves or in the large number of persons who ascended the peak, any symptoms (apart from the effects of the bright light) not referable to the same cause. (4) After acclimatisation had occurred these symptoms disappeared, with the exception that hyperpnœa on exertion or on holding the breath for a few seconds was still much greater than usual. Periodic breathing was still observed occasionally, and blueness of the lips and face was present after continuous and powerful exertion, such as walking up hill. (5) The respiratory exchange during rest remained about normal in the one subject on whom exact experiments were made, and the respiratory exchange during work did not appear to be markedly increased. (6) After acclimatisation the alveolar carbon dioxide pressure was diminished from about 40 mm. to about 27 mm. during rest or moderate exertion, which corresponded to an increase of about 50 per cent. in the ventilation of the lung alveoli. During severe exertion the alveolar carbon dioxide pressure was about half what it normally is during similar exertion, which corresponded to an increase of about 100 per cent. in the hyperpnœa; and owing to a temporary alteration in the respiratory quotient the breathing was still further increased, so that it was for a time increased to thrice what it would have been at sea-level with the same oxygen consumption. (7) The change in the level of alveolar carbon dioxide pressure occurred gradually after going up, and disappeared gradually on coming down, the change taking a number of days to reach completion. (8) The percentage of hæmoglobin in the blood increased for several weeks on the summit of Pike's Peak, and varied in different acclimatised persons from 115 to 154 per cent. on the scale of the Gowers-Haldane hæmoglobinometer, corresponding to an oxygen capacity of from 21 to 28·5 c.c. of oxygen per 100 c.c. of blood. The number of red corpuscles per cubic mm. of blood increased parallel with the hæmoglobin, and the percentage volume of red corpuscles, as determined by the hæmatocrit, also increased in proportion to the percentage of hæmoglobin. (9) A large increase in the total amount of hæmoglobin (determined by the carbon monoxide method) in the body occurred during the first three weeks, and along with this increase there was found, except in the first week, a slight increase in blood volume, as well as the increase, already referred to, in the percentage of hæmoglobin. (10) On coming down from Pike's Peak the hæmoglobin percentage diminished much more rapidly than the total hæmoglobin, so that the blood volume was still further increased at first. It required about four weeks for the excess of hæmoglobin and blood volume to disappear, though the hæmoglobin percentage fell to normal much earlier. (11) So far as the authors could ascertain, there was very little change in the rate of circulation on Pike's Peak after acclimatisation. Pulse and blood pressure were but little affected. In most cases, however, there was a slight increase in the pulse-rate. (12) After acclimatisation the oxygen pressure in the arterial blood (measured by the carbon monoxide method) rose during rest to about 35 mm. of mercury, or 66 per cent. above the alveolar oxygen pressure, and remained at a level of only about 12 mm. below the normal oxygen pressure at sea-level. Immediately after ascending the peak, and before acclimatisation had occurred, the arterial oxygen pressure was found to be about 45 mm. below normal, and only slightly above the alveolar oxygen pressure. This change appears to be due to a progressive increase in the activity of the alveolar epithelium in secreting oxygen inwards. On raising the alveolar oxygen pressure to normal, the difference between alveolar and arterial oxygen pressure diminished rapidly. (13) Acclimatisation to high altitudes is due mainly to the increased secretory activity of the alveolar epithelium, but partly also to the increased lung ventilation, and to a lesser extent to the increased hæmoglobin percentage in the blood. The acclimatisation takes some days to develop. During rapid ascents in balloons or aëroplanes it would not have time to develop, and this explains the contrast between the experience of balloonists, &c., and that of mountaineers who ascend gradually.—J. **Barcroft**: The effect of altitude upon the dissociation curve of the blood. The affinity of hæmoglobin for oxygen depends, among other things, upon the hydrogen ion concentration of the blood. After removing the CO_2 from blood, a scale was made out for the blood of each person plotting the percentage of oxyhæmoglobin at a standard oxygen pressure vertically, and the amount of acid added to the blood horizontally. Thus, by estimating the percentage of oxygen in the hæmoglobin of blood at high altitudes, an estimate can be made of the acid which has been contributed to it by the organism. It thus appeared that at each altitude the alkalinity of the blood decreased (apart from CO_2). This was so in the resting individual, but much more markedly so during exercise. The dissociation curve of blood exposed to the CO_2 pressure of the alveolar air confirmed the result that during rest the dissociation curve remains constant. During activity the affinity of the blood for oxygen decreases, and the hæmoglobin is able to unite with less oxygen in the lung, and to do so at a lower rate. On the other hand, the rate of dissociation in the tissues increases. The acid which accumulates in the blood is not lactic acid entirely, and during rest only to a slight extent. The persons whose blood was most alkaline (apart from CO_2) were most prone to sickness.—R. **Kirkpatrick**: Note on *Astrosclera willeyana*, Lister. *Astrosclera willeyana*, Lister, is a small columnar, or mushroom-shaped, organism, somewhat resembling a coral in appearance. It has been described by various zoologists respectively as a calcareous sponge, a siliceous sponge, and a coral. Mr. Kirkpatrick, who dredged numerous specimens from a depth of 50 to 100 fathoms off Christmas Island, Indian Ocean, has found that the organism is a siliceous sponge with a supplementary skeleton of aragonite, and that it owes its unique character (viz. that of forming a supplementary skeleton of aragonite) to its association with a degenerate *Floridean alga* (red seaweed). Certain of the sponge cells envelop the spores of the alga, and secrete around them concentric layers of aragonite. The little spherules so formed are in several respects comparable with the cyst pearls of pearl oysters and mussels. The spherules are at first loose and separate, but later become welded together so as to form a firm coral-like skeleton. The encysted algal spores may be killed and wholly calcified, or they may retain their vitality and germinate, so as to form branching thread-like filaments, which bore their way through the solid calcareous walls. The algal plants in the soft tissues of the sponge are of microscopic dimensions.—Dr. H. B. **Fantham**: *Herpetomonas pediculi*, nov. spec., parasitic in the alimentary tract of *Pediculus vestimenti*, the human body-louse. *Herpetomonas pediculi* is a parasitic flagellate protozoon. It has been investigated especially in body-lice reared and fed on the author's own blood. It also occurs in "wild" lice, but only some 8 per cent. are infected, and then slightly. The life-cycle of the parasite comprises pre-flagellate, flagellate, and post-flagellate stages, which gradually merge into each other. These forms of the parasite occur broadly in the fore-, mid-, and hind-gut respectively of adult lice, while pre-flagellate stages also occur in the digestive tract of larval *pediculi*. The pre-flagellate stage resembles the Leishman-Donovan body. The length of the flagellate body varies from 11 μ to 26 μ, while the single free flagellum is usually about as long as the body. Oval, encysted post-flagellate stages may be recovered from the fæces of infected lice. Striated thick-walled cysts occur very rarely. The mode of infec-

tion is casual, cysts being swallowed accidentally by lice. There is no hereditary infection. *H. pediculi* is important in at least two respects:—(1) it occurs in human body-lice, which themselves may act as carriers of disease in certain circumstances in some parts of the world; also (2) it has been asserted that parasites belonging to the genera Herpetomonas and Crithidia, occurring in blood-sucking insects, are stages in the life-cycles of trypanosomes of vertebrates. Although many lice, infected with *H. pediculi*, had been bred on the author's body, fed only on his blood throughout their lives, and kept confined, yet no trypanosome has been found in his blood, whether examined by smear, thick film, culture, or by sub-inoculation into white rats, the experiments having extended over a period of nearly three years. Also, rats inoculated with *H. pediculi* have not developed trypanosomes. *H. pediculi* is a harmless parasite of the digestive tract of *Pediculus vestimenti*, and has no connection with any vertebrate trypanosome. The possible occurrence of such a natural Herpetomonas in lice must be remembered when experimenting with *pediculi* as possible transmitters of Leishmania.—Captain A. D. **Fraser** and Dr. H. L. **Duke**: An antelope trypanosome. Ten days after blood of a bushbuck, which was shot on the shores of the Victoria Nyanza, had been injected into a healthy goat, trypanosomes appeared in the goat's blood. The same species of trypanosome was present in blood smears made from another bushbuck and a sikitunga, which were shot in the same neighbourhood. The small characteristic trypanosome corresponds morphologically to the one which was discovered in cattle in Uganda, and was named *Trypanosoma uniforme* by the Royal Society Sleeping Sickness Commission, 1908–10. This is shown by curves representing the distribution, by percentages, in respect to length of the antelope trypanosome and *T. uniforme*. Cattle, goats, sheep, and bushbuck were infected. Monkeys, pigs, dogs, cats, guinea-pigs, and white rats proved to be refractory. It is concluded that the trypanosome found in the antelope was *T. uniforme*. Experimentally it was shown that laboratory-bred *Glossina palpalis* were capable of transmitting this species of trypanosome from infected to healthy animals. Of six experiments, four were successful. The flies became infective in from twenty-seven to thirty-seven days, and the infection in the fly was always limited to the proboscis. In order to ascertain if *G. palpalis* caught on the Lake-shore, near where the infected antelope had been shot, were naturally infected, flies were collected there and brought to Mpumu, where they were fed on a healthy goat. After 1020 flies had been put on the goat it became infected with *Trypanosoma uniforme*. Some days afterwards *T. vivax*, with which wild flies had previously been shown to be naturally infected, also appeared in the goat's blood. The conclusions are:—(1) this trypanosome, which is of fairly frequent occurrence among Lake-shore antelope, is *T. uniforme*; (2) the available evidence points to *Glossina palpalis* as being the carrier of this species of trypanosome; (3) *G. palpalis* caught on the Lake-shore are naturally infected with *Trypanosoma uniforme*.

PARIS.

Academy of Sciences, January 8th.—M. Lippmann in the chair.—Paul **Sabatier** and A. **Mailhe**: The catalytic decomposition of formic esters. The authors have previously shown that formic acid suffers catalytic decomposition in two different ways, some catalytic agents, such as titanium dioxide, producing carbon monoxide and water, others, such as finely divided metals and zinc oxide, giving rise to carbon dioxide and hydrogen. Catalysis by the oxides of thorium, manganese, &c., takes place in both ways. The study has been extended to the action of these various catalytic agents on the formic esters, and the predominant reaction is a decomposition of the ester into alcohol and carbon monoxide.—G. **Fayet**: A new comet of short period. Observations on a very faint comet, of about seven years' period, discovered by M. Schaumasse.—M. **Tzitzéica**: Isothermal surfaces.—Paul **Lévy**: The integro-differential equations of M. Hadamard.—P. **Helbronner**: Survey of the higher regions of the French Alps.—Marcel **Oswald**: A simple relation between the coefficient of expansion of liquids and the temperature. If α be the coefficient of expansion at T° absolute, T_c the critical temperature absolute, then the expression $\alpha = \frac{1}{2T_c - T}$ holds good. Using the general formula $\alpha = \frac{1}{\lambda T_c - T}$, the values of λ obtained with various liquids approximate closely to 2.—C. **Matignon** and M. **Lassieur**: Actions of nitrogen and oxygen on magnesium. Oxygen begins to act on magnesium at 600° C., and nitrogen at about 670° C., the former acting much the more rapidly. The addition of mercury to form an amalgam does not facilitate these reactions.—L. C. **Maillard**: Action of amino-acids on the sugars. Amino-acids act rapidly at 100° C., slowly at 37° C., with various sugars, producing brown substances, with elimination of carbon dioxide and water. The carbon dioxide is split off from the amino-acid. The action is general, having been obtained with glycocine, sarcosine, alanine, tyrosine, glutamic acid, &c.; of these, alanine acts the most readily.—Marin **Molliard**: Comparison of the phenomena of oxidation in galls and in the homologous normal organs. The respiratory quotients for normal leaves of the elm, and for the galls produced by *Tetraneura Ulmi*, are practically the same in darkness; but in light, in an atmosphere containing 8 per cent. of carbon dioxide, for the same volume of this gas absorbed, much less oxygen is evolved by the galls than by the sound leaves.—J. **Winter**: Remarks on the gastric acidity. There is no uniform type of gastric juice, its composition depending on the food taken, the psychic state, &c. There is no direct connection between the production of gastric juice and that of its acid constituents.—H. **Labbé** and L. **Violle**: Elimination of aminoid nitrogen in depancreatised dogs. In depancreatised dogs the ratio of the urinary amino-acid nitrogen to the total nitrogen of the urine is about four times as great as for normal animals.—P. **Magitot**: The possibility of preserving the human cornea in a living state after removal from the body. A human eye, removed in a case of glaucoma, was kept for eight days in hæmolysed human serum, the cornea, previously opalescent, gradually regaining its transparency. Part of this cornea was then grafted into another patient's cornea which had become entirely opaque owing to an accident. The transplanted cornea has retained its transparency after seven months, and the vision is one-tenth normal.—Robert **Lévy**: Relation of arachnolysin to the female genital organs of spiders.—Maurice **Arthus**: Intoxication by venoms and by proteids. The effects of snake poisons on rabbits closely resemble those of anaphylaxis, therefore a rabbit sensitised by injection of proteid material should be rendered more sensitive to snake venoms, and *vice versâ*. This is found to be the case. The venom of the cobra has two distinct actions, one an effect common to snake poisons, the other a curare-like action confined to the venoms of a restricted number of snakes.—L. G. **Seurat**: The life-cycle of the Spiroptera of the dog.—F. **Picard**: The biology of the potato-moth (*Phtorimaea operculella*) and its occurrence in France. This moth, which inflicts great damage on the potato crop in the United States, Australia, and other parts of the globe, has lately appeared in various districts in France, but so far its distribution there is not wide. Disinfection with carbon bisulphide appears to be the only remedy.—A. **Quidor**: Torsion of the Lernæidæ, and their affinities to Sphyrion and Hepatophylus.—Louis **Gentil**: Geological observations on the route of General Moinier's column between Fez and the Atlantic Coast.—E. A. **Martel**: The cañon of the Rhone.—Alfred **Angot**: Value of the magnetic elements at the Observatory of Val-Joyeux to January 1, 1912.—Alfred **Angot**: Mean value of the cloudiness at the time of the forthcoming total eclipse of the sun. The chances for and against fine weather along the central line in France on April 17 have been arrived at from consideration of the weather, at Paris and Nantes, for the period April 15 to 19 during the twenty years 1891–1910. The unfavourable cases exceed the favourable by nearly 2 to 1.

January 15.—M. Lippmann in the chair.—B. **Baillaud**: The catalogue of stars published by M. Cosserat, director of the Observatory of Toulouse. Remarks on vol. viii. of the "Annales de l'Observatoire de Toulouse."—Émile **Picard**: A general theorem relating to

uniform functions of one variable connected by an algebraical relation.—E. **Vallier**: The present position of the ballistic problem. A *résumé* of the formulæ that have been proposed to connect the air resistance with the velocity of a projectile.—Auguste **Righi**: Sparks in rarefied air and under the action of a magnetic field. The effect produced is illustrated by a photographic reproduction; an illustration of a special form of vacuum tube is also given, by means of which the mechanical effects of the spark in gases under reduced pressure have been studied.—The secretary announced the death of Jacob Amsler, correspondant for the section of mechanics.—J. **Hadamard**: A question relating to viscous liquids. An acknowledgment of priority to a paper by M. Rybczynski.—Louis **Roy**: The general equations of flexible membranes.—M. **de Broglie**: The observation of the Brownian motion in gases at low pressures. Working with fumes of phosphorus in air at about 1 mm. pressure, the independence of the Brownian motion and the pressure has been approximately verified for pressures between wide limits, but starting from a certain pressure (some millimetres of mercury) the agitation tends to increase.—C. **Loenhardt** and A. **Boutaric**: Cryoscopy in sodium thiosulphate crystallised with five molecules of water. A direct determination of the latent heat of fusion calorimetrically gave L=47·9 at the temperature 48·5°, and using this value in the van 't Hoff formula, the molecular lowering found is K=42·8. The direct determination of K with urea as the solute gave K=42·6. It is important that the solvent should contain water of crystallisation corresponding exactly with the formula $Na_2S_2O_3.5H_2O$, and details of the method of working are given.—Eugène **Wourtzel**: A new determination of the atomic weight of nitrogen. The method is based on the determination of the weight of oxygen required to convert a known weight of nitric oxide into the peroxide N_2O_4. Five experiments gave N=14,007 (O=16), the extreme values being 14,005 and 14,008.—A. **Besson**: The preparation of magnesium silicide and its decomposition by acids. A study of the reaction between magnesium powder and finely divided quartz, and of the conditions giving a maximum yield of magnesium silicide. Hydrochloric acid was found to be the best acid for attacking the silicide, the maximum yield of hydrogen silicide obtainable being from 6 per cent. to 7 per cent.—L. **Hugoneng** and A. **Morel**: The combinations of chromium hydroxide with the amino-acids derived from the albumens.—A. **Guyot** and A. **Kovache**: The action of formic acid upon the triarylcarbinols. Triphenylcarbinol $(C_6H_5)_3.C(OH)$, heating with 20 times its weight of anhydrous formic acid, is quantitatively reduced to the hydrocarbon triphenylmethane, and the reaction is general for triarylcarbinols.—A. **Tison**: The dichotomic nervation in the Conifers. Dichotomy is shown to be the normal mode of ramification in certain appendices of Conifers.—G. **Arnaud** and Ed. **Foëx**: The form of Oïdium of the oak in France.—A. **Marie** and Léon **MacAuliffe**: The morphological characters of 61 French murderers and suicides.—A. **Magnan**: Food and the length of the intestine in mammals. Results of the dissection of 280 mammals show that the nature of the food is an important factor in the evolution of the alimentary canal.—M. **Bizot**: The brachio-antibrachial in the Cheiroptera.—Mlle. E. **Peyrega** and F. **Vlès**: An oxyhæmoglobin band in the ultraviolet spectrum of blood. This band, in position near Cd 12, was first noted by Soret in 1883, but its existence has since been denied by many investigators. The authors' investigations confirm those of Soret, and they consider that the negative results obtained subsequently were due to too rapid variations of the concentration.—E. **Vasticar**: The structure of the internal pillars of Corti's organ.—A. **Trillat**: The influence of the gases evolved by putrefying organic substances on the growth of bacteria.—Paul **Vuillemin**: A human parasitic fungus, *Glenospora graphii*.—P. **Chaussé**: A new distinctive character of the human and bovine tubercle bacillus. The domestic animals, dog and cat, contract tuberculosis much more easily from the bovine tubercle bacillus than from that of human origin.—J. **Bridré** and A. **Boquet**: Vaccination of sheep against scab by means of a specially prepared virus. The process of preparing the modified virus is described in detail, and from the results of experiments on 300 sheep the method would appear to be of general application. It has several advantages over the method in current use, the main one being that the closed local lesion is not contagious.—F. **Kerforne**: The nature and origin of the iron minerals of the forest of Lorges (Côtes-du-Nord).—Émile **Haug** and Léon **Bertrand**: The geological structure in the north of the department of Var.—J. **Vallot**: The measurement of the subterranean excavation produced by the spring of Fon Tréboula.—M. **Thoulet**: A bathy-lithological map of the sea floor on the coasts of the Gulf of Lyons.

NEW SOUTH WALES.

Linnean Society, November 29, 1911.—Mr. W. W. Froggatt, president, in the chair.—P. **Cameron**: A collection of parasitic Hymenoptera (chiefly bred) made by Mr. W. W. Froggatt in New South Wales, with descriptions of new genera and species. Part ii. Five genera and nineteen species of the family Chalcididæ are described as new. The type-specimens of three species were bred from the codlin-moth.—R. E. **Turner**: A revision of the Australian species of the genus Cerceris (Hymenoptera). Eighteen species, including one described as new, are treated of. The types of all the species, except the common *C. australis*, Sauss., have been consulted. The dry conditions prevalent over a large part of Australia are eminently suitable for the members of the genus. Nevertheless, it may prove not to be so well represented as in North Africa and India, for the section of the genus, characterised by a raised plate at the base of the second ventral segment, seems to be entirely absent from Australia.—Dr. R. **Greig-Smith**: Contributions to a knowledge of soil-fertility. No. iv. The agricere and bacterio-toxins of soil. Soils which have been heated to 65°–75° in order to kill off the phagocytic protozoa of Russell and Hutchinson give a greatly increased bacterial growth after treatment with the volatile disinfectants or fat-solvents. This effect is obtained with the soil-bacteria and with added test-bacteria. The treatment with disinfectants, therefore, does something more than destroy the protozoa. One is justified in ascribing the effect to the translation of the agricere by the behaviour of the various layers of the soil, following the treatment with ether or chloroform. The top layers, which contain most translated agricere, give lessened bacterial growths, and, conversely, the lowest layers produce greater numbers of bacteria than the intermediate soil. The action of the agricere cannot be so clearly shown in soils heated at higher temperatures, on account of the disturbing influences of the natural toxins and the heat-toxins of Pickering. The volatile disinfectants have no action upon the toxins of the soil, either in destroying or translating them. The enhanced bacterial growth after chloroform treatment could not be credited to traces of disinfectant remaining in the soil. It was noted that an abnormally toxic soil became normal after heavy rains, and experimental work showed that the toxins were washed from the upper into the lower layers.—D. **McAlpine**: The fibro-vascular system of the pear (pome). After maceration in water for five days, the elaborate fibro-vascular system may be satisfactorily displayed. It has the same general plan as that of the apple, described in detail in a paper read at the last meeting.—A. B. **Walkom**: Note on a new species of Favosites from the Yass District, N.S.W. The fossil coral described occurs in the Silurian beds of Derrengullen Creek, near Yass, together with *F. gothlandica*, Lam., and *F. basaltica*, Goldfuss, var. *salebrosa*. It is more nearly allied to the former, but has the corallite tubes generally larger, the tabulæ more closely spaced, the septa more regularly arranged and shorter, and the mural pores usually in three vertical rows.

BOOKS RECEIVED.

A Dictionary of Applied Chemistry. By Sir Edward Thorpe, C.B., F.R.S., assisted by eminent contributors. Revised and enlarged edition. Vol. i. Pp. viii+758. (London: Longmans and Co.) 45*s*. net.

Papers and Proceedings. Fifth Annual Meeting, American Sociological Society, held at St. Louis, Mo., December 27–30, 1910. Vol. v. Pp. vi+267. (Chicago: University of Chicago Press; Cambridge University Press.)

Scientific Features of Modern Medicine. By Prof. F. S.

Lee. Pp. vii+183. (New York: Columbia University Press; London: H. Frowde.) 6s. 6d. net.

Sea Fisheries: their Treasures and Toilers. By Prof. M. A. Hérubel. Translated by B. Miall. Pp. 366. (London: T. Fisher Unwin.) 10s. 6d. net.

Maryland Geological Survey. Lower Cretaceous. Pp. 622. (Baltimore: Johns Hopkins Press.)

Forest Physiography: Physiography of the United States and Principles of Soils in relation to Forestry. By Dr. I. Bowman. Pp. xxii+759. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd.) 21s. net.

Handbuch der Pharmakognosie. By A. Tschirch. Lieferung 22–28. (Leipzig: C. H. Tauchnitz.) 2 marks each.

Physico-chemical Calculations. By Dr. J. Knox. Pp. viii+188. (London: Methuen and Co., Ltd.) 2s. 6d.

Technical Arithmetic and Geometry. By C. T. Millis. Second edition. Pp. xvi+299. (London: Methuen and Co., Ltd.) 3s. 6d.

A First Year Physical Chemistry. By Dr. T. P. Hilditch. Pp. xx+176. (London: Methuen and Co., Ltd.) 2s.

J. H. Van't Hoffs Amsterdamer Periode, 1877–1895. By Drs. W. P. Jorissen and L. Th. Reicher. Pp. 106. (Helder: C. de Boer, jun.)

A Junior Course of Practical Zoology. By the late Prof. A. Milnes Marshall, F.R.S., and Dr. C. H. Hurst. Seventh edition. Revised by Prof. F. W. Gamble, F.R.S. Pp. xxxvi+515. (London: Smith, Elder and Co.) 10s. 6d.

The Great Star Map. By Prof. H. H. Turner, F.R.S. Pp. vi+159. (London: J. Murray.) 2s. 6d. net.

Heredity and Society. By W. C. D. Whetham, F.R.S., and C. D. Whetham. Pp. viii+190. (London: Longmans and Co.) 6s. net.

The Principle of Individuality and Value (the Gifford Lectures for 1911). By Dr. B. Bosanquet. Pp. xxxvii+409. (London: Macmillan and Co., Ltd.) 10s. net.

Fourth Report of the Wellcome Tropical Research Laboratories at the Gordon Memorial College, Khartoum. Vol. B.—General Science. By Dr. A. Balfour and others. Pp. 333. (London: Baillière, Tindall and Cox.) 18s. net.

Cocoa and Chocolate: their Chemistry and Manufacture. By R. Whymper. Pp. xi+327. (London: J. and A. Churchill.) 15s. net.

American Permian Vertebrates. By Prof. S. W. Williston. Pp. 145+plates. (University of Chicago Press; Cambridge University Press.) 10s. each.

Jelineks Psychrometer-Tafeln. Anhang: Hygrometer-Tafeln. By J. M. Pernter. Sechste, erweiterte Auflage. Pp. xii+128. (Leipzig: W. Engelmann.) 7 marks.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 25.

ROYAL SOCIETY, at 4.30.—Determination of the Co-efficient of Interdiffusion of Gases and the Velocity of Ions under an Electric Force, in terms of Mean Free Paths: Prof. J. S. Townsend, F.R.S.—Note on the Scattering of α-Particles: Dr. H. Geiger.—The Effect of Temperature upon Radioactive Disintegration: A. S. Russell.—On the Relation between Current, Voltage, Pressure, and the Length of the Dark Space in Different Gases: F. W. Aston and H. E. Watson.—On the Viscosities of Gaseous Chlorine and Bromine: Dr. A. O. Rankine.—The Testing of Plane Surfaces: Dr. P. E. Shaw.—Antelope Infected with *Trypanosoma gambiense*: Captain A. D. Fraser, R.A.M.C., and Dr. H. L. Duke.

ROYAL INSTITUTION, at 3.—The New Astronomy: Prof. A. W. Bickerton.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Heat Paths in Electrical Machinery: Miles Walker and H. D. Symons.

FRIDAY, JANUARY 26.

ROYAL INSTITUTION, at 9.—The Pressure of a Blow: Prof. B. Hopkinson, F.R.S.

PHYSICAL SOCIETY, at 5.—Exhibition of a Direct-reading Instrument for Submarine Cable and other Calculations: R. Appleyard.—On the Vibration Galvanometer and its Application to Inductance Bridges: S. Butterworth.—Note on a Negative Result connected with Radio-activity: J. H. Vincent and A. Bursill.—On Sealing-metals: Dr. P. E. Shaw.—Krypton and the Auroral Spectrum: T. W. Page.

SATURDAY, JANUARY 27.

ROYAL INSTITUTION, at 3.—The Banyoro: A Pastoral People of Uganda: (2) Birth and Death Customs; Rev. J. Roscoe.

ESSEX FIELD CLUB (at the Essex Museum, Stratford, Essex), at 6.—Weather Observations in connection with the Work of the Essex Field Club: William Marriott.

MONDAY, JANUARY 29.

ROYAL SOCIETY OF ARTS, at 8.—Ocean Waves, Sea-beaches, and Sand-banks: Dr. Vaughan Cornish.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Exploration in the Canadian Rockies: Prof. J. Norman Collie, F.R.S.

INSTITUTE OF ACTUARIES, at 5.—The Investment of Life Assurance Funds: G. E. May.

TUESDAY, JANUARY 30.

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

ROYAL SOCIETY OF ARTS, at 4.30.—Irrigation in South Africa: W. A Legg.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Central Heating- and Power-plant of McGill University, Montreal: R. J. Durley.

WEDNESDAY, JANUARY 31.

ROYAL SOCIETY OF ARTS, at 8.—Recent Progress in Radio-telegraphy: Prof. G. W. Osborn Howe.

THURSDAY, FEBRUARY 1.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* The Bacterial Production of Acetylmethylcarbinol and Butylene Glycol from Various Substances: Dr. A. Harden, F.R.S., and Miss D. Norris.—On the Distribution of the Nerves of the Dental Pulp: J. H. Mummery.—A Method for Isolating and Cultivating the Mycobacterium Pseudo Tuberculosis enteritidis bovis Jöhne, and some Experiments on the Preparation of a Diagnostic Vaccine for Pseudo Tuberculosis enteritis of bovines: F. W. Twort and G. L. Y. Ingram.—On the Fossil Flora of the Forest of Dean Coalfield (Gloucestershire), and the Relationship of the Coalfields of the West of England and South Wales: E. A. N. Arber.—The Chemical Action of Bacillus Cloacæ (Jordan) on Glucose and Mannitol: J. Thompson.—Simultaneous Colour Contrast: Dr. F. W. Edridge-Green.

LINNEAN SOCIETY, at 8.—Fourmis des Seychelles reçues de M. Hugh Scott: Prof. A. Forel.—Tipulidæ from the Indian Ocean: F. W. Edwards.—Sciaridæ, mit einem Anhang von Dr. J. J. Kieffer (Beschreibung neuer Sciariden von den Seychellen Inseln): Dr. Günther Enderlein.—Ichneumonidæ from the Indian Ocean: C. Morley.—New Fishes from Aldabra and Assumption, collected by Mr. J. C. F. Fryer: C. Tate Regan.

ROYAL INSTITUTION, at 3.—The Phenomena of Splashes: Prof. A. M. Worthington, C.B., F.R.S.

FRIDAY, FEBRUARY 2.

ROYAL INSTITUTION, at 9.—Vital Effects of Radium and other Rays: Sir J. M. Davidson.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Steam-turbines: Some Practical Applications of Theory: Captain H. Riall Sankey, R.E.

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