THURSDAY, APRIL 21, 1898.

A NEW DEPARTURE BY THE RAY SOCIETY.

The Tailless Batrachians of Europe. Part i. By G. A. Boulenger, F.R.S. Pp. 210. (London: The Ray Society, 1897.)

THE publication of this elegant treatise marks an event in the history of the Ray Society upon which its members, so long content with a diet of insects, are to be heartily congratulated. Of the 210 pages of the work, 121 are devoted to an "Introduction" in which the classification, taxonomic characters, skeleton, viscera, habits, and reproduction of the Batrachia Ecaudata are successively dealt with on broad lines, special sections being added on hybrids and geographical distribution. The remaining ninety pages are devoted to a systematic treatment of the Discoglossidæ and Pelobatidæ (*i.e.* of eight of the twenty European species which the author admits), in which specific diagnoses, geographical varieties, the skeleton, habits, eggs, tadpole, and habitat, are categorically dealt with in popular but trustworthy terms. This arrangement has involved the author in an amount of repetition, but owing to the judicious placing of the seventy-seven processed drawings which adorn the work, all suspicion that this may be needless disappears, text and illustrations being found to supplement each other in accordance with a well-conceived plan. In addition, there are two maps and ten plates, six of the latter being admirable examples of the chromo-lithographer's art, of which it is praise sufficient that the author declares them to have fully satisfied his aspirations. The classification adopted is that of Cope, as emended by the author in the course of five-and-twenty years' experience, its leading feature being the grouping together of the genera *Alytes*, *Bombinator*, and *Discoglossus*, as a family (the Discoglossidæ) having well-defined and lowly affinities, which all recent investigation has confirmed. Mr. Boulenger is the foremost among the world's younger herpetologists, and in knowledge of his experience acquired during the custody of the world's greatest collection of reptiles and batrachians, of his devotion to his calling, and of his well-tried judgment, expectation ran high on the announcement of the work. It has been realised; suffice it to say that the book marks an epoch in the popularisation of zoological science, and must take its place in history beside the memorable works of Rösel von Rosenhof and Spallanzani, "Die in Deutschland lebenden Saurier" of Leydig, and others of the kind. It abounds in original observation and teems with enthusiasm, and without it no zoological library worthy the name can be complete.

The section dealing with the viscera is somewhat less satisfactory than the rest, but it is fair to the author to remark that he purposely excludes a general description of the "internal soft anatomy," and confines his attention to the "structure of the lungs and urogenital apparatus," which he regards as "of special importance from the point of view of the systematist." He in this way leads up to his morphological *tour de force*, in which (Sections 9 and 12 more particularly) he deals in an altogether masterly manner with the breeding habits and metamorphosis, earlier published papers upon which have rendered him famous. And in this connection it is particularly noteworthy that an observer of such ripe experience should pronounce against the popular ideas concerning the significance of the tadpole stage. Believing, as we do, that the conception of the frog's climbing up its own phylogenetic tree is erroneous, and that in the recognition of characters expressed in the term "derotrematous," in respect to which condition some living Batrachia are veritable fishes, far-reaching generalisations founded on the piscine resemblances of the tadpole are superfluous and have been misleading, we hail with much satisfaction the author's assertion that "larval forms such as the tadpoles are outside the cycle of recapitulation."

The only call for revision which we note is in the terminology, and that more particularly anatomical. The usage of the terms "epicoracoid" and "sternum" is regrettable, since the former, as an independent element of the shoulder-girdle, has no existence in the Batrachia, and in them the latter is known to be no derivative of the costal skeleton. "Abdominal cavity" is equally inexpressive, and the application to the vertebræ of the term "dorsal"[1] (still so barbarously retained for the thoracic of the amniota) is wrong. The description of the os cruris on one page as the "crus or tibia" and on another as the "tibia-fibula," like that of the investment of the ovum as a "gelatinous envelope" and a "sticky mucilage," is contradictory; while the reference to the fronto-parietals of *Pelobates*, on p. 35, is incomplete, by lack of insertion after "in" of the words "the adult." "Articulary balls" is amusing in its unconventionality, and "adhesive sub-buccal apparatus" is needlessly involved. The description of the so-called external type of vocal-sac as occurring in *Rana*, involving "a diverticulum of the mylo-hyoid muscle" and the said "slits at the sides of the throat," is calculated to convey a wrong impression of the facts, and error appears most seriously to have crept into the account given of the genital ducts of the males, in a manner alluded to below, for which it will be seen the author is little to blame.

The above-named are but trivial defects and unfortunate modes of expression, which in no way detract from the merits of the book. The author in his preface deplores the fact that few persons share with him a fondness for the Batrachia Ecaudata, and it must be admitted that, with the Teleostean Fishes and other groups of animals forming culminating series in definite lines of modification, these have been largely neglected by recent investigators, who, fascinated by the lowly and more generalised, have put them aside as useless in their specialisation. The study of the Teleostei is now setting these persons right on fundamentally important topics, and we claim that the remarks appended to this review justify the assertion that in the study of the despised Anura there lies the settlement of that which is to-day one of the most vexed questions concerning the genital ducts of the vertebrata. And tempted thus to speculate

[1] "Presacral" is the only term by which these can be accurately described in the Batrachia.

upon what remains to be ascertained about mere frogs and toads, the mind reverts to their mechanism of accommodation for vision within and without the water, our knowledge concerning which is an absolute blank. If we may judge by analogy to the inanimate, displacement of the lens of an altogether remarkable order must take place, and there is thus opened up a line of investigation of absorbing interest alike in its morphological, physiological, and physical aspects, in which, to say the least, there probably lies the explanation of the remarkable series of accessory eye-muscles which these animals possess.

That a great deal remains to be done in the study of these familiar creatures is certain. The author has produced a masterly treatise upon their classification and distribution, upon which he is now a leading authority. He deals with a subject historically associated in a prominent manner with the labours of English-speaking zoologists, and tells us that he will be content if those who use the book may derive from the perusal of its pages one-tenth of the pleasure it has given him to write them. His preface, in which this sentiment occurs, is positively infectious in its enthusiasm, force of personal example, and love of science for its own sake; and neither he nor we could desire more of his book than that it might stimulate to action some one who should in turn succeed him as a foremost authority upon the group of animals with which it deals.

Concerning the vestigial portions of the urinogenital apparatus above referred to, the author, relying only upon macroscopic characters and following Spengel, has described the duct which in *Alytes* receives the vasa efferentia as Müllerian; and he regards the vesicula seminalis in all forms as a derivative of that. He omits mention, however, of the vestigial Müllerian duct of the male *Rana*, which, though exceedingly delicate, is usually present; and this is the more regrettable, since Marshall proved microscopically that it skirts the outer border of the vesicula as an independent tube. The relationships of the vesicula to the so-called "ureter" in *Rana*, and to the presumed Müllerian duct in *Alytes*, the alleged homology of which has been challenged, are thus seen to be identical, wherefore the latter would appear to represent the Wolffian duct proper, and the so-called "ureter" of the Anura either a specialised portion of that, or an independent duct arising from the kidney, as might well be from the condition in *Alytes* and some Urodela. Comparative embryologists will not need to be reminded that a precisely similar difficulty besets the interpretation of the corresponding parts in the Elasmobranch fishes, and as concerning the Anura more particularly the whole matter, anomalous to an unparalleled degree on the Spengelian interpretation, apparently harmonious and exceptionally instructive by extension of Marshall's observation, demands renewed microscopic inquiry. Indeed, to the present writer it has long appeared that the male genitalia of *Alytes* and *Discoglossus*, as here interpreted, conform to a type transitional between that of the Urodela in which a fully-developed Wolffian body, differentiated into a sexual and a renal portion, is present, and of the higher Anura, in which the homologue of the renal part receives the vasa efferentia, and to justify the conclusion that the latter condition is secondary and associated with the suppression of the sexual part. And if this be so, an additional argument will have been furnished for the lowly affinities of the Discoglossidæ. G. B. H.

PREHISTORIC CIVILISATION IN EGYPT.

Recherches sur les Origines de l'Égypte. Ethnographie Préhistorique et Tombeau Royal de Négadah. Par J. de Morgan. Avec la collaboration de MM. Wiedemann, Jéquier, et Fouquet. Pp. x + 395. (Paris: Leroux, 1897.)

THE large section of the scientific public which is interested in prehistoric remains will, we are sure, cordially welcome the second part of M. de Morgan's work on "Les Origines de l'Égypte," which is now before us. Every reader of the first part waited, we fear with some impatience, for the supplementary facts which were known to be forthcoming; and now that they are in our hands, it is more possible to judge of the general effect of M. de Morgan's recent discoveries upon the sciences of archæology and anthropology. For some years past the natives of Upper Egypt have been offering numbers of curious objects for purchase to the tourist and wandering Egyptologist, and the said objects were so remarkable from artistic and other points of view, that more than one archæologist have pronounced them to be forgeries. That these objects came from several different places in Upper Egypt was quite certain, but it was hard to believe the fact, and most people, whatever they said, privately thought the statements of the natives to be unbelievable.

M. de Morgan was the first to find the solution of the difficulty, and now he has triumphantly proved that these strange objects do really come from a number of sites which extend along the Nile Valley from Cairo on the north to Wady Halfa on the south, and that they represent the remains of a people who occupied Egypt before the Egyptians who have hitherto been known to us from inscribed statues, temples, &c. In the second chapter of the present volume of his work he gives a list of these sites, and it may be considered the most important section of his book; it is much to be hoped that now circumstances have obliged him to transfer the field of his labours to Persia, others, whether they be English or French, may take steps to examine by means of systematic excavations the sites of which he has given us such a full list.

But though M. de Morgan has not been alone in making researches concerning the history of the remote period in which these sites were occupied, and though Messrs. Petrie and Amélineau have collected much information from their excavations at Amrah, Ballas, and Nakada, it must not for one moment be imagined that all the questions connected with the prehistoric people of Egypt can be answered, or all difficulties solved. Nor can it be said whence this people came, or when they first occupied their stations in the Nile Valley; at present it is difficult even to find a name for them which will satisfy both M. de Morgan and Mr. Petrie. M. de Morgan, basing his opinion upon anthropological evidence adduced by Dr. Fouquet, as much as upon the archæological evidence which he himself has carefully sifted, has come to the conclusion that the people whose remains he has found are as old as any race known in the world, and that, in any case, they are the earliest inhabitants of Egypt. On the other hand, Mr. Petrie calls them the "New Race," which appellation, viewed in the light of the evidence given in M. de Morgan's book, is clearly wrong, and shows that Mr. Petrie did not understand the facts of the case.

According to M. de Morgan the word "Egyptian" signifies the man who migrated from Asia to Egypt, whose civilisation was peculiar to himself, and whose ethnic history is still unknown. Between him and his predecessor, whom we may call the aboriginal inhabitant, he draws a sharp distinction both mentally and morally, and the former was mesaticephalic and the latter dolichocephalic. It is important to note that the *indigènes* had smooth and fair hair, and that they belonged to the white race; thus the old theory that the Egyptians were of negro origin receives another blow, and incidentally it is quite clear that the Cush referred to in the Bible as the home of the Egyptian is not Ethiopia. In the chapter on the indigenous peoples of Egypt we have a most useful account of the various objects which have been found in the prehistoric sites, well illustrated by scores of woodcuts which will prove invaluable to those who have not the opportunity of studying the originals, and at the end is given a good account of the various methods of burial employed by the *indigènes* of Egypt.

In the earliest times the dead were buried without any attempt being made to mummify the body or to strip the bones of their flesh. Later, the flesh was stripped from the bones, which were then buried, frequently in great disorder; sometimes the body was simply hacked in pieces so that it might be packed easily in a small space. Still later, an attempt to preserve the body by mummification was made; for Dr. Fouquet has found traces of bitumen in the bones which he has examined. In the earliest tombs no metal objects have been found, but of those in which no instruments of iron and bronze have been discovered, the famous tomb at Nakada which M. de Morgan first excavated, and has described in the fourth chapter, is the best known example. It is, of course, quite easy to see from the remains of offerings found in the prehistoric tombs that the belief in a future life of those who made them was both well established and widely known. And if they believed in a future life it seems that they must of necessity have believed in a divine power, and to have the superstitions which take the place of religion among early peoples. The abominable practice of cannibalism which Mr. Petrie attributed to his "New Race," finds no support in the account which M. de Morgan has given of this people, and we agree with Dr. Verneau, who in discussing this subject says—

"Les faits allégués à l'appui de cette assertion s'expliqueraient tout aussi bien si l'on admettait simplement un décharnement à l'air libre, précédant l'ensevelissement définitif."

Mr. Petrie's sensational discovery therefore falls to the ground.

Space will not allow us to discuss the objects which M. de Morgan found in the tomb of Nakada, much less to refer to the interesting deductions made by M. Wiedemann from them; it must suffice to say that quite new light is thrown upon many well-known facts, and that many of our preconceived notions must be abandoned. Of special interest to the anthropologist is Dr Fouquet's minute description of the skulls of the *indigènes* of Egypt; the careful measurements, too, will be invaluable to him. Neither M. de Morgan nor Dr. Fouquet attempts to assign a date to the occupation of the land of Egypt by this people, and no guess is made at the length of its duration.

Though M. de Morgan's last work does much to settle the difficulties which his own discoveries have raised, many questions must, we fear, for some time remain open. But to him all students owe a big debt of gratitude, both for the careful way in which he has collected and stated his facts, and for the zeal with which he carried out his excavations; his work is of peculiar value from the fact that he never forgets his task as an expounder of facts so far as to become an advocate. The mere Egyptologist would have misread the evidence of the prehistoric graves because he never takes the trouble to realise that a good Egyptologist is not necessarily a good archæologist, and we must be thankful that for once the right work fell into the right hands. All will, however, regret that the French Government has removed M. de Morgan from Egypt to Persia, especially as they did so at the time when he was doing his best work.

A COUNTY FLORA.

The Flora of Berkshire. By George Claridge Druce. Pp. cxcix + 644. (Oxford: Clarendon Press, 1897.) [Published 1898.]

THIS volume is worth a review, for it has merits found in but few "Floras," and failings common to many.

In 1886 Mr. Druce published "A Flora of Oxfordshire"—a flora, except for the inclusion of some account of the lower plants, of the very ordinary type. In his second flora, while omitting the lower plants except *Characeæ*, he introduces in his critical notes on species a new feature. Every variation has a claim on the botanist's attention; and where can local varieties be better considered than in a local flora? It is a good feature in the book. And, further, the mania for names or for giving prominence to names does not offend. The varieties are usually mentioned in these notes in a way which gives an appearance of proportion to the enumeration, and so do not appear—undefinable gradations as they often are—in series like so many milestones along the road.

A county flora must always be considered from the dictionary standard. The main body is of necessity a work of reference. Viewed in this light, we find in the "Flora of Berkshire" merits and demerits. The division of the county into geographical areas is satisfactory, much more so than in the "Flora of Oxfordshire," where they are very unequal. In a level region, such as that of our Midland counties, there are no natural areas, unless they be made by the soil. To follow the outlines of the various formations, as Babington well did in his "Flora of Cambridgeshire," would for Berkshire be a difficult task; and Mr. Druce may not have done amiss in defining his regions by drainage. The result of his division is that every region contains some chalk, and consequently some of its characteristic vegetation.

An original dictionary is aggravating; and Mr. Druce is unwise in choosing, by his changes in nomenclature, to publish such. Of all places, except perhaps a seedsman's catalogue, such alterations could not be more out of place. And when he selects to give *Potamogeton* two genders he becomes pedantic. To expect a man with more common sense than leisure to inquire before writing the name of a species of this genus whether its author made it masculine or neuter, is to proffer him a fetter of a nature as galling as purposeless. It may be safely said that this is a demerit possessed by no other English county flora.

In the next place, a county flora must be considered as a geographical study. Great pains are usually taken to get together accurate facts (and this flora is no exception); but the builder tips up his bricks and mortar at your door, leaving the building to your own architectural fancy. As long ago as 1863, in Baker's "North Yorkshire," an admirable model was set, but no one has followed in the same lines. Mr. Druce in the introduction gives a long description of his districts, and long lists of the noteworthy plants, but in the summary he fails to point out any connection between these; he points out the soils of the county well—perhaps not so well as in Pryor's "Hertfordshire Flora"—but fails to summarise their effects on the plant formations; he has pointed out the deforesting of the land, but hardly notices its effects; and he has given us agricultural returns, and passes unnoticed the effects of agriculture. Surely such things should be the crowning of such a book—a bringing into one view the long arrays of facts which have gone before. It is a fault of most floras that they are wanting in this.

This "Flora of Berkshire" forms a thick volume of more than 800 pages; and it is not free from irrelevant remarks. For instance, the fossil shells of the Lower Greensand (p. xxxi) have no bearing on the subject; the history of the "Imp" stone (p. xlii) is out of place; most of the matter on river drainage (pp. xlvii–liii) is of little use; to be informed that the late M. A. Lawson compiled a MS. index to Jaeger's "Adumbratio" (p. clxxvii) is not of interest, and but poor salve to one who needs use those two cumbersome volumes; nor does it in the least benefit us to be told that Mr. Druce has been unable to elicit any reply from certain critical botanists.

Caution, too, is sometimes left behind. That *Elodea* is dying out by reason of the absence of the ♂ plant (p. 465) is merely a conjecture. A little knowledge of recent literature should have shown that *Nepeta Glechoma* var. *parviflora* (p. 402) is merely a condition. In fact, Mr. Druce's "Flora of Berkshire," founded on so much labour, deserved a careful revision before it went to press, and did not get it. It may rank with our best county floras in some ways; but most of these are far from approaching a high scientific standard. There is a tendency now to aim at more ambitious works than catalogues of "Phanerogams." The comprehensiveness of Purchas and Ley's "Flora of Herefordshire," the notice of the past vegetation of the peat in Hind's "Flora of Suffolk," the scattered biological notes of Scott-Elliot's "Flora of Dumfriesshire," and the critical remarks of Druce's "Flora of Berkshire" are good signs, which we hope may lead to better things. I. H. B.

AMONG THE ISLANDS OF THE PACIFIC.

Wild Life in Southern Seas. By Louis Becke. Crown 8vo. Pp. viii + 369. (London: T. Fisher Unwin. 1897.)

THE author of "Pacific Tales" and "By Reef and Palm" stands in no need of introduction either to the reader of fiction, or to the more serious-minded who seek for information upon a part of the world where the "personally-conducted" tour is as yet unknown. Mr. Becke, in virtue of his twenty-six years of wandering among the islands of the Pacific, has made himself an acknowledged authority upon most of them, from the Carolines to the Paumotus, and now that Major Sterndale is no longer with us, is probably better qualified to speak of this region as a whole than any person now living, though there are doubtless others whose knowledge of individual groups is more extensive. The volume before us is upon the same lines as "By Reef and Palm," a collection of reminiscences *per ci per là*, rather less full of deeds of bloodshed, perhaps, than the latter volume, and containing more of interest to the naturalist and ethnologist, but at the same time possibly not devoid of fiction, or at least of fact and fiction commingled. Some of the articles seem familiar to us; one at least, upon *Birgus latro*, has appeared in the columns of the *Field*.

The volume is one which will appeal especially to the sea-fisherman who has tasted of the delights of reef-fishing in Pacific waters, for half a dozen or more of the articles are devoted to this sport in one shape or another. The abundance of fish is not less remarkable than their variety. Mr. Becke tells us that in the Ellice group he has seen as many as twenty canoes loaded to sinking point in less than an hour; while, as for size, the *takuo*, a large species of albacore, reaches the weight of 120 lb. and more. Shark-fishing is no very novel amusement, perhaps, but catching flying-fish is a sport not so widely practised, and Mr. Becke's description of it is a vivid one. He has also done well in putting together his sketch of the history of whaling in the South Seas.

No new light is thrown upon the curious stone buildings and fortifications which exist over the length and breadth of the South Pacific, and have for so long puzzled archæologists, though Mr. Becke speaks of what are probably the most extensive of all—those on Espiritu Santo. Some interesting facts concerning population are given. It has now been known for some time that the extinction of these island peoples in consequence of the advent of the whites, formerly regarded as an immediate certainty, is not only not impending, but is never likely to occur, except by the process of fusion—that the census minimum has been reached, and that steady increase is the rule rather than the exception. Funafuti, the island lately visited by the coral-boring expedition, is a good example of this. About sixty or seventy years ago its population was estimated at 3000; in 1870 Mr. Becke counted only 160; and now it is said that there are over 500 inhabitants. Nanomaga, too, can scarcely be quoted as an example of the extinction of the native, for here, in an area of a square mile, we find a population of more than 600—a density only equalled by that of some of the islands of the neighbouring Gilbert group. It is to be hoped that the author of "Wild Life in Southern Seas" may some day put his knowledge of the islands into more regular and scientific form. F. H. H. G.

OUR BOOK SHELF.

Mediterranean, Malta, or Undulant Fever. By M. Louis Hughes, Surgeon-Captain Army Medical Staff. Pp. xi+232; figs. iv.; tables xv.; charts xx. (London: Macmillan and Co., Ltd., 1897.)

THE book before us is an exhaustive monograph upon an apparently, up to the present, neglected variety of continued fever, viz. Mediterranean or Malta fever. The author, at the beginning of the monograph, gives reasons why this fever should be regarded as a definite specific disease—distinct, on the one hand, from malarial and, on the other, from enteric fever, and suggests that it should in future receive the name of undulant fever. The term Mediterranean, Gibraltar, or Malta fever is, according to him, misleading, as apparently ascribing to the disease a geographical limitation which it does not possess.

In Chapter ii. a discussion will be found of the bacteriology of the disease. The author's observations, so far as the presence of a definite micro-organism, and the artificial production of the fever in monkeys are concerned, confirm Bruce's earlier results. Chapter iii. is devoted to symptomatology, and concludes with a description of the usual complications and sequelæ. In Chapter iv. the author discusses fully differential diagnosis, prognosis, and morbid anatomy. The final chapter is devoted to the consideration of prophylaxis and treatment. Two good indices conclude the volume.

The work will doubtless be of great service to those who are engaged in military or civil practice at Gibraltar or Malta, and must further be regarded as a valuable addition to the literature of continued fevers.

F. W. T.

Lehrbuch der Vergleichenden Mikroskopischen Anatomie der Wirbelthiere. Zweite Teil, Schlund und Darm. Von. Dr. Med. Alb. Oppel, a. o. Professor an der Universität Freiberg i.B. Pp. 681, with Plates. (Jena: Gustav Fischer, 1897.)

THIS volume is a worthy successor to its predecessor on "The Stomach," published in 1896, and we have nought but praise for it. At first sight it would appear well-nigh impossible that two such works could be successfully compiled in so short a time; but there is internal evidence that the book bears a direct relationship to a series of papers which its author has published during the last eight years, and that its preparation has been a prolonged labour of love. The present volume opens with a dissertation upon the structural plan of the alimentary canal and its derivatives, extending to thirty-one pages; and in the rest of the book the ordinarily recognised regions of the intestine, and the œsophagus, are successively dealt with in an exhaustive manner, structure and function being alike considered. The work closes with a 36-page alphabetical record of literature arranged according to authors' names. The mode of treatment of the subject, like that of the preceding volume on the stomach, is thoroughly systematic and logical; and while the pages of the book bristle with references to original authorities, its style is nowhere pedantic. Though termed a text-book, it is an exhaustive work of reference such as we believe the advanced scientific text-book of the future must become. There are 343 admirable text illustrations and four exquisite plates, well worthy the text and the immense labour its author has bestowed upon it. We note one or two omissions, as, for example, of all mention of the intestinal valve in the Teleostei (*Cheirocentrus*) and of Huxley and Parker's observations upon the cœcal and colic valves of *Lepus*. The fuller paper by Laguesse might have been referred to, as might the observations of Mazza and Perugia upon the rectal glands of *Chimæra* and other matters which could be mentioned. All that is really important, however, is recognised. The work fills a gap in our literature, and to its author students and teachers stand alike indebted for a masterly treatise which will long remain the standard book of reference upon the subject with which it deals.

Spectrum Analysis. By John Landauer, LL.D. Authorised English edition by J. B. Tingle, Ph.D., F.C.S. Pp. 239 + x. (New York: Wiley and Sons. London: Chapman and Hall, 1898.)

THAT there is a real need for a fairly comprehensive text-book of spectrum analysis of moderate size will be acknowledged by all who have occasion to teach the principles of the subject, or to employ its methods for analytical purposes. To meet this need appears to be the object of the book before us, though it does not claim to be exhaustive. The treatment of the subject is historical throughout, and there is a great number of useful references to important memoirs, while particulars of the spectra of elements and compounds occupy nearly one-third of the volume. As a general text-book of the subject, apart from its astronomical applications, the book has much to recommend it; but it leaves a great deal to be desired as a guide to the practical details of spectroscopic work, which, as the translator remarks, "furnishes so many opportunities for an excellent training in accuracy of observation and manipulative skill." The lack of the practical touch is frequently indicated. In the table of magnesium lines (p. 143), for example, the lines of the arc and spark spectrum are grouped together, and the omission of the most striking line of the latter at λ 4481, possibly for the reason that it is all but invisible in the arc, might cause much loss of time to a student who happened to observe this line and attempt to ascertain its origin. Again, there are no instructions for photographing spectra, although in the majority of cases this is by far the best method to adopt in practice. Least satisfactory of all, the whole subject of comparing observed with tabulated spectra is far too cursorily dealt with to be of real value to the practical student.

In various theoretical matters, such as the relationship of the lines of an element to each other, the subject-matter is well up to date; but, as already hinted, the astronomical applications are scarcely touched upon.

The illustrations call for little remark. Most of them are well-worn, and we especially regret that the author has seen fit to prolong the life of the feeble map of the solar spectrum on p. 187, which so inadequately represents Fraunhofer's beautiful original.

Tabellarische Uebersicht der Mineralien nach ihren krystallographisch-chemischen Beziehungen geordnet. Vierte Auflage. By P. Groth. (Braunschweig, 1898.)

THE fourth edition of the well-known tables of the Munich Professor closely resembles its predecessor in appearance and in general character, but has in reality been considerably modified. Each well-define d mineral group is now introduced by a general discussion of the chemical and crystallographic relationships, in place of the notes appended to each group in the earlier editions; and the crystal class to which each mineral belongs is defined. Thus the book, while preserving the form which is now so familiar to every student of mineralogy, is in reality much more of a treatise on mineral chemistry than it was before. In fact, it may be regarded as the most useful text-book on this subject available for a student. The researches of Penfield and of Clarke have thrown a flood of new light upon the chemistry of minerals, and Prof. Groth is, as is well known, never slow to incorporate the latest results of science in his books.

These tables are indispensable to the student, and of immense use to the systematic mineralogist: to the latter especially in those passages which express the critical views of an author of unrivalled experience and judgment upon minerals of obscure composition.

The following examples, chosen almost at random, will suffice to illustrate the modifications which have been introduced into the old classification. Pyrrhotite is now FeS, and is placed in the Wurtzite group; Lorandite, the new sulpharsenite of thallium, is placed with Miargyrite; Ilmenite has been removed from the Hæmatite group of oxides, and is classed with Pyrophanite as a titanate of iron, in consequence of recent observations by Penfield.

But it is needless to multiply examples. The book should be the handy companion of every mineralogist. It is only necessary that in this, as in former editions, the reader should bear in mind that rational formulæ in mineralogy are never free from the taint of speculation.

LETTERS TO THE EDITOR

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Sub-Oceanic Terraces and River Valleys of the Bay of Biscay.

WILL you allow me to add to my communication, which appeared in NATURE of March 24, regarding the results of investigations carried out by means of the Admiralty charts beyond the coast of the British Isles, a still further statement regarding the Bay of Biscay? The results are not less remarkable and suggestive of great changes of level than are those indicated by the soundings to the west of the British Isles, which I hope to describe in full at the meeting of the Victoria Institute on May 2. We have the same general physical contours: first, the Continental shelf, or platform, stretching out for a distance of over 100 miles along the northern edge of the bay, but narrowing southwards till along the coast of Spain it contracts to an average breadth of twenty to thirty miles. At its outer margin the shelf breaks off at the 200-fathom line in a grand escarpment, continuous with that of the British platform, and descending with a more or less steep descent to somewhat over the 1200-fathom line. Off Cape Ortegal the escarpment is almost precipitous, for the total descent of 7000–8000 feet is effected within a horizontal space of about four miles; from the base of the escarpment the ocean-floor, formed of calcareous ooze, stretches gradually away to depths of 2600 fathoms and upwards. The escarpment forms the natural boundary between the region of *Globigerina* ooze and the Continental platform of sand, mud and gravel with shells.

Lastly, the old channels of several of the river valleys can be distinctly traced when they approach and intersect the grand escarpment. This is remarkably so in the case of the Loire, the Adour, the Las Cubas and Caneiro rivers. The Adour passes out to the deep ocean through a continuous deep cañon or gorge of 100 miles in length—marked on the Admiralty chart at its upper end as "Fosse de Cap Breton." At a distance of thirty miles from the coast the bed of the cañon is about 3174 feet below the general level of the Continental shelf, and at a distance of sixty-two miles it descends to a depth of about 5442 feet below the same level. The cañon itself can be distinctly traced to the depth of 9000 feet (1500 fathoms), where it opens out on the oceanic floor, representing the feature known by American geologists as "the base-level of erosion"—in other words the limiting depth of river-erosion at the time when the land was elevated, and indicating the extent of the elevation as compared with the ocean level of the present day. The "embayments" of the other rivers mentioned can be traced to about the 1200-fathom contour. Such concurrence of evidence as regards the great up-lift, presumably reaching its maximum at the commencement of the Glacial Epoch, is conclusive in its testimony. The British and Continental platform was probably referable to the Mio-pliocene period. EDWARD HULL.

April 19.

Dust Fog in the Canaries.

IN amplification of the notice published in NATURE concerning the dust shower encountered by the *Roslyn Castle* off the west coast of Africa, I have the honour of sending you the following description of the phenomenon as experienced in the city of Laguna (Teneriffe), that I have received from Prof. Calvo, keeper of the Meteorological Station. I send also a summary of the meteorological register.

AUGUSTO ARCIMIS.

Instituto Central Meteorológico, Madrid, April 14.

From the first hours of the evening of February 15, there was observed a sensible but light fog; neither the strength of the wind (E. gentle breeze) nor any other phenomenon indicated that the supposed condensed vapours could be African dust transported by the air. As the night advanced, the force of the wind increased, until it reached the value of a moderate gale. At about 5 a.m. on the 16th, some large drops of rain fell, but were inappreciable in the rain gauge. For a very short time the wind subsided, by and by becoming again a gentle breeze during the day and blowing due E. The fog became more dense, causing depression and a disagreeable feeling produced by its dryness. The sun, on account of its light being pale and feeble without the usual rays, was confounded with the moon; and it reminded one of the light of a voltaic arc seen through a frosted glass. The flame of a match appeared with a very marked violet hue. The drinking waters became salty and coloured as by oxide of iron. The dust was grey and extremely fine, and deposited itself on every object.

On February 19, from the early morning the sky was again clear and transparent, and the wind was blowing from the N. and N.W.

Meteorological Observations taken at Laguna (Teneriffe), during the Dust Fog, in February 1898.

Feb.	Hours.	Barometer at 0° and sea level.	Thermometer (Dry).	Thermometer (Wet).	Humidity.	Evaporation.	Maximum thermometer.	Minimum thermometer.	Wind. Direction.	Wind. Force.	Sky.
					%						
11	9	766·2	14·3	11·0	66				N.	3	Blue
	3	764·5	21·0	15·0	49	1·5	21·2	6·0	S.	3	,,
12	9	766·1	20·0	12·7	38				N.	3	,,
	3	765·5	17·7	13·8	63	2·1	19·5	6·5	N.	3	Cloudy
13	9	766·9	14·3	12·0	75				N.	3	,,
	3	765·9	16·2	13·5	73	2 6	18·3	10·0	N.	3	,,
14	9	767·1	14·3	12·0	75				N.E.	3	,,
	3	764·7	15·7	13·0	72	1·8	19·0	9·0	E.	3	,,
15	9	765·4	14·4	10·3	56				E.	4	Overcast and foggy
	3	762·7	16·0	13·0	69	2·1	17·3	9·0	E.	7	,,
16	9	761·6	14·3	9·6	51				E.	4	,,
	3	760·2	16·3	12·0	57	2·4	17·8	10·0	S.E.	3	,,
17	9	763·2	14·0	10·7	61				E.	3	,,
	3	761·4	14·0	12·0	78	2·1	19·0	9·8	S.	3	,,
18	9	763·3	13·8	12·3	83				N.	3	Cloudy
	3	762·5	14·0	12·0	78	1·1	14·8	8·0	N.W.	3	,,
19	9	764·0	13·0	11·0	77				N.	1	,,
	3	763·0	14·0	12·8	86	1·1	15·0	9·0	N.	3	,,
20	9	765·1	12·8	10·2	70				N.	3	,,
	3	763·5	16·8	12·5	58	2·2	18·0	8·2	N.	3	,,

THE PHLEGRÆAN FIELDS.

THE fired rocks and hills of volcanic origin stand in so striking a contrast to those of aqueous origin, that they have exercised a very powerful influence on the thoughts of man in all ages. Frequently associated with such formations are the phenomena which we are accustomed to refer to as volcanic—"burning mountains," boiling springs, gaseous exhalations, terrifying noises—all shrouded with a mystery which demands explanation. Even in a locality in which the volcanic fires have been extinguished or have long remained quiescent, the peculiar configuration of the ground often keeps alive the tradition of former outbursts of subterranean fire, and the tradition usually supplies the explanation of the configuration. The ancient Romans, long before the awful catastrophe of A.D. 79, seem to have been quite aware that Vesuvius had not always been in a condition to support the rich cultivation which covered its slopes in their day. It is only in rare cases that the inquirer is rewarded by finding that the history of a heap of burnt soil is preserved; more often he will hear vague stories of the direful effects of prehistoric struggles of Cyclops or other mythological monsters.

In a recent research[1] I have endeavoured, by examining the marks with which the Phlegræan Fields are scored, like a much over-written palimpsest, to collect materials for a history of the alterations which the surface of the country has undergone. Within the Phlegræan Fields, west of Naples, only two volcanic structures have been formed within the historical period. For trustworthy information respecting all structures but the Monte Nuovo and the lava stream from the Solfatara we are entirely dependent upon the facts collected by the geologist and the geographer. In my work I was chiefly guided by the desire of estimating how far the existing superficial configuration or morphography of a volcanic region is an indication of the past history of its development. With this end in view purely topographical features, selected according to certain principles, were studied, and from them a theory of their origin and relative age was constructed. The results obtained by the method admit of being tested by the results of geological research whenever the latter is possible.

The importance of a method which will yield information respecting the past history of a volcanic country from a mere superficial examination is very considerable. The volcanic regions of the sea-bottom and of the moon are alike inaccessible to the stratigraphical geologist. The only kind of information obtainable is that respecting the superficial configuration; and therefore it is of the greatest importance that the value of a method which will enable us to utilise this information, in reading the records of the past, should be carefully estimated by experiment within the sphere of the geological critic.

The Phlegræan Fields are well suited for the trial of such a method, because within a small area the face of the country records the results of long-continued volcanic activity and of denudation both by sea and rain. Within an area of not much more than fifty square miles are collected the assemblage of volcanic vents and crater walls, the presence of which distinguishes the Campi Flegrei from the adjoining level plains of fertile volcanic soil of the Campagna Felice, stretching right away inland to the limestone slopes of the Apennines.

By far the most important topographical features within this region are composed of loose ashes or of compacted tufa. Lava-streams or heaps of lava characteristic of so many other volcanic regions cover but a small part of the surface of the country at the present day; in the future, no doubt, their harder, more resistent qualities will cause them to stand more prominent when the forces of denudation have removed the superincumbent layers of more readily erosible tufa.

Many of the hill forms are readily reducible to the simple type of a volcanic crater wall surrounding a crater, such as is naturally formed by fragmentary materials ejected from a vent and allowed to fall uniformly around that vent. In the Phlegræan Fields there are five almost perfect examples of such volcanic ring walls. Of these, Monte Nuovo is still to be seen in much the same condition as it was immediately after its eruption in September 1538. The Fossa Lupara, Solfatara, Astroni and Cigliano are hardly less perfect examples of typical volcanic craters. The topographical aspect of all is identical. In each a crater is entirely surrounded by an almost circular wall, which has a steep and sometimes precipitous crater-slope on the inside, but a more gradually inclined cone-slope on the outside.

FIG. 1.—Crater of Astroni from the North-East. In the distance is part of the crater wall of Archiagnano culminating in the Torre Nocera.

In addition to these hills, which are volcanic cones of the first rank of symmetry and preservation, there are others which are not less certainly volcanic cones produced in the same way, but which have had their symmetry marred by the removal of their flanks, either by marine erosion or by destructive eruption from an adjacent volcanic vent. The walls of the craters of Capo Miseno, Porto Miseno, Bacoli, Campiglione and Nisida, have all been more or less removed on the side turned towards the sea, and, with the exception of the Campiglione crater wall, are still being eroded away at the present time. The craters of Porto Miseno and Nisida are submerged, and being in communication with the open sea by breaches in their walls, afford good harbours for small vessels. The floors of the other craters are above sea-level. On the other hand, the

[1] "The Phlegræan Fields." By R. T. Günther. (*Geographical Journal*, 1897, vol. x. pp. 412–435, and 477–499, with 8 maps and 15 figures.)

crater walls of the Fondi di Baia, Lago d'Averno, and the two outer crater rings of the Cratere di Campana, fragmentary materials. In fact, there seems little reason to doubt their origin as segments of volcanic crater walls.

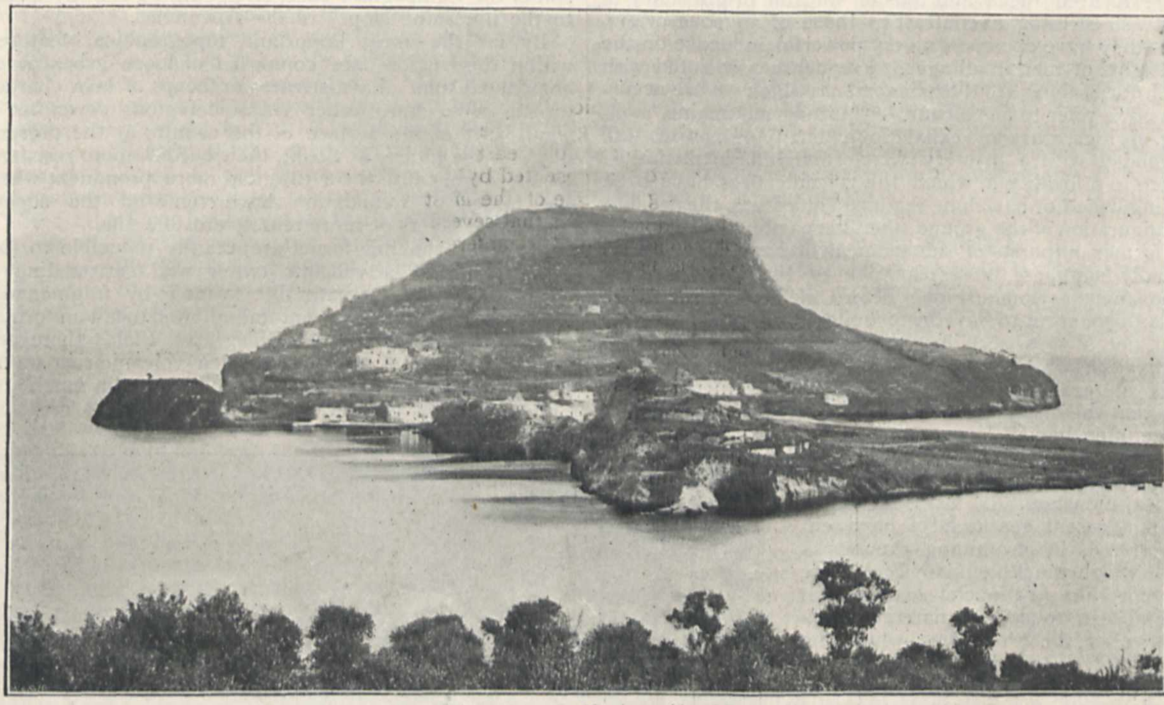


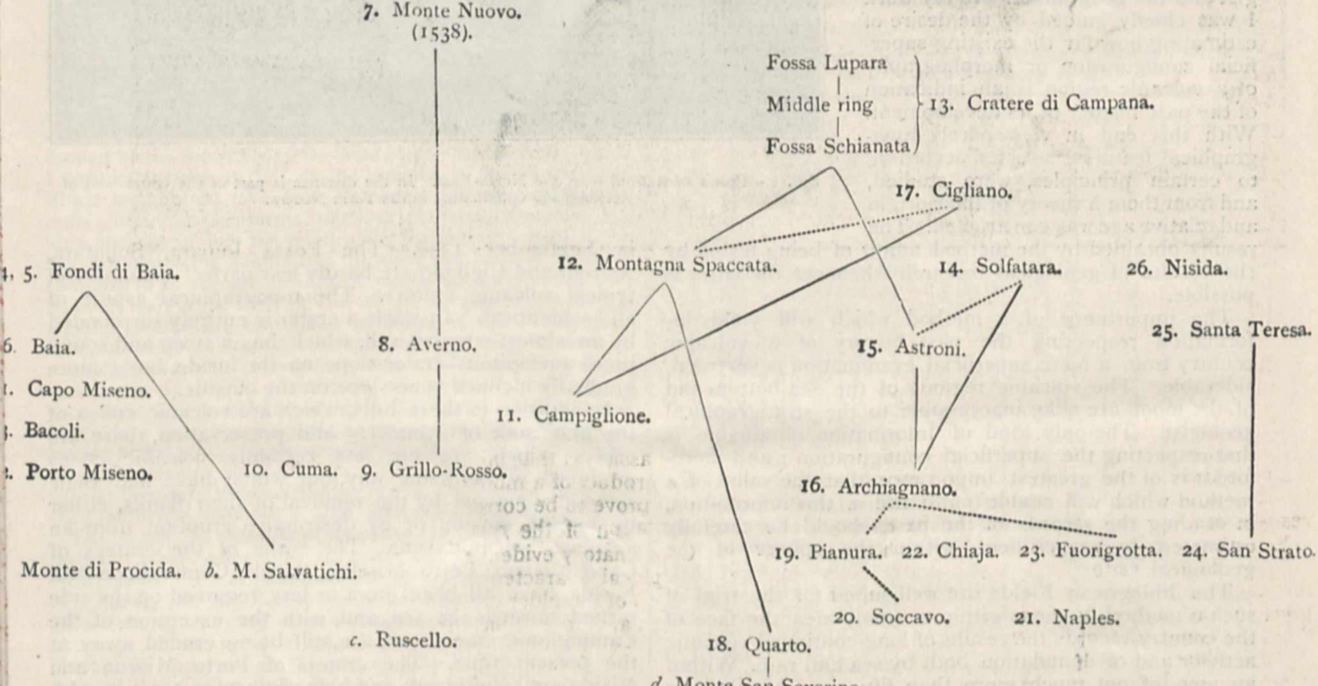
FIG. 2.—Capo Miseno from the Northern side of Porto Miseno.

have been partially obliterated by outbursts from other volcanic vents on or near their periphery.

In all these cases of partially destroyed crater walls, their shape on the whole agrees very well with that of the five perfect crater walls enumerated above, and with the generalised type of a volcanic cone composed of

Passing now from the hills which bear a more perfect resemblance to a typical crater wall to those in which the resemblance is less perfect, I have been led to adopt the following criteria as indications: firstly, of whether a hill can be regarded as a segment of a volcanic crater wall or not; and, secondly, of the position of the volcanic crater.

TABLE SHOWING SUPPOSED CHRONOLOGICAL ORDER OF FORMATION OF VOLCANOES OF PHLEGRÆAN FIELDS.



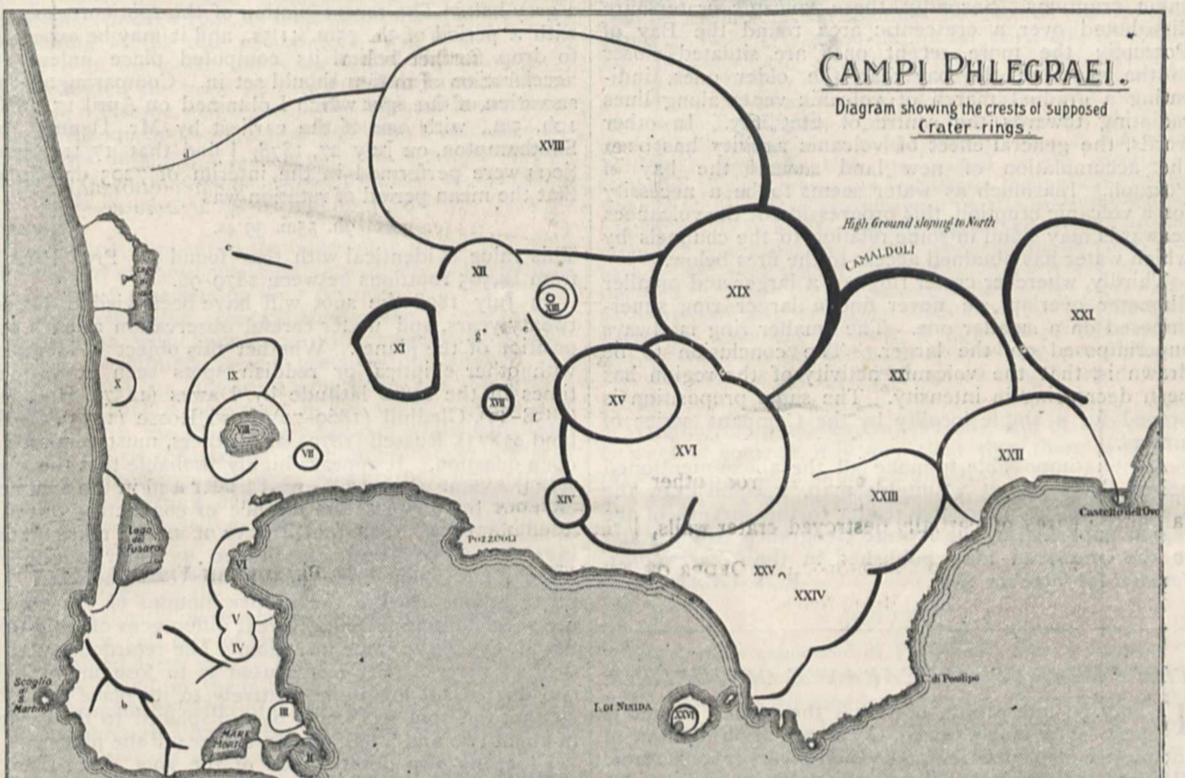
(1) If a hill is convex towards one side and concave towards the other, it is assumed that the crater which it formerly surrounded was situated on the concave side; and the radius of the crater at any level is indicated by the radius of the arc formed by the horizontal projection of the horizontal curve of the crater slope at the same level.

(2) A further indication of position is afforded by the fact that in almost every case the natural crater slope is much steeper than the corresponding cone slope.

(3) If arc-shaped hills be so situated that a curve approaching a circle can be drawn so as to pass along all their ridges, it is an indication that the hills are parts of one and the same crater wall.

to have once formed part of the walls of volcanic craters whose position is sufficiently well-indicated by the criteria enumerated above, are shown in the accompanying map. The map was constructed by drawing lines along the highest ridges of the hills enclosing undoubted volcanic craters, and then along those of less certain origin. The lines were then thickened according to a definite scale in which the breadth of line was made proportional to the height of the hill above sea-level. The highest hills in the north-east are over 1500 feet above sea-level, and are represented by the broadest lines.

One of the most striking features brought out in this map is that several of the crater-ring walls end abruptly in the circumference of others. Where this is the case



Explanation of Map.

I. Capo Miseno
II. Porto Miseno
III. Bacoli
IV., V. Fondi di Baia
VI. Baia
VII. Monte Nuovo
VIII. Lago d'Averno
IX. Monte Grillo, Monte Rosso
X. Cuma
XI. Campiglione
XII. Montagna Spaccata
XIII. 3 Cratere di Campana
XIV. Solfatara
XV. Astroni
XVI. Archiagnano
XVII. Cigliano
XVIII. Quarto
XIX. Pianura
XX. Soccavo
XXI. Naples
XXII. Chiaja
XXIII. Fuorigrotta
XXIV. San Strato
XXV. Santa Teresa
XXVI. Nisida
a. Monte Salvatichi
b. Monte di Procida
c. Monte Ruscello
d. Monte San Severino
e. Pacifico ridge
f. Astroni-Cigliano ridge
g. Crisci mound

(4) In the Phlegræan Fields there is nothing more common than to find volcanic cones denuded on the side facing the sea. It is, therefore, probable that the last vestiges of a volcanic crater ring will be on the land side.

Examined with especial regard to these points, the hills of Baia, Monte Grillo and Monte Rosso, Cuma, Montagna Spaccata, and many others admit of interpretation as segments of volcanic crater walls. Lastly, there are some hills which may possibly be remnants of volcanic cones; but if they are, they are so worn and denuded that I have not been able to assign any position on satisfactory evidence to the vent from which they have been erupted.

The hills of the Phlegræan Fields which are considered

it is assumed that the crater wall ending in the other is the product of a more ancient eruption. If this assumption prove to be correct, we have a very easily observable indication of the relative ages of the intersecting hills. Confirmatory evidence is often supplied by the physiographical characters of the hill slopes themselves. The slopes of the older crater walls seem to be, as a rule, less steep, and to exhibit the weather-worn scars of erosion and denudation to greater perfection than the steeper gradients of the younger crater slopes.

In the table given on p. 584 are set forth the volcanic structures so as to indicate their chronological relationships, so far as I have been able to make them out. The only crater of known age is Monte Nuovo: the most salient features of its eruption were recorded by an eye-witness in the sixteenth century. The others probably date from prehistoric times; otherwise, such a marvel as an extensive eruption could not have escaped mention by some Greek or Roman author. In the table, the younger volcanic structures are arranged above those which are considered to be older, and lines connect those between which it is thought that some evidence of relative age can be detected.

In my recent paper I have shown that almost all the hills of the Phlegræan Fields are either the entire walls of volcanic craters or of portions of walls of volcanic craters which have been to a greater or less extent washed away by the action of rain or the sea, or have been partially destroyed or buried by more recent volcanic eruptions. Secondly, these volcanic craters are distributed over a crescentic area round the Bay of Pozzuoli; the more recent ones are situated closer to the shore of the bay than the older ones, indicating a gradual march of volcanic vents along lines radiating towards the centre of that bay. In other words, the general effect of volcanic activity has been the accumulation of new land around the bay of Pozzuoli. Inasmuch as water seems to be a necessity for a volcanic eruption, this progression of the volcanoes seawards may stand in some relation to the channels by which water has obtained access to the fires below.

Thirdly, wherever crater rings of a larger and smaller diameter overlap, we never find a larger ring superimposed on a smaller one. The smaller ring is always superimposed on the larger. The conclusion to be drawn is, that the volcanic activity of the region has been decreasing in intensity. The same proposition is proved for a single locality by the Campana series of craters.

As it is impossible to make all the above-mentioned points clear without a suitable map, I would draw the attention of the interested reader to the surveys of the region published by the Istituto Geografico Militare, and to the contoured map published in the *Geographical Journal* for October 1897. R. T. GÜNTHER.

THE PRESENT APPEARANCE OF JUPITER.

IT may be interesting, now that the planet Jupiter is very favourably situated, to call attention to a few of the more conspicuous features which diversify its surface. Many of these objects will be sure to have come under the repeated observation of all those observers who have been habitually examining the planet in their telescopes.

It is fortunate that at the present time there are a large number of conspicuous markings on the planet. These are situated in different latitudes, and will allow some excellent redeterminations to be made of the velocities of the various longitudinal currents.

There are a great many dark and bright spots visible near the equator, on the north side of the southern equatorial belt. Some of these at the date of writing (April 18) are placed in the following longitudes, which are computed on the basis of System I. (daily rate 877°·90 = 9h. 50m. 30s.) in Mr. Crommelin's ephemerides in *Monthly Notices* for January 1898.

	Bright spots.	Dark spots.
	°	°
Long.	80	71
,,	146	94
,,	209	116
,,	238	127
,,	270	155
,,	349	216
		279
		319
		355

These markings are moving at approximately the same rate as the zero meridian System I., but I find that in several cases there is a disposition of the spots to decrease in longitude; hence I believe that their rotation periods will prove to be slightly less than 9h. 50m. 30s. The bright spots exhibit great variations in their appearance, and some irregularities of motion. A spot which is conspicuously brilliant on one night may, a few evenings later, have declined so much that it can scarcely be discerned.

The great red spot is still visible, and its present longitude is about 24°, so that it follows the zero meridian of System II. in the ephemerides by about forty minutes. The spot has the aspect of a faint dusky ellipse with a light interior, and it is connected on its south side with a grey belt. The recent motion of the spot corresponds with a period of 9h. 55m. 41·5s., and it may be expected to drop further behind its computed place unless an acceleration of motion should set in. Comparing an observation of the spot which I obtained on April 17, 1898, 12h. 5m., with one of the earliest by Mr. Dennett, of Southampton, on July 27, 1878, I find that 17,414 rotations were performed in the interim of 7203 days, and that the mean period of rotation was

9h. 55m. 39·4s.

This value is identical with that found by Prof. Hough from 14,505 rotations between 1879-96.

In July 1898 the spot will have been visible during twenty years, and under careful observation at each opposition of the planet. Whether this object is identical with other elliptical or reddish spots seen at various times in the same latitude by Dawes (1857), Huggins (1858-59), Gledhill (1869-70), Lord Rosse (1873), Copeland (1873), Russell (1876), and others, must remain an open question. It appears highly probable that the spot was the same as that observed by Russell in the summer of 1876, but there is an absence of connecting observations in 1877. And the identity of two or more markings cannot be absolutely proved by their longitudes when a fairly long interval has intervened between the observations, because the proper motions of the object are variable, and introduce great differences of longitude not always in the same direction. The retarded westerly drift of the red spot has caused it to lose more than 900 degrees of longitude relatively to its place in 1878, so that the spot has really been displaced to the extent of about two and a half circumferences of the planet.

From my own observations of the spot since 1880, I have obtained the following rotation periods for a certain interval during each apparition:—

Limiting observations.	Rotations.	Period. h. m. s.
1880 Sept. 27–1881 March 17	413	9 55 35·6
1881 July 8–1882 March 30	640	9 55 38·2
1882 July 29–1883 May 4	674	9 55 39·1
1883 Aug. 23–1884 June 12	710	9 55 39·1
1884 Sept. 21–1885 July 8	700	9 55 39·2
1885 Oct. 24–1886 July 24	659	9 55 41·1
1886 Nov. 23–1887 Aug. 2	609	9 55 40·5
1888 Feb. 12–1888 Aug. 22	462	9 55 40·2
1889 May 28–1889 Nov. 26	439	9 55 40·0
1890 May 22–1890 Nov. 25	451	9 55 40·2
1891 Aug. 7–1892 Feb. 2	432	9 55 42·2
1892 Aug. 15–1893 March 8	495	9 55 42·3
1893 Aug. 9–1894 March 24	548	9 55 41·2
1894 Nov. 25–1895 May 10	401	9 55 41·2
1895 Aug. 24–1896 Feb. 22	439	9 55 41·3
1896 Sept. 27–1897 April 25	514	9 55 40·8

The red spot has been falling behind the zero meridian during the last six or seven years, but at a very slow rate, the mean annual retardation being only about six minutes.

There are a number of dark, elongated spots or short belts placed in various regions of the planet. They are conspicuous objects on nights when the seeing is good, and the times of their passages across the planet's central meridian are easily secured. The following are the longitudes of a few of these formations as computed from System II. of the ephemerides:—

			Long.
		°	°
1. Dark elongated spot in	Lat.	+ 15 ...	120
2. „ „	Lat.	− 35 ...	150
3. „ „	Lat.	+ 15 ...	254
4. „ „	Lat.	+ 33 ...	268
5. „ „	Lat.	+ 39 ...	282
6. „ „	Lat.	+ 15 ...	298

Nos. 1, 3 and 6 are placed in the bright tropical zone, and immediately outlying the northern edge of the north equatorial belt. They are moving somewhat faster than the red spot, as their longitude appears to be decreasing at the rate of about 10° per month. Nos. 4 and 5 in the north temperate zone are moving at approximately the same velocity as the red spot.

There are some well-defined irregularities in the north side of the northern equatorial belt, which exhibits both white and dark spots. Their motion is evidently controlled by a rapid current similarly to that of the white and dark equatorial spots, but not, perhaps, quite so extreme.

Bright spots appear in the zone south of the red spot, and several of these are being attentively followed with the object of determining their periods.

On the whole the planet's appearance is now singularly replete with detail, and will compare favourably with that exhibited at any previous opposition. The great red spot has, it is true, long since lost the intense brick-red colour it displayed in the years 1878–81; nor have we now the exceedingly brilliant white equatorial spots of the period named. But appearances are now visible on the disc which were absent then, and among the most interesting of these are the elongated dark spots situated just outside the margin of the north equatorial belt.

Though past observation has fully demonstrated the proper motions of the different markings and the decreasing velocity of several of them, it is highly important that the rate of the various currents should be redetermined every year. The character and number of the spots found in them should also be recorded, and measures made to determine the latitudes of the belts. Pursued through a long series of years, such data might ultimately give us the proof of periodical variations in the character and number of the spots, and possibly also in their rates of motion. W. F. DENNING.

THE LONDON UNIVERSITY BILL.

THE friends of education and many friends of the Government are disappointed at the postponement of the second reading of this Bill in the House of Commons. The cynics are saying that aristocratic Government and University representation are either jointly or severally responsible for this recurrent paralysis in the treatment of a question of the greatest importance to the greatest city of the world.

NATURE is not a political organ, and these points need not therefore occupy us; we can only express regret that the way in which all matters connected with science and education are handled in this country is so vastly different from that meted out to them in France or Germany. The *Times* writes as follows:

It is no longer denied in any quarter that the absence of a teaching University in the capital of the British Empire and the greatest city in the world is an anomaly and almost a scandal. The alternative which commends itself to Mr. Moulton and the anti-reform party is that a new teaching University should be set up alongside of the present examining University, but this scheme has been rejected by the vast majority of intelligent men who have taken even the slightest pains to look into the subject. What the Government desire—in accordance, we believe, with the immense preponderance of authority on this question—is to connect a teaching University, under which degrees will be given as the hall-mark of a systematic intellectual training, with the existing system of examination pure and simple. The latter, it is pointed out, is left entirely untouched, though there is a strong and growing conviction that it never can be, even in part, a true development of the highest education, but must tend, more and more, to pass under the dominion of the crammer. But the preservation of the existing method of giving degrees makes it imperative, if the teaching work of the University is to be a reality and not a sham, that there should be a double system of examinations, the one for "internal" and the other for "external" students. The Bill provides, necessarily and inevitably, for this distinction, but the most careful securities are adopted that no unfair advantage shall be given to the former class, and, especially, that the examination of students by the teachers who have trained them shall be supplemented and checked by the admission of an independent element. It would seem to be forgotten that the medical degrees of the London University, which undoubtedly stand highest in public estimation and of which the standard is rigorously high, are granted on the reports of examiners many of whom are teachers in the medical schools. The cry for identity of examinational tests is irrelevant and inconsistent. It is, as Dr. Allchin urges, "an attempt to subordinate the examinations to the requirements of those who have neither been trained nor educated in the fullest sense of the word." This is the very essence of the bondage from which for many years past the higher education in London has been struggling, under the guidance of such men as Huxley, to escape, and from which deliverance is now in sight, if Ministers will only have the courage of their opinions and be true to their pledges.

Whether the paralysis comes from want of knowledge or want of courage, it is very clear that there is at the present a great gap in our administrative machinery, and one which a Scientific and Educational Committee of the Privy Council might easily fill if the right men were appointed to it.

NOTES.

THE death is announced of Prof. Aimé Girard, member of the Section of Rural Economy of the Paris Academy of Sciences. Referring to the deceased investigator at the meeting of the Academy on April 12, M. Th. Schlœsing remarked: M. Aimé Girard was the highest authority on chemical and agricultural industries in the Academy. After some valuable scientific work he was nominated professor of industrial chemistry at the Conservatoire des Arts et Métiers, in succession to Payen. His teaching revealed the dominating object of his efforts. Affable and cheerful, loyal and entirely disinterested, he possessed all the attributes required to gain the confidence of manufacturers. The producers whose places he visited, in France and in other countries, became and remained his friends; they gave to him a large amount of information which he used to enrich his attractive lectures, and in return M. Girard offered them advice suggested by his experience and his own investigations. In a few years his masterly researches on vegetable fibres, wheat, farinas, sugars and woods had made him the first authority upon these matters, and he was frequently consulted by the Government on subjects concerning the great industries of paper, alcohol, sugar, flour, and bakery. The study of these products led to inquiries as to crops. In this new direction M. Girard rendered valuable services, and, after his researches on the cultivation of sugar-beet and the improvement of the potato, he obtained among agriculturists the same position and the same sympathies which he enjoyed in the industrial world. Though weakened in recent years by illness, and saddened by repeated troubles, he nevertheless continued his work. He died while occupied in applying to wheat of various origins the new methods of analysis which were the subject of a recent communication to the Academy. The vacancy which his death has caused enables us to estimate the high place which he occupied in scientific societies and in the committees in which he took part.

We learn from the *Electrician* that a banquet to M. Z. Gramme, to celebrate his receiving the decoration of Commander of the Ordre Léopold, was lately held at the Hôtel Métropole, Brussels. The Senator, M. Montefiore-Lévi, presided, and among the guests, who numbered 130, were Prince Roland Bonaparte, the Minister M. Nyssens, representing the Belgian Government, the Burgomaster and Aldermen of Brussels, M. Mascart (president of the Organisation Committee), M. A. d'Arsonval (president of the Société Internationale des Electriciens), and M. Hippolyte Fontaine, manager of the Gramme Company. M. Mascart, in an eloquent speech, traced the career of M. Gramme, from his commencement as a simple workman in the tiny Belgian village of Jehay-Bodégnée down to the present day, and presented the great Belgian electrician, in the name of the electricians of the whole world, with a fine gold medal engraved by Chaplain. After the banquet the guests were received by the Town Council in the Hôtel de Ville. Profs. Ayrton and Silvanus Thompson, who had been appointed delegates by the Institution of Electrical Engineers, were unable to reach Brussels on account of a storm, and the illuminated address of congratulation, of which they were to have been the bearers, had to be sent by post. Numerous congratulatory telegrams were received, including one from Lord Kelvin and one from Mr. W. H. Preece.

The ninth international Congress of hygiene and demography was opened at Madrid on April 10. About two thousand members attended the Congress, but less than fifty English delegates were present. The opening ceremony took place in the National Library, under the presidency of the Minister of the Interior, who was supported on the right by the Governor of Madrid, the acting President of the Congress, Dr. Julian Calleja, and by the Secretary-General of the Congress, Dr. Amalio Gimeno; on the left by Prof. Brouardel (Dean of the Paris Faculty of Medicine) and the Mayor of Madrid. Dr. Calleja delivered the inaugural address, and in a few words of greeting extended a warm welcome to the members of the Congress, wisely reminding the audience that the science of public health was confined to no nation in particular and to no one science specially. Dr. Brouardel spoke on behalf of the Permanent International Committee, and he was followed by delegates from the nations represented at the Congress, after which the Minister of the Interior pronounced the Congress open. In the evening a gala performance was given in honour of the members of the Congress at the Spanish Theatre. A reception was held at the Athenæum Literary Club on the evening of Monday, April 11, and on Friday, April 15, there was a reception of the members of the Congress at the house of the Prime Minister, while on Saturday certain delegates had the honour of presentation at Court. The scientific work of the Congress was carried on in the various sections during the whole of last week, and a large number of papers of importance to the science of public health were read.

The fifth centenary of Paulo Toscanelli and Amerigo Vespucci is being held with much gaiety at Florence. The festivities will continue until the end of this month, and the programme comprises a geographical congress and the inauguration of several monuments.

About 10·15 p.m. on Tuesday, April 5, a meteor of exceptional size and brilliancy was observed at Ealing slowly traversing the sky in an easterly direction. After a few seconds the meteor burst, and then shot forward with increasing velocity, and disappeared after being visible about ten seconds.

A lecture upon "The Progress of Optics during the Present Century" will be delivered at the Mansion House this evening, by Dr. G. Lindsay Johnson, under the auspices of the Worshipful Company of Spectacle Makers. The Lord Mayor, and subsequently the Astronomer Royal, will preside at the lecture.

The ninth annual meeting of the Museums Association will be held at Sheffield in the first week of July. The Lord Mayor and Corporation of Sheffield offer a cordial welcome to all members of the Association, and are very desirous of making the meeting in every respect successful. All the business will be carried on in the Town Hall, the use of which has been granted to the Association. The President-elect is Alderman W. H. Brittain, and the Secretary is Mr. E. Howarth, Public Museum, Sheffield, to which address communications from members who propose to read papers should be sent.

At the annual meeting of the Iron and Steel Institute, to be held on Thursday and Friday, May 5 and 6, under the presidency of Mr. Edward P. Martin, the Bessemer gold medal for 1898 will be presented to Mr. Richard Price-Williams in recognition of the active part he took in the early days of the use of steel on railways. Among the subjects of papers that are expected to be read and discussed are: The iron industry of the Urals, by Prof. H. Bauerman; the solution theory of iron, by the Baron Hanns Jüptner von Jonstorff; brittleness in soft steel, by Mr. C. H. Ridsdale; allotropic iron and carbon, by Mr. E. H. Saniter; the crystalline structure of iron, by Mr. J. E. Stead.

The third annual Congress of the South-eastern Union of Scientific Societies will be held in the Town Hall, Croydon, on June 2-4. On Thursday evening, June 2, the President-elect, Prof. G. S. Boulger, will deliver the annual address. Among the papers to be read on the following day are—entomology as a scientific pursuit, by Mr. J. W. Tutt; the place of geology in education, by Prof. Logan Lobley; the nature of the soil in connection with the distributions of plants and animals, by Dr. H. Franklin Parsons; natural gas in Sussex, by Mr. C. Dawson. On Saturday, June 4, a discussion will take place on ideals for natural history societies, and how to attain them; and Mr. E. M. Holmes will read a paper on botanical work still wanting workers. A museum arranged by the local committee, illustrating the natural history of the neighbourhood and other subjects, will be open during the Congress.

The *Times* correspondent at Athens writes, under date April 18:—The French School of Archæology was to-day the scene of a brilliant assembly. The King, who was accompanied by the Crown Prince and Princes George and Nicholas, arrived at eleven o'clock, and tendered his congratulations to M. Homolle, director of the School, on the occasion of its jubilee. M. Zaimis (the Prime Minister), M. Romas (President of the Chamber), M. Delyanni, M. Ralli, and all the principal members of Athenian society were present, together with a great concourse of foreign visitors. In the course of an interesting address, M. Homolle made the announcement that M. Syngros, the Greek millionaire, had decided to erect a museum at Delphi. Speeches were then delivered by M. Cavadias, in the name of the Greek Archæological Society, by Dr. Dörpfeld, on behalf of the foreign schools in Athens, and by M. Collignon, as representing various French scientific institutions. Count d'Ormesson, the French Minister in Athens, also delivered an address.

By establishing a National Zoological Park, having for its chief object the collection and preservation of American animals likely to become extinct, the Smithsonian Institution has been the means of developing an intelligent interest in such collections in the United States, and has stimulated other enterprises of a similar character. Among similar zoological preserves, which have been projected and established in the United States since the establishment of the National Zoological Park, are the following:—The Blue Mountain Forest Park, established by the late Mr. Austin Corbin, is a large tract of forest and abandoned farm land, situated in the western part of New Hampshire, comprising an enclosed area of 26,000 acres. Within this enclosure are kept about 4000 wild animals, including 74 bison, 200 moose, 1500 elk, 1700 deer of different species, and 150 wild boars. These animals are rapidly multiplying, and, with the exception of the bison, which are sheltered and fed during the winter, live in perfect freedom. In the Adirondack region of New York a game preserve of 9000 acres has been stocked with elk, Virginia deer, mule deer, rabbits, pheasants, &c., and Mr. W. C. Whitney has established a preserve of 1000 acres in the Berkshire hills, near Lenox, Mass., where he maintains not only the species of animals above mentioned, but also bison and antelope. Other preserves are Ne-ha-sa-ne Park, in the Adirondacks, 8000 acres; Tranquillity Park, near Allamuchy, N.J., 4000 acres; the Alling preserve, near Tacoma, Wash., 5000 acres; North Lodge, near St. Paul, Minn., 400 acres, and Furlough Lodge, in the Catskills, New York, 600 acres. These are all fenced enclosures, well stocked with animals. At Pittsburg, Pennsylvania, in one of the public parks, a number of buildings intended for the exhibition of animals are being constructed. These are already nearing completion, and will cost more than 200,000 dollars, exclusive of the animals they are to contain. A further collection of buildings and enclosures intended for American animals only is also projected for that city. Finally, the New York Zoological Society has obtained from the city of New York a grant of some 261 acres in the southern portion of Bronx Park, near that city, for the purpose of establishing there a zoological garden, which is to be free to the public for at least five days in each week. Plans are now being prepared for the development of a collection on the most generous and attractive scale. The bulletin issued by the Society states that it is expected that there will be at once spent 125,000 dollars for preparing the ground, and 250,000 dollars for buildings and enclosures.

THE colony of beavers in the National Zoological Park, Washington, have now made themselves completely at home. The animals have constructed three large dams, one of which is at least 4 feet high. Each of these has been built wholly by the beavers themselves, either from trees felled by them within the enclosure or from branches furnished them for food. They cut this material into suitable lengths, which they drag to the water, float to the dam, and there combine with mud and twigs to form a compact structure. In connection with each dam they have built houses, together with several smaller burrows in the bank. The entrance to the houses is always under water, and can only be reached by diving. The animals have become quite accustomed to the presence of man, and it is believed that under proper restrictions the public may be allowed to see them at work.

DR. A. SLABY, professor of electro-mechanics and heat-mechanics in the Technical High School at Charlottenburg, contributes to the *Century Magazine* (April) an illustrated article upon telegraphy by electric waves—*stromtelegraphie* or "telegraphy by circuit" he terms it. Prof. Slaby describes how he succeeded in establishing communication between Schöneberg, near Berlin, and Rangsdorf, at a distance of twenty-one kilometres. The Emperor of Germany ordered the balloon department of the army to assist in the experiments, and balloons were anchored at the two places chosen for the transmitting and receiving stations. At both stations thin copper wire was fastened to the baskets of the balloons, reaching two hundred and fifty metres to the apparatus. Connection with the earth was made by means of swords stuck in the ground. The first telegram received under these conditions is reproduced in the article, and the clearness of the Morse characters upon it is most remarkable. The distinctness of the dots and dashes seems all the more noteworthy because of the highly electrical condition of the atmosphere on the day of the experiments. The results demonstrated the possibility of using captive balloons on the high sea for purposes of communication by ethereal telegraphy. In place of balloons, kites of the modern form can be used; for Prof. Slaby says a few experiments have convinced him that they are perfectly adapted to carrying the thin wires required to connect with the apparatus. In connection with Prof. Slaby's observations, it is noteworthy that, during the past few months successful experiments on electrical communication without intervening wires have been made at places on the South Coast, under the direction of Signor Marconi. Regular communication has been maintained between Bournemouth and Alum Bay—the distance between the two stations being about 14½ miles. Signals have also been exchanged between stations 18 miles apart, and arrangements are being made to test the capabilities of the instruments to receive at Cherbourg signals transmitted at Bournemouth—the intervening distance being about 60 miles.

THE concluding part of the 26th *Ergänzungsband* of *Petermann's Mittheilungen* contains a very comprehensive account of the distribution of rainfall over the solid portions of the globe, by Dr. A. Supan. The first rain-chart of the world was published by Prof. E. Loomis in 1882, in the *American Journal of Science*. During the last fifteen years the number of rainfall stations has greatly increased, and the quality of the observations has, generally speaking, much improved. Still the distribution is far from satisfactory, as more than half of the observations emanate from Europe, and even there large tracts are badly represented. The construction of a rain-chart always presents great difficulties, because the distribution of rainfall depends so greatly upon local conditions, upon the exposure of the gauges, and the accurate measurement of snow. And to be strictly comparable the periods ought to be the same. But in a comprehensive work, such as that now in question, the author has no choice but to select the best available materials, and this Dr. Supan has done, and gives full particulars as to the sources from which the information is obtained. In addition to tables giving the monthly and yearly values, the author gives a full discussion of the rainfall of various districts, and the charts show very clearly both the mean annual amounts and the seasonal distribution. The work forms a valuable contribution to our knowledge of the subject.

REFERRING to the report from Vienna that Dr. Schiff has successfully treated cases of lupus vulgaris by means of Röntgen rays, the *British Medical Journal* remarks that his process is to set up an independent inflammation in the lupoid area by exposing the part to a very intense radiation. So far, investigations into the germicidal effects of Röntgen rays have gone to show that their activity in this respect is not greater than that of ordinary light. But Dr. Schiff's result is not a germicidal one, and it is known that inflammation, and even necrosis, may result from exposure in certain cases, although the determining factor which leads to injury in some cases but not in others under apparently similar conditions is unknown. It is not, however, altogether improbable that Dr. Schiff's results may be due to a direct germicidal action of Röntgen rays on the tubercle bacillus. Light is deleterious to this organism, and Dr. Finsen, of Copenhagen, has reported cases of cure in lupus by protracted exposure to concentrated light, so arranged that the ultra-violet rays predominated.

We have received the first part (for 1896–97) of the *Transactions* of the British Mycological Society. Descriptions are given of several new Fungi, or of species new to Britain.

The *Botanisches Centralblatt* states that Dr. C. Marchesetti has undertaken a botanical expedition to Upper Egypt and Palestine; and Dr. M. Pedersen (of Copenhagen), an investigation of the vegetation of Disco Island, Greenland.

At the venerable age of ninety, Prof. R. A. Philippi resigns the directorship of the National Museum at Santiago, Chile, which he has held for forty-three years. He is succeeded by his son.

As "Circular No. 13," the United States Department of Agriculture (Division of Botany) publishes a description, with excellent drawings, of the edible and poisonous Fungi natives of the States, by Mr. Frederick V. Colville.

Prof. D. P. Penhallow reprints from the *Transactions* of the Royal Society of Canada a useful review of Canadian botany from 1800 to 1895, being a paper read before the Botanical Section at the last meeting of the British Association.

The *American Naturalist* for February gives a full account of the first annual meeting of the Society for Plant Morphology and Physiology, held at Ithaca, N.Y., on December 28 and 29, 1897, at which many important and interesting botanical papers were read.

The *Botanical Gazette* for March gives a list of the persons officially designated by the Government as botanists or mycologists in the United States, fifty in number. These are situated at fifty-one State experiment stations. Every State in the Union, with the exception of ten, has its State botanist, New York and Connecticut having two each.

The firm of J. B. Baillière et fils, of Paris, is publishing a "Bibliographie Botanique," to appear in five monthly parts of 32 pp., each of two columns. The first fascicle, comprising the letters A to C, will appear shortly. The titles of about 10,000 volumes and pamphlets will be included in the work; the date of publication, number of pages, and some account of the contents will, in each case, be included.

Under the title, *Die Metamorphose der Pflanzen, im Lichte palæontologischer Thatsachen*, the well-known palæontologist, Dr. Potonié adduces arguments, derived from the geological history of plants, in favour of the view that all the higher forms of vegetable life have been derived, by metamorphosis, from the forking of an archaic thalloid structure.

The *Biologisches Centralblatt* continues to publish a succession of interesting papers in both branches of Biology. The phenomena of impregnation in the Rhizopods, non-sexual propagation in Phanerogams, the relationship between the arctic and the antarctic plankton, spermatogenesis in *Paludina vivipara*, the relationships between Phanerogams and Cryptogams, are among the subjects discussed in the most recent numbers.

We learn from the *Journal of Botany* that a new British flora is in preparation by the Rev. E. F. Linton, who will take the *London Catalogue* for the basis of his work. A large number of "forms," and not a few distinct species, have been added to our flora since the publication of the last edition of the existing manuals. The publication is also announced of a flora of Cheshire by the late Lord de Tabley, which will be edited by Mr. Spencer Moore. The flora of Kent, by Mr. F. J. Hanbury and the Rev. E. S. Marshall, is nearly ready for the press.

Petermann's Mittheilungen contains a new geological map of Java and Madura, by Dr. R. D. M. Verbeek, which is a considerable advance on that published by Junghuhn in 1855. A short paper discusses the relation of the topography of the islands to their geological structure.

Dr. Max Eckert, of Leipzig, contributes a paper to *Petermann's Mittheilungen* on the Karren and Schratten districts of the German Alps. Various forms of primary and secondary Karren are recognised; the most typical form occurring in pure chalk at levels where weathering is greatest—*i.e.* between 1600 and 2300 metres.

In a paper published in the *Zeitschrift für praktische Geologie*, Prof. Dr. Rudolf Zuber, of the University of Lauberg, discusses modern theories of the formation of petroleum. The author believes that the hypotheses at present in the field are either too purely chemical or too purely geological, and he criticises a number of them from this point of view, without, however, advancing anything definitely new to take their place.

We have received a reprint, from the *American Antiquarian*, of a paper on the geography of the Tsimshian Indians, by Mr. G. A. Dorsey. The Tsimshian Indians form one of the most important stocks of the North-west; they inhabit villages on the Nass and Skeena rivers of British Columbia, and are distinct in language from the neighbouring tribes. Mr. Dorsey's paper chiefly consists of a list of the villages, and notes as to name, position, &c., of each.

The instruments devised for recording the occurrence of an earthquake, or analysing its motion are very numerous, and are described in many scientific journals. Dr. R. Ehlert has, therefore, rendered a great service by collecting and classifying in one memoir (Gerland's *Beiträge zur Geophysik*, vol. iii.) the accounts of all the more important seismographs and seismoscopes that have so far been constructed.

The latest addition (No. 1084) to the Smithsonian Miscellaneous Collections is a "Bibliography (1748–1896) of the Metals of the Platinum Group"—platinum, palladium, irid m, rhodium, osmium, ruthenium—by Prof. J. L. Howe. The publication of this volume was recommended by the Committee of the American Association for the Advancement of Science having charge of indexing chemical literature. All papers upon metals of the platinum group found in scientific literature to the close of 1896 are given in the order of the date of appearance, and are also indexed according to subjects and authors. It is thus easy to determine what papers have been published upon the physical and chemical characteristics and properties of any members of the platinum group of metals. The volume will therefore be of the highest value to many scientific investigators; and by publishing it the Smithsonian Institution has increased the obligations which men of science owe to the Institution for making works of this character available.

The additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mr. H. Times; a Silver-backed Fox (*Canis chama*), a Suricate (*Suricata tetradactyla*) from South Africa, presented by Mr. W. Champion; a Grey-breasted Parrakeet (*Myopsittacus monachus*) from Monte Video, presented by Mrs. Evelyn Heathcote; a Gold Pheasant (*Thaumalea picta*, ♂) from China, presented by Mrs. Abbot Robinson; a Long-necked Chelodine (*Chelodina longicollis*) from Australia, presented by Mr. R. Kirkwood; an Isabelline Bear (*Ursus isabellinus*) from India, deposited; a Red-vented Cockatoo (*Cacatua hæmaturopygia*) from the Philippine Islands, two Toco Toucans (*Ramphastos toco*) from Guiana, a Lapwing (*Vanellus cristatus*, two Knots (*Tringa canutus*) from Lincolnshire, purchased; a Gayal (*Bibos frontalis*, ♀), a Mouflon (*Ovis musimon*, ♂), a Hog Deer (*Cervus porcinus*, ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET PERRINE.—The following is a continuation of the ephemeris of Comet Perrine for the ensuing week, from Prof. H. Kreutz's computation :—

1898.		R.A. h.	m	s.		Dec. °	′		Br.
April 22	...	23	48	19	...	+46	15·0	...	0·64
23	...		53	37	...	46	50·3		
24	..	23	58	57	...	47	24·3		
25	...	0	4	19	...	47	57·1		
26	...		9	42	...	48	28·7	...	0 58
27	...		15	6	...	48	59·0		
28	...	0	20	32	..	+49	28·1		

THE AURORA SPECTRUM.—Prof. E. C. Pickering tells us in a *Circular* (No. 28) of the Harvard College Observatory that the attempts made at photographing the spectrum of the aurora have proved successful, Mr. Edward S. King having obtained two plates, one on April 1, 1897, and the other this year on March 15. On the first of these photographs four bright lines were visible after an exposure of 147 minutes, but uncertainty existed as to the wave-lengths of these lines. In the more recent negative two bright lines were obtained after an exposure of 141 minutes. The brightest of these extends from 3892 to 3925, the wave-length of the second being 4285. Assuming that these two lines were photographed in 1897, the wave-lengths of the four lines then obtained would be 3862, 3922, 4288, 4694.

As regards the first two lines, 3862 and 3922, nothing as yet can be said, as visual observations of the aurora have not extended so far. The line 4288 seems probably to be the same as observed in previous auroræ by Lemström, Wijkander and Oettingen, the wave-lengths given by them being 426, 428 and 424 respectively. The last of the four lines at 469 is a well-observed aurora line, having been seen no less than nine times by observers ; its probable origin is the hot carbon band, which extends from 467–474.

Prof. Pickering mentions that the spectroscope employed to obtain these photographs was not specially designed for the purpose, but a new instrument is in course of construction with which it is hoped better results will be obtained.

THE MOVEMENT OF SOLAR FACULÆ.—By a minute study of the magnificent series of observations on sun-spots, made by Carrington and Spörer, the difference between the times of rotation of the spots in different latitudes has been determined with great accuracy. Thus a strict relation was found to exist between the angular velocity of any spot and its latitude, the former decreasing as the latter increased. Dunér further showed that exactly a similar law existed in the case of the general surface of the sun, but with this exception, that the velocities of each latitude for latitude did not agree. An interesting inquiry was then to investigate the behaviour of the faculæ, which recent photographic methods have shown are so numerous over the solar disc. Faculæ, as many observers of the sun know, are not such stable phenomena as spots ; nevertheless Wilsing, after a laborious investigation, came to the conclusion that they were imbued with a velocity that was constant for all latitudes, and equal to a movement of 14°·27 in 24 hours. Belopolsky, at a later date, adopted a different method of investigation, and was led to draw the conclusion that faculæ obeyed the same law of the variation of the angular velocity of rotation as the spots. More recently Wolfer, after a method somewhat analogous to that employed by Wilsing, came to the same conclusion as that arrived at by Belopolsky.

In consequence of the high importance that would be attached to a definite result of so interesting a problem, Dr. W. Stratonoff has undertaken a very complete investigation of the whole subject, using as his data the fine photographs that have been obtained in the last few years (*Mémoires de l'Académie Impériale des Sciences de St. Pétersbourg. Classe Physico-Mathématique*, vol. v. No. 11). Out of a total number of 400 plates, for the years 1891–1894, he used 234 for this research, as will be seen from the following list, showing by whom they were taken :—

1891	...	60	...	Belopolsky.
1892	...	57	...	,,
1893	...	76	...	,, and Stratonoff.
1894	...	41	...	Stratonoff, Orbinsky and Eydokimoff.
Total		234		

We cannot enter at length into the details of the method M. Stratonoff has employed in this long investigation, but must confine ourselves simply to the results obtained. The measurements of the heliographic latitudes and longitudes of each of the 1062 faculæ employed are given in the communication in one table, while a second is confined to the heliographic latitude of each facula with its angular velocity of rotation. The sum total of the research is that Wilsing's result is not corroborated, for it is found that the faculæ in different latitudes do not move with a constant velocity ; in fact, the variation of the angular velocity of rotation must be represented by a more complicated law than that in use for the spots. For latitudes 0°–8° the angular velocity of the faculæ remains nearly constant ; from 9°–16° it decreases rather rapidly to the extent of nearly 0°·4 ; for some range of latitude the velocity becomes again nearly constant, tending to increase rather than decrease. A rapidly slowing down of about 0°·5 takes place between latitudes 25° to 34°, and after that in higher latitudes a very gradual diminution in velocity is noticed more pronounced than was the case in the equatorial zone. Thus it will be seen that velocities of rotation at the highest and lowest latitudes differ by nearly a degree, the characters of this variation being the same for both hemispheres. Spots, it may be added, have the tendency to diminish the velocity of rotation of faculæ. As regards the movements of faculæ, spots, and the solar surface, the faculæ in all latitudes have the greatest velocity of rotation ; then come the spots which move more slowly, and lastly the solar surface, which has the least movement of all. M. Stratonoff suggests that perhaps these facts owe their origin in their difference of heights above the envelope of the sun. The author concludes his interesting paper with a series of instructive curves which convey very clearly to the eye the results of the investigation.

YEAST AND ALCOHOLIC FERMENTATION.

THOUGH the knowledge of the existence of alcoholic fermentation and the preparation of alcoholic liquids dates back to very remote antiquity, it is only within comparatively recent times that an accurate acquaintance with the actual nature of the process has been obtained. By the older writers many processes have been confused together under the name fermentation, though they have nothing in common but the evolution of gas which takes place as they go on. The true alcoholic fermentation, the formation of gas in the intestines of animals, and the effervescence which takes place when an acid is poured upon chalk, have all thus been grouped together as comparable phenomena. Of these different processes, however, that of alcoholic fermentation has been made most widely a subject of study, and from about the end of the seventeenth century definite views as to what it really consists of have been entertained by scientific men.

The correspondence between the alcoholic fermentation of the wort of beer, the must of wine and other saccharine liquids, and the disengagement of a gas under the influence of leaven in the manufacture of bread, had been noticed at a considerably earlier period. Very strange ideas were entertained as to the nature and action of the leaven. It was by some writers held to be of the same nature as that of the hypothetical philosopher's stone, and just as the latter was supposed to be able to transmute all metals by contact with them, so the leaven was considered to be able, in some occult way, to transform the dough into something resembling itself. One fact of importance comes out amidst all the mass of confusion, though its interpretation leaves much to be desired. This is the discovery that a very small quantity of leaven is capable of transforming an almost indefinite amount of the dough. The dough was, however, thought to be converted into leaven, and the capability established was distorted into a mark of identity with the philosopher's stone.

It was known, too, at an early date that besides an evolution of gas, alcoholic fermentation is always accompanied by the formation of a deposit in the fermenting liquid, which takes the form sometimes of a sediment, sometimes of a scum floating on the surface. By many writers considerable importance was attached to this deposit, and to it was attributed some special occult force capable of determining the changes which could be observed. These changes were held by some investigators to be chemical in nature, but still to be altogether different from ordinary chemical reactions. Valentin, who wrote towards the close of the sixteenth century, suggests that the deposited matter communicates to the liquid a kind of internal inflammation, and determines thereby a purification of it, separating its limpid from its turbid constituents. Valentin realised that alcohol makes its appearance in the fermenting liquid, but supposed that it was in some way pre-existent in the extract of the germinated barley grains, and became active and capable of distillation only after being liberated from impurities which accompanied it, and which masked its special properties.

Van Helmont, who wrote in 1648, though confusing fermentation with effervescence, like most writers of the time, yet distinguished that a special gas, which he called the "gas of wine," was produced during the former action, and pointed out that it was different from the spirit of the wine.

Attention was drawn to a distinction between effervescence and fermentation by de la Boë in 1659 and by Lemery in 1675. The first of these writers held the sounder view as to this difference, stating that in effervescence the chief reaction is one of combination, while in fermentation it is a question of decomposition. Lemery held, less accurately, that the chief difference between them was one of relative rapidity, fermentation being a slower and more complicated process. This theory of fermentation is stated by himself in the following words:—

"Pour expliquer cet effet, il faut savoir que le moust contient beaucoup de sel essential ; ce sel comme volatil faisant effort dans la fermentation pour se détacher des parties huileuses par lesquelles il etait comme lié, il les pénètre, il les divise et il les écarte jusqu'a ce que par ses pointes subtiles et tranchantes, il les ait rarefiées en esprit ; cet effort cause l'ébullition qui arrive au vin, et en même temps sa purification ; car il en fait séparer et écarter les parties les plus grossières en forme d'écume, dont une portion s'attache et se pétrifie aux côtés du vase, et l'autre se précipite au fond, c'est ce qu'on appelle le tartre et la lie. L'esprit inflammable du vin n'est donc autre chose qu'une huile exaltée par des sels."

Apparently the first ideas on the subject that may be regarded as at all clear, were advanced by Becher in 1682, and they mark an epoch in the development of our knowledge of it. This author ascertained the fundamental fact that only saccharine liquids are capable of undergoing alcoholic fermentation, and he showed that the alcohol does not exist as such in the original must of wine, but is formed during the operation of fermentation. Becher thought its formation to be due to a kind of combustion, as he ascertained that access of air is needed to set up the phenomenon.

About the same time a theory of the nature of fermentation was advanced, which has much in common with the ideas maintained in later times by Liebig. This was due to Willis and to Stahl, both of whom entertained similar opinions on the subject. It was that the ferment which they recognised as the factor that started the operation is a body possessing a peculiar internal movement or vibration, and that it transmits this vibration to the fermenting material. Of course in the condition of chemical science at the time, there was no satisfactory statement possible as to the nature of the changes caused by such vibration, but Stahl suggested that various decompositions and recombinations resulted therefrom.

The next marked advance in our knowledge must be associated with the name of Lavoisier a century or more later. Up to his time no quantitative researches into the subject had been carried out. The bodies capable of fermentation had been ascertained up to a certain point ; besides the alcoholic, the acetic fermentation had been discovered, and a general analogy had been established between fermentation and putrefaction. The products of these fermentations had been ascertained to be carbonic dioxide, alcohol, and acetic acid. Very little acquaintance had been made with the ferment, which was shortly to be recognised as a definite vegetable organism.

While Becher first pointed out the necessity for the presence of sugar in the fermenting liquid, Lavoisier studied quantitatively the relations of the sugar to the derivatives of it formed during the fermentation, and came to the conclusion that the operation consists of a separation of the sugar into two parts, one of which becomes oxygenated to form carbonic dioxide, while the other is converted into alcohol. He says that if it were possible to recombine these two substances, alcohol and carbonic dioxide, sugar would again be formed.

It is apparent that though Lavoisier's methods of analysis were imperfect, and his figures inaccurate in consequence, yet his general conclusions were sound. Towards the year 1815 analyses by Gay-Lussac, Thénard, and de Saussure fixed definitely the composition of sugar and alcohol. These more accurate analyses confirmed Lavoisier's position, but revealed a discrepancy which for a long time remained unexplained. Computation of the composition of sugar based upon the CO_2 and alcohol formed during its fermentation pointed to its having the formula $C_6H_{12}O_6$ (taking the modern values of the atomic weights), the decomposition being capable of expression by the equation $C_6H_{12}O_6 = 2C_2H_6O + 2CO_2$. The analysis made by Gay-Lussac and Thénard of cane-sugar itself demanded the formula $C_{12}H_{22}O_{11}$. These authors were unable to account for the discrepancy which remained unexplained till Dubrunfaut in 1832 observed that before cane-sugar could ferment, it became transformed into another form of sugar which is non-crystallisable. Dumas and Boullay in 1828 tried to reconcile the discrepancy by assuming that the fermentation is accompanied by the absorption of water. We have in the work of these three investigators the substance of what we now know to be true, that the fermentation of cane-sugar involves two processes, the hydrolysis of the cane-sugar with the formation of hexoses, and the decomposition of these with the formation of alcohol and carbonic dioxide.

During the progress of these investigations into the chemistry of fermentation a certain study of the fermenting body was being carried on by various observers. As long ago as 1680 the yeast of beer was examined microscopically by Leuwenhœk, who stated that it was composed of little ovoid or spherical globules, but was not able to determine their nature. Subsequent writers considered them to be of animal origin, but very little was definitely ascertained about them till the fourth decade of the present century, when Cagniard de Latour, repeating Leuwenhœk's experiments, saw that yeast is composed of a mass of organised globules capable of reproduction by budding, and appearing to belong to the vegetable kingdom. He concluded that very probably they disengaged the carbonic dioxide and fermented the liquid by some effect of their vegetation. Before de Latour and writers contemporary with him the yeast was generally considered to be of an animal rather than a vegetable nature, this view being promulgated especially by Fabroni, Desmazières, and Astier, the latter of whom held that it could only live at the expense of the sugar which it decomposed. Since the time of Meyen the true systematic position of yeast has been recognised.

The work of Astier and of C. de Latour laid the foundation for the more complete and satisfactory views of Pasteur, whose researches have thrown so much light upon the whole process of fermentation.

One of the most important discoveries that we owe to Pasteur is that alcoholic fermentation is accompanied by the coincident formation of glycerine and succinic acid, and that, therefore, the equation given above by no means represents all that is taking place in a fermenting liquid. Without committing himself to an equation to represent the whole decomposition, Pasteur determined by quantitative methods that about 4 per cent. of the sugar which disappears in the process of fermentation does not give rise to alcohol, but to glycerine and succinic acid. In addition to ordinary ethylic alcohol, also small quantities of higher alcohols, in varying quantities, are always or generally formed.

Pasteur's theory of fermentation is the natural outcome and the completion of the ideas of Astier and of C. de Latour. In his own words it may be stated : "Mon opinion la plus arrêtée sur la nature de la fermentation alcoolique est celle-ci : L'acte chimique de la fermentation est essentiellement un phénomène corrélatif d'un acte vital, commençant et s'arrêtant avec ce denier. Je pense qu'il n'y a jamais fermentation alcoolique sans qu'il y ait simultanément organisation, développement, multiplication de globules, ou vie continuée, pour suivie, des globules déjà formés."

This hypothesis, originally advanced by C. de Latour, did not, however, obtain acceptance at once. It was opposed strongly by Liebig, who put forward a view which is a modification of that advocated so long before by Willis and by Stahl. According to Liebig, the cause of fermentation is an internal molecular movement or vibration which a body in the course of its decomposition communicates to other matters whose elements are held together with very feeble affinity. Liebig says : "La levure de bière, et en général toutes les matières animales et végétales en putréfaction, reportent sur d'autres corps l'état de décomposition dans lequel elles se trouvent elles-mêmes ; le mouvement qui, par la perturbation d'équilibre, s'imprime à leurs propres éléments, se communique également aux éléments des corps qui se trouvent en contact avec elles."

This explanation seemed to apply to all fermentations besides the alcoholic one, and was for that reason favourably received by many; some, indeed, thinking that all fermentations were fundamentally alike, and that the different products were due to the degree of the alteration of the decomposing substance.

This view led to the idea that the action of the yeast was not due to its vital processes, but rather to a decomposition of its proteid constituents regarded simply as nitrogenous substance.

A third hypothesis was advanced by Berzelius, who thought that fermentation is a contact action due to a catalytic force. This idea has met with very little support.

Pasteur's biological explanation of the action of yeast gradually made itself accepted, even to a certain extent modifying Liebig's position. The latter chemist, in his later writings, while adhering to his theory of a molecular vibration, insists that it is not antagonistic to Pasteur's views, but that the movement is set up by the organisms in the course of their vital activity.

The dependence of alcoholic fermentation on the presence of yeast in a living and active condition seemed, so far as the earlier observers went, to be absolute, and the power of the organism to bring it about appeared to indicate a special property of the yeast cell. The question, however, was soon raised whether or no this property was shared by other organisms than this simple one; whether, in fact, it was not rather a manifestation of certain powers of vegetable protoplasm when placed under abnormal conditions. Reasons for holding the latter view were soon forthcoming.

In 1869 MM. Lechartier and Bellamy published an account of some experiments made with ripe fruits, which they kept for several months in the absence of oxygen. They found that under these conditions the fruits gave off continuously a certain quantity of CO_2, and that at the end of the experiment the pulp contained a measurable quantity of alcohol. Microscopic examination of the pulp showed it to be free from any yeast cells. These observations were shortly afterwards confirmed by Pasteur.

In speculating as to the part which these fermentative processes play in the life of the vegetable cell, Pasteur came to the conclusion that the fermentative power was connected with nutrition in the absence of free oxygen, and that the effort to obtain oxygen under these conditions led to the decomposition of the sugar. He strengthened himself in this opinion by experiments on the cultivation of yeast in the absence of free oxygen, carried on side by side with others in which the gas was supplied freely to the organism. In these experiments he found that the relative weights of yeast formed and sugar decomposed were very different under the two conditions. When no oxygen was supplied, fermentation was very slow, and for one part of yeast formed 60 to 80 parts of sugar disappeared. When oxygen was admitted the fermentation was very rapid, but for one part of yeast formed not more than 4 to 10 parts of sugar were decomposed. This difference was not due to any weakening of the energy of the yeast in the second case, for when some of it was removed and made to act on sugar in the absence of oxygen, it behaved just as did that which was used in the first experiment.

In this way Pasteur was led to hold that fermentation is a kind of intra-molecular respiration, a view which, however, was not allowed to pass without challenge.

Schützenberger argues against it with some force, pointing out at the outset that there seems to be a contradiction between the facts and Pasteur's inferences. In the presence of free oxygen we have a very active fermentation set up, while the yeast is said to possess less fermentative power. Schützenberger claims that the fermentative power is not the same thing as the power of growth, nutrition, and multiplication; that it is a distinct quality which exists in the yeast cells so long as they are living, but is not directly related to the respiratory process.

He bases his view on experiments carried out to ascertain how respiration is affected under changed conditions. The results he obtained were briefly the following:—

(1) In a watery liquid without sugar, but containing oxygen in solution, the quantity of oxygen absorbed in unit time by a gramme of yeast is constant, whatever proportion of oxygen is present.

(2) In a saccharine liquid, containing also albuminous matter, and with oxygen in solution, the same result is obtained, except that the quantity absorbed in unit time is greater.

(3) In two digestions, carried on side by side for some time, one being supplied continuously with oxygen and the other deprived of it, the former produced most alcohol.

If the decomposition of the sugar had been the result of the respiratory activity of the yeast cells at the expense of the combined oxygen of the sugar, it would seem that fermentation should either not have taken place at all in the presence of free oxygen, or that it should have been much less than in the other case, whereas the reverse is what is found.

Hence, Schützenberger comes to the conclusion that the sugar is alimentary and not respiratory.

Pasteur's theory has also found a powerful opponent in Naegeli, who held views much like those advanced by Liebig, Willis and Stahl. He thought that the decomposition of the sugar is brought about by vibrations of the plasma molecules, transferred to the fermentable substance, and that it takes place to a small extent only inside the cells, but to a much greater one in the liquid outside them.

A great development of our knowledge of the details of fermentation has taken place during the last twenty years, due in large measure to the labours of Hansen. Prior to 1878 much uncertainty prevailed concerning the true Saccharomycetes. By most laborious and careful cultivation, an acquaintance has been made by him with the life-history and mode of behaviour under various conditions of six definite species of these fungi. Other investigators have described other species, and a copious literature has sprung up on the subject.

Another fact of importance has also been ascertained which explains the discrepancies of analysis observed so long ago by Gay-Lussac, Dumas and others. It was mentioned above, that the composition of the fermented sugar as computed from the measurement of the CO_2 and alcohol it furnished, must be expressed by the formula $C_6H_{12}O_6$, while the analysis of cane-sugar showed it to be $C_{12}H_{22}O_{11}$. Dumas suggested that it took up water during the alcoholic fermentation. It is now known that this hydrolysis takes place before such a fermentation begins, and that it is set up by a special enzyme which can be extracted from yeast. If a watery extract be made of yeast pressed till nearly or quite dry, the cells give up to the solvent a body which has been called *invertin* or *invertase*. When a liquid containing this is added to a solution of cane-sugar, the latter is found to be very rapidly split up according to the equation

$$C_{12}H_{22}O_{11} + H_2O = C_6H_{12}O_6 + C_6H_{12}O_6.$$

Two sugars are formed, one of which rotates a beam of polarised light to the right, the other to the left. These, which were on this account termed *dextrose* and *levulose* respectively, are now known as *glucose* and *fructose*. These two sugars are those which undergo the alcoholic fermentation, while the cane-sugar itself is incapable of so behaving. The extract of the yeast can carry out the hydrolysis without the cells themselves being present.

More recently still, the sugar *maltose*, which is the product formed by the action of diastase on starch, and which is consequently always present in malted grain, has been ascertained to undergo a similar hydrolysis to cane-sugar, but to yield two molecules of glucose in consequence. The enzyme which causes this hydrolysis is also present in the malt. It is called by some writers *glucase*, by others *maltase*.

Fischer states that such an hydrolysis is necessary in the case of all polysaccharides, or sugars with the empirical formula $C_{12}H_{22}O_{11}$. Thus the sugars which are immediately capable of giving rise to alcohol are especially glucose and fructose; those which are commonly found in the liquids which are fermentable being, in addition, cane-sugar and maltose. The latter always undergo conversion or hydrolysis, and form one or both of the former.

The course of action on mixtures of these sugars in the presence of different species of yeast is often very different. Thus Hansen's six true species of Saccharomycetes all hydrolyse both cane-sugar and maltose, besides carrying on alcoholic fermentation of their products. *S. Marxianus* differs in not attacking maltose, while *S. membranæfaciens* ferments none of them, and does not contain invertase. Other organisms have similar idiosyncrasies.

Fischer advances a hypothesis to explain this great variety of action, which throws a great deal of light on the subject. Recognising, as it is now possible to do, that different sugars have different molecular configurations, he suggests that the fermentative principle of the yeast, whatever it may be, must possess a corresponding or complementary configuration, and so be able to come into very close relation to the molecule of the sugar it ferments, much as a key can only unfasten a lock for which it is constructed and to whose parts its own shape corresponds. The configuration of the two fitting as it were into each other, the disruption of the sugar molecule by the action or possibly vibration of the fermentative principle becomes conceivable.

Fischer does not base this hypothesis upon supposition merely, but has tested it by studying the action of some of the soluble enzymes upon the bodies they attack. His results with invertase are very interesting. According to Van 't Hoff's stereochemical theory, there are possibly to be found two methyl-glucosides, α and β, which differ only in their configuration. Fischer synthesised both these bodies and heated a quantity of each with 20 times its volume of invertase solution to 30–33° C. At the end of some time about half of the α body was hydrolysed, yielding glucose as one of its products. The β body underwent no change. Yet the two methyl-glucosides have the same composition, are formed from the same alcohol (methyl alcohol) and from the same sugar (glucose), and differ only in the configuration of a single carbon atom rendered asymmetric by the introduction of the methyl group into the sugar.

The great advances made in the study of fermentations under the action of soluble enyzmes during late years, has drawn the attention of many to the possibility of the secretion of an alcohol-producing enyzme by the yeast cells. It is evident that the introduction of the idea of an enyzme need not involve a new view as to what fermentation itself is. It is only necessary to substitute the secreted enzyme for the protoplasm of the cell, as the active agent in the process.

The idea was advanced some time ago by Berthelot, who compared both lactic and alcoholic fermentations to the conversion of starch into sugar. It has also been suggested by Moritz Traube and by Hoppe-Seyler.

The enyzme has, according to Buchner, actually been prepared from very active yeast by grinding the cells and squeezing the fluid contents from the resulting mass under the very heavy pressure of 500 atmospheres to the square inch.

As a review of Buchner's work appeared in this journal comparatively recently, it is not necessary to recount his experiments in detail.

The discovery, should it be confirmed, deals a very heavy blow to the vibration theories of fermentation due to Liebig and Naegeli. Their views are only tenable on the theory that most, if not all, of the action takes place in the liquid outside the cells. If Buchner is correct, and the work is done by means of an enzyme, it must necessarily be *intra-cellular*, for enzymes, so far as they have at present been investigated, show no tendency to diffuse through such a membrane as the cell wall. It also militates against Pasteur's theory of intramolecular respiration, which demands the idea of the decomposition being brought about by chemical action between the protoplasm and the body from which it, according to the theory, obtains its oxygen.

J. Reynolds Green.

THE METALS USED BY THE GREAT NATIONS OF ANTIQUITY.[1]

At the beginning of this century little was known of the great nations of antiquity, except through the classic poets and historians, and the sacred writings of the Hebrew people. Since then our knowledge has been enormously increased by the labours of scholars and explorers; the ruins of ancient cities have been exhumed, and the contemporary literature of Egypt and Assyria, inscribed on papyri or tablets of clay, and painted or carved on the walls of temples, palaces and tombs, has been deciphered. What is in some respects still more important is, that objects found in these ruins have thrown great light upon the daily life of the people, and their ornamental and useful arts. One of the departments of this inquiry concerns the metals used by the different nations, and at the different epochs of their history; and it is to this that my attention will be confined this evening. The difficulty I experience is the vast amount of material; and I cannot attempt anything more than a general view of the subject, and some of the most salient points.

The area over which the inquiry extends is that of the lands bordering on the eastern half of the Mediterranean, and stretching eastwards to the Persian Gulf. The time, so far as Egypt is concerned, includes the whole period from the first Pharaoh, Menes, to the conquest of the country by Alexander the Great; ranging from about B.C. 4400 to B.C. 332. The chronology employed throughout is that of Dr. Wallis Budge, of the British Museum, who has adopted in the main that of Brugsch Bey. This period of 4000 years appears to me reasonable, and errs, if anything, on the side of moderation. Our knowledge of the other nations does not extend to anything like so remote a time.

Egypt.

If we take as our starting-point Seneferu's triumphal tablet in Wady Maghara, in the Sinaitic peninsula, we see the king flourishing his battle-axe over the head of his enemy. This symbolises the conquest of the copper and turquoise mines of that region, and implies, of course, their previous existence as a source of wealth. In the hieroglyphic inscription above his head there is not only the king's name spelt phonetically, but in the royal titles are seen two ideographs which bear upon our subject. One is the necklace or ornamental collar which is the well-known symbol for gold; and the other an axe, the head of which resembles rather that of a copper than of a stone weapon. These titles have no reference to the metals themselves, but mean "Golden Horus" and "Beneficent Divinity." Before such symbols could be used to express abstract ideas, they must have been well known in their concrete form. The date assigned to Seneferu is B.C. 3750; but the discoveries of the past year have put in our possession the actual metals themselves, of a much greater antiquity. M. de Morgan, late Director General of Antiquities in Egypt, has explored an enormous royal tomb at Nagada, the centre chamber of which contained the mummy of the Pharaoh, with the cartouche of King Menes, the reputed first King of Egypt. If it be really his tomb, the probable date will be B.C. 4400. What is interesting to us is that in two of the chambers, among a multitude of articles made of ivory, quartz, porphyry, wood, alabaster, tortoiseshell, mother-of-pearl, obsidian, earthenware, cornelian, glass and cloth, there were found some small pieces of metal, viz. two or three morsels of gold, and a long bead of that metal of a somewhat crescent form, together with some articles of copper—a kind of button, a bead, and some fine wire. The button was analysed by M. Berthelot, the well-known French chemist and politician, to whom we are indebted for the examination of a very large number of ancient metallic objects; he states that it is nearly pure copper, without arsenic or any other metal in notable proportion.

These are the oldest metallic objects in the world to which we can assign a probable date. But Prof. Flinders Petrie had discovered, three years ago, also at Nagada, a great number of objects of the same character, and among them a few small copper implements. Some filings from a dagger, a celt, and a little harpoon were analysed by me, and found to consist of practically pure copper, without any trace of tin. The remains of these filings are in the little bottles on the table. The age of these tools must be comparable with that of the royal tomb, and may possibly be even older.

Of about the same period, and perhaps even earlier, are a number of tombs at and near Abydos, which have been explored by M. Amélineau, bearing the names of kings unknown to history, accompanied by hieroglyphics of archaic form. In these have been found larger quantities of copper utensils, viz. pots, hatchets, needles, chisels, &c., which M. Berthelot also finds to be nearly pure metal, but some contain a little arsenic. It would appear, therefore, that the Egyptians, at the very beginning of the historic period were acquainted with the use of gold and copper. Let us follow the history of these two metals, beginning with gold, which, as it is generally found native, was probably the first known to man.

According to a letter just received by me from M. Berthelot, all or nearly all the ancient gold that he has examined contains more or less silver. This pale coloured gold is sometimes termed electrum, and was found in great quantity in Asia Minor, where the Pactolus and other streams "rolled down their golden sands." Gold is frequently represented in the Egyptian sculptures and pictures; for instance, in the very interesting scenes of social life at Beni Hassan, *circa* B.C. 2400, illustrations of which I now throw upon the screen, we see the goldsmiths making jewellery, weighing out the metal, melting it in their little furnaces with the aid of blowpipe and pincers, washing it, and working it into the proper forms. In the picture of a bazaar at Thebes we

[1] A Friday evening discourse delivered at the Royal Institution, on February 11, by Dr. J. H. Gladstone, F.R.S.

find a lady bargaining for a necklet; and in another picture we see the weighing of thick rings of gold and of silver, which were used as articles of exchange. I wish I could show you the exquisite gold jewellery, inlaid with gems, found in the tombs of four princesses buried at Dahshur, about B.C. 2350, and which is now exhibited in the museum of Gizeh; but I can throw upon the screen the photograph of the beautiful enamelled gold necklace of Queen Ahhotpu, B.C. 1700. The great kings Seti I. and Rameses II., B.C. 1300, worked extensive gold mines in Nubia, which yielded gold free from silver.[1]

To return to the history of copper. In the inscriptions we cannot distinguish between copper and its various alloys, for they are all expressed by the general term *chemt*, and the symbol of the battle-axe blade. But if we can get the substance itself and analyse it, we know what we are dealing with. Many specimens of copper implements dating from the fourth to the sixth dynasty, say from B.C. 3750 to 3100, have been examined. They consist of almost pure copper. One of the earliest, analysed by me, was a piece of a vessel from El Kab, which contained 98 per cent. of copper, the remaining 2 per cent. being made up of bismuth, arsenic, lead, iron, sulphur, and oxygen, evidently the impurities in the original ore.

It was evidently very important for the Egyptians to harden the copper as much as possible; and this might be effected in several ways: (1) by hammering, (2) by the admixture of arsenic, (3) by the admixture of tin, (4) by the admixture of zinc, (5) by the presence of a certain amount of oxygen in the form of cuprous oxide. As to arsenic, some of the oldest copper implements contain a notable quantity. Dr. Percy found 2·29 per cent. in a knife which was dug up some distance below a statue of Rameses II.; and I found 3·9 per cent. in a hatchet from Kahun, dating back to B.C. 2300. It is said, however, that the addition of 0·5 per cent. of arsenic is sufficient to produce a hardening effect; and many specimens of ancient copper implements contain this amount, though the proportion of arsenic in copper ores themselves rarely exceeds 0·1 per cent.

As to the mixture of tin. It is well known that bronze, the alloy of copper and tin, is stronger than pure copper. The extent of this depends upon the proportion of the two metals, and probably on other circumstances. The oldest supposed occurrence of an admixture of tin is in a bronze rod found by Flinders Petrie in a mastaba at Medum, probably of the fourth dynasty, which I found to contain 9·1 per cent. of tin. It seemed so improbable that tin should be employed at so remote a period, and that in sufficient quantity to make what we call gun-metal, that I was suspicious of its genuineness, notwithstanding the very circumstantial account of its discovery; but M. Berthelot has since found in a ring from a tomb at Dahshur, believed to be not much later than the third dynasty, 8·2 per cent. of tin; and in a vase of the sixth dynasty, 5·68 per cent. of tin. These seem to restore the credit of Dr. Petrie's specimen. At a later period weak bronzes become common. Thus, at Kahun tools found in a carpenter's basket by Prof. Petrie contained varying amounts of tin from 0·5 to 10·0 per cent.; 6 or 7 per cent. of tin was subsequently common. Bronze implements abound in Egypt. I am able not only to throw upon the screen representations of arrow- and spear-heads and battle-axes, but, through the kindness of Sir John Evans, to show a beautiful large spear-head with an inscription of King Kames (B.C. 1750) down the blade. I am also indebted to Prof. Flinders Petrie and Dr. Walker for this collection of implements of the twelfth dynasty from Illahun, including a fine mirror with ivory handle, necklets, and a bronze casting for a knife which was never finished; also many objects of the eighteenth dynasty, or thereabouts, such as a sword, dagger and axe, together with mirrors, bracelets, earrings and pendants, and a steelyard. My own collection contains specimens of what are believed to be razors of different types, and small statuettes.

As to the admixture of zinc. There does not seem to be any specimen of brass, properly so called, found in Egypt within the period of our inquiry; but various attempts are known to have been made to imitate gold, of which aurochalcum is an instance, and that may have been yellow brass.

As to oxygen. It is generally supposed to exist in copper in the form of the red cuprous oxide; and most of the copper, and many of the bronze, implements have a covering of this substance. This is caused by the gradual formation of an oxychloride of copper through the action of alkaline chlorides in the soil, aided by the air and moisture. Berthelot has worked out the chemistry of this substance very fully, and shows how when once formed it gradually works its way into the solid metal, transforming it into the suboxide, and frequently disintegrating it. Some good specimens of little bronze images suffering this disintegration are exhibited by Mr. Joseph Offord. Two at least of the copper adzes on the table consist to the extent of 30 or more per cent. of oxide of copper; they are exceedingly hard, and it becomes a question whether the formation of the oxide is due to the slow chemical change, or whether it was purposely produced in the manufacture in order to harden them. The effect of different proportions of oxygen on the tenacity of copper is known to be very various, and certainly deserves further investigation.

It is difficult, or rather impossible, to express in definite figures the advantage gained by the ancient Egyptian metallurgists through this alloying of the copper. Arsenic, tin, or zinc may and do affect the hardness or the tenacity, or the elasticity, in different ways, and also according to the proportion of the metal united with the copper. Thus there are several very different kinds of alloys of copper and tin, though they are all included under the name of bronze; moreover, a piece of copper which has been exposed to a considerable stress is permanently altered in its properties. Again, in any table of numerical values it should be taken into account whether the copper with which the alloys are compared had been made as pure as possible, or contained a normal amount of oxygen.[1] We must rest contented with the knowledge that copper can be rendered stronger and more serviceable by these means, and that the ancient artificers were acquainted with the fact.

After the extensive use of copper and bronze in ancient Egypt, other metals were gradually employed. Silver, as distinct from electrum, seems to have been little used, except for ornamental purposes.[2] The diadem of one of the kings named Antef (B.C. about 2700), and that of the Princess Noubhotep (B.C. 2400), were made of silver and gold. Silver also occurs among the beautiful jewellery of the princesses buried at Dahshur, and that of Queen Ahhotpu. But when the intercourse between Egypt and the neighbouring nations of Asia was better established, silver became much more common; thus we find it frequently mentioned in the Great Harris papyrus (B.C. 1200), in which the King Rameses III. describes his magnificent presents to the temples and priesthood of Egypt. The metal lead also occurs frequently in the same lists, and was used, as elsewhere, for mixing with copper and tin in the formation of the easily fusible bronze used for statuary.

Tin has a more interesting history. We have found it used in combination with copper as far back as perhaps B.C. 3400, and enormous quantities of it must have been afterwards employed. It is still a question whether in the first instance some stanniferous copper ore was used, or whether the Egyptians found that the addition of a certain black mineral was advantageous for hardening their copper, or whether from early days they reduced the metal from its ore and added it to the copper in the furnace. That, at any rate, they were afterwards acquainted with the metal itself, is clear from the discovery by Flinders Petrie of a small ring at Gurob (B.C. 1450), which, on examination, I found to be of tin, imperfectly reduced from its ore. Berthelot has also analysed what was essentially a tin ring, though alloyed with copper, dating about a century later; and Prof. Church describes a scarab of the same metal, which was found on the breast of a mummy of about the seventh century B.C. This metal also appears more than once among the rich gifts catalogued on the papyrus of Rameses III., if "*tehi*" is to be so translated.

Although kohl, the sulphide of antimony, was used for blackening the eyebrows from a very early period, I am not aware of any metallic antimony in Egypt of older date than some beads found by Prof. Petrie at Illahun in a tomb of about 800 B.C. They proved to be fairly pure metal. It is curious that the art

[1] Since the lecture was delivered the Egypt Exploration Fund has issued a memoir, under the title of "Deshasheh," from which it appears that in the very ancient tombs at that place there were found a few gold beads and copper objects, and a picture of an artificer weighing a copper bowl.

[1] For tabulated results of experiments bearing on these points, see "The Testing of Materials of Construction," by Prof. Cawthorne Unwin; and the second Report to the Alloys Research Committee of the Institution of Mechanical Engineers, by Prof. Roberts-Austen, with the discussion thereon.—*Proc. Inst. Mech. En.*, April 1893.

[2] In the translation of "The Book of the Dead," by Dr. Wallis Budge, vol. iii., published since the lecture, it appears that in one of the oldest chapters, said to have been found by Herutataf, about B.C. 3600, there is a formulary to be said over a scarab of greenstone encircled with a band of refined copper, and having a ring of silver.

of preparing this metal was afterwards lost, and only rediscovered in the fifteenth century of our era.

The period of the first use of iron in Egypt is at present a matter of great controversy. Some contend for its use even in the mythological period, while others would bring it as late as 800 or 600 B.C. There exist the oxidised remains of some wedges of iron intended to keep erect the obelisks of Rameses II. at Tanis, which is near the border of Palestine; but there is no positive proof that they were placed there during his reign. I have little doubt, however, that the Black *Baa*, mentioned several times in the Harris papyrus, B.C. 1200, is the same as the *μελας σιδηρος* of Hesiod; *i.e.* iron. In the long account which King Piankhi gives of his invasion of Egypt from the Upper Nile, he mentions iron more than once among the presents made to him by the minor chieftains of the time in token of their submission, indicating that at this period, B.C. 700, it was still not very common.

Assyria.

In the country lying between or near the Euphrates and the Tigris we have some antiquities dating, perhaps, as far back as any in Egypt. We have also a great amount of Accadian and Assyrian historical and other literature on tablets and cylinders of clay, and on the walls of the great palaces and temples. As in the case of Egypt, the discoveries of the remotest age are those which have been most recently published. Dr. Peters has just given us the records of the explorations of the American Oriental Society at Nippur, and describes the successive layers of the great temple of Bel. These appear to indicate the absence of metal in very remote periods. The oldest specimens are those recently found by M. de Sarzec at Tello (Lagash) in Southern Chaldæa. They consist of some votive statuettes, and a colossal spear, an adze and curved hatchet, all of copper without tin, according to M. Berthelot's analysis. A small vase of antimony, and a large one of silver have also been found. The period of these is supposed to be some considerable time anterior to B.C. 2500. At Tel el Sifr, in the same neighbourhood, Mr. Loftus discovered a large copper factory, in which were cauldrons, vases, hammers, hatchets, links of chain, ingots, and a great weight of copper dross, together with a piece of lead. The date of these is believed to be about B.C. 1500. At Nippur the American explorers found at a higher level, in the temple of Bel, what they term a jeweller's shop, which consisted of a box full of jewellery, mainly precious stones, but also containing some gold and copper nails; these apparently date from about B.C. 1300. In Babylonian graves and other places of about the same period there have been found objects made of copper and iron and silver wire; but the use of metals seems much more restricted in these great alluvial plains than in contemporary Egypt. Iron, however, was perhaps an exception. According to Messrs. Perrot and Chipiez, excavations at Warka seem to prove that the Chaldæans made use of iron sooner than the Egyptians; in any case, it was manufactured and employed in far greater quantities in Mesopotamia than in the Nile Valley; in fact, at Khorsabad M. Place found hooks and grappling irons, fastened by heavy rings to chain cables, picks, mattocks, hammers, ploughshares, &c., in all about 157 tons weight. Mr. Layard also found at Nimroud a large quantity of scale armour of iron in a very decomposed state, but exactly resembling what is represented in the sculptures of warriors. Of this he collected two or three basketfuls.

Coming down to the period of the great Babylonian Empire, we find very large treasures of the precious metals changing hands during their sanguinary wars. Thus, on the black obelisk of Shalmaneser II. in the British Museum, we have depicted the embassies from different nations bringing their tribute to the feet of the king; the second of these has an inscription reading: "The tribute of Jehu, son of Omri; silver, gold, bowls of gold, vessels of gold, goblets of gold, pitchers of gold, lead, sceptres for the king's hand, and staves; I received." The gates of his palace at Balawat, now at the British Museum, were of stout timber strengthened with bands of bronze, and the Trustees kindly gave me a small piece of the metal for analysis; it yielded about 11 per cent. of tin. The grandson of this king, Rimmon Narari III., probably B.C. 797, took Damascus, and the spoil, according to the inscriptions, comprised 2300 talents of silver, 20 of gold, 3000 of copper, 5000 of iron, together with large quantities of ivory, &c.

Lenormant gives two verses of a magical hymn to the god Fire, which exist both in Accadian and Assyrian; they run—"Copper, tin, their mixer thou art; gold, silver, their purifier thou art."

Palestine.

Between the great territories o. Egypt and Assyria lies a narrow strip of country, small in extent, but very important in the history of civilisation, commerce and religion. During the period of which we are speaking it was occupied by a succession of different nations. It formed part of the possession of the great Hittite people. We cannot read their inscriptions, and we know little of their history. We have, however, bronze and silver seals that are supposed to belong to them, and curious bronze figures. They seem to have had abundance of silver, probably from the mines of Bulgardagh in Lycaonia. We read of Abraham purchasing a piece of land from Ephron the Hittite for which he weighed out "four hundred shekels of silver current money with the merchant." He was, in fact, rich in silver and gold, and among the presents given to Rebekah were jewels of silver and jewels of gold.

The first notice of metals in Palestine to which we can give an approximate date is in connection with the invasion of that land, and other countries further to the eastward, by the great Egyptian King Thothmes III. He led his army through the plain of Esdraelon, and gained a victory at Megiddo, and amongst the spoil were chariots inlaid with gold, chariots and dishes of silver, copper, lead, and what was apparently iron ore. This took place about B.C. 1600. The original of the long treaty of peace and amity between Katesir, King of the Hittites, and Rameses II. is said to have been engraved on tablets of silver.

When the Children of Israel left Egypt they were, of course, acquainted with the metals used in that country. They borrowed the jewels of silver and gold of their oppressors; and of these the golden calf was afterwards made. We read, too, of the "brazen serpent,"[1] and of elaborate directions for the use of silver, gold, and brass in the construction of the Tabernacle. Lead is mentioned once, but iron seems to have been unknown to them, the word never occurring in the Book of Exodus; and though it is occasionally mentioned in the later Books of Numbers, Deuteronomy and Joshua, it is always with reference, not to the Israelites, but to the nations they encountered. Thus we read of the Midianites having gold, silver, copper, iron, tin and lead, which were to be purified by passing through the fire; of the King of Bashan, a remnant of the Rephaim, who had the rare luxury of an iron bedstead, which was kept afterwards as a curiosity at Rabbah; and of the spoil of the Amorite city of Jericho, comprising gold, silver, copper and iron. Later on the Canaanites were formidable with their "nine hundred chariots of iron"; and later still the Philistines, whose champion, Goliath of Gath, was clad in armour of bronze, and bore a spear with a heavy head of iron. Among the materials collected by David in rich abundance for the building of the Temple were gold, silver, bronze and iron; but the best artificers in metals were furnished by Hiram of Tyre, at the request of Solomon. During the reign of the latter there was an immense accumulation of these precious metals in Jerusalem. The comparative value of the different materials is indicated by the words of the prophet in describing the Zion of the future, "for brass I will bring gold, and for iron I will bring silver, and for wood brass, and for stones iron" (Isaiah lx. 17). Another prophet (Jeremiah vi. 29, 30) uses the simile of the refining of silver by the process of cupellation.

The great mound of Tel el Hesy affords a very perfect example of the débris of town upon town during many centuries; and of the light that these mounds throw upon the progress of civilisation. When Joshua, after the decisive victory of Beth-horon, led his troops to the plain in the south-west corner of Palestine, he besieged and took Lachish, a city of the Amorites. It then became an important stronghold of the Israelites: its vicissitudes are frequently mentioned at various dates of the sacred history, as well as on the Tel el Amarna tablets. The mound has lately been explored by Messrs. Petrie and Bliss; and in the remains of the Amorite city (perhaps B.C. 1500) there are large rough weapons of war, made of copper without admixture of tin; above this, dating perhaps from 1250 to 800, appear bronze tools, with an occasional piece of silver or lead, but the bronze gradually becomes scarcer, its place being taken by iron, till at the top of the mound there is little else than that metal. The Palestine Exploration Fund has kindly lent me specimens of these finds for exhibition. About B.C. 700,

[1] The word "brass" at the time of the translation of our Bible was used indiscriminately for copper or any of its alloys. In the Old Testament it never refers to the alloy of zinc, to which the term is now confined.

Lachish was the headquarters of Sennacherib, during his invasion of Palestine. From it he sent his messengers to Hezekiah, and at the same town he received the peace offering of the Jewish king, 300 talents of silver and 30 talents of gold, to raise which he had to despoil his palace and the Temple. In Sennacherib's own version of the transaction, the silver is given as 800 talents, and the gold 30. Lachish was finally deserted about 400 B.C.

GREECE.

We know little of the very early history of Greece, for the most ancient monuments bear no inscriptions, and literature did not commence till the time of the Homeric poems. In these, and in Hesiod, there are many graphic descriptions of the habits and arts of the heroic period, including the use of metals; and many of the towns described in them have recently been explored with great success, and have yielded up the very materials about which they sang.

Probably the earliest find has been in the volcanic island of Santorin, where, under beds of pozzolana, which are supposed to date about 2000 B.C., have been found two little rings of beaten gold and a saw of pure copper. In the Ashmolean Museum there are a very ancient silver ball, and beads of the same metal rolled from the flat; also a spear-head of copper. These were obtained from Amorgos. In Antiparos there have also been found very ancient objects of silver mixed with copper.

Passing to the mainland, the towns of the Peloponnesus and the mound of Hissarlik, the supposed Troy, have been explored by Dr. Schliemann, Dr. Tsountas, and Dr. Dorpfeld; and they reveal what is termed the Mycenæan period, which figures so largely in the poems of Homer and Hesiod. In these the precious metals, gold and silver, are constantly mentioned, together with *χαλκος*, generally translated brass. Thus, in the description of Achilles' shield, we are introduced to Hephaistos at his great forge on Etna, heating the bars of silver, or brass, or tin, or gold, and then hammering them on the anvil, so forming the designs which represent so beautifully the various scenes of peace and war. After having fashioned the shield, he is represented as forging for the warrior a cuirass of copper, greaves of tin, and a helmet with a golden crest.

Homer frequently mentions iron, but generally gives it the epithet "worked with toil," and treats it as a rare and costly metal. Thus a huge iron discus was given as a valuable prize to the hero who could throw it the farthest in the athletic games at the funeral of Patroclus.

Mr. W. E. Gladstone, who has long turned the great powers of his mind from time to time to Homeric studies, wrote me last summer: "The poems of Homer showed me, I think, forty years ago that they represented in the main a copper age." The reasons he assigns in his letter, as well as in his published works, are fairly conclusive, and the recent explorations, and the analyses of Dr. Percy, Prof. Roberts-Austen, and others, have shown that in the early period of the Mycenæan age copper without tin was employed for numberless purposes; but as time advanced, bronze came into use. At Hissarlik, in the lowest and second city have been found a gilded knife-blade, needles and pins, of practically pure copper; while in the third and sixth cities occur battle-axes of copper containing 3 to 8 per cent. of tin. In the very old town of Tiryns, the palace apparently had its walls covered with sheets of copper; much lead was also found there. At Mycenai, the Achaian capital, the metals in use were gold, silver, copper, bronze and lead; copper jugs and cauldrons are common, and great leaden jars for storing grain; also elegant bronze tools and cutlery; mirrors, razors and swords. In the tombs the bodies are laden with jewels, largely ornaments of gold, with a much smaller amount of silver.

Some of these objects illustrate the poems of the time; thus, in the Odyssey we find Nestor making a vow to Athenæ: "So the heifer came from the field; . . . the smith came holding in his hands his tools, the means of his craft, anvil and hammer, and well-made pincers, wherewith he wrought the gold. Athenæ, too, came to receive the sacrifice. And the old knight Nestor gave gold, and the other fashioned it skilfully, and gilded therewith the horns of the heifer, that the goddess might be glad at the sight of her fair offering." Now at Mycenai there was found the model of an ox-head in silver, with its horns gilded, and between them a rosette of gold, not directly attached to the silver, but to a thin copper plate. In Vaphio, a town near Sparta, of a somewhat later period, tombs were found containing many beautiful objects in silver, gold and bronze. Especially noteworthy are two golden cups embossed with figures of bulls and men; in the one case it is a spirited hunt in the woods, in the other a peaceful scene on the meadows. Iron, in Mycenai, appears only as a precious metal of which finger-rings are formed.

In the remains of a Greek colony in Cyprus, belonging to the end of the Mycenæan period, which is now being explored by the British Museum, iron plays a much more important part. At Athens also large iron swords, which belonged to the ninth or tenth century B.C., have been found in an old cemetery.

After this came the intellectual period of Grecian history. Aristotle must be mentioned in any account of the science of the day; and he it is who gives us the first description of the metal mercury, and also how to produce the alloy which we call brass, by heating together copper and calamine, the carbonate of zinc. Metallic zinc, however, was not known for many centuries afterwards.

CONCLUSION.

In tracing back the history of these great nations we have found evidence of a time when metals were little, if at all, employed: the potter's art was well known, and early man became wonderfully proficient in working hard stone, and especially flint. The earliest indications we have of metals are of gold and copper, both being scarce, and no doubt costly. Gold was probably the earliest to attract the attention of mankind, because it occurs native, of bright yellow colour, and is easily worked. Copper, however, dates to a similar period, so far as the remains which have come down to us are concerned. Probably the deep blue carbonate, such as occurs in Armenia, was first worked. When silver was first used is not very evident, but it is certain that it was far more common in the northern portion of the area we have been considering, than in the southern. The metallurgy of copper was doubtless a matter of much study and experiment, so as to produce the hardest metal. This seems to have led to the discovery of tin, but at what precise period we know not; nor do we know whether it was brought from Etruria, or found in some nearer region. Mines of tin were certainly worked at Cento Camarelle, as Egyptian scarabs have been found in the old workings,[1] and near Campiglia and in Elba, as well as in the Iberian peninsula. This search for the metals, and the necessity of carrying the ore or rough metal to the places where it was wrought, or of the finished material to distant customers, must have greatly promoted commerce. This took place both by land and sea, in caravans and ships. In this way tools and other objects were disseminated through the more distant parts of Europe and Asia: the similarity of type over large areas shows a common origin, and hence we can even roughly form an opinion as to whether they were introduced in earlier or later times. Thus, in Switzerland and Scandinavia we meet with copper implements as well as bronze, and ancient as well as modern forms; while in Britain we find no evidence of copper tools, though bronze objects are abundant.

The Phœnicians, arriving on the eastern shores of the Mediterranean from the direction of the Persian Gulf, formed an important nation for about 1000 years, from B.C. 1400 to B.C. 400. They were great artificers, but not having much originality they adopted the patterns and designs of Egypt or Assyria. They were also pre-eminently traders, and founded cities and emporia of commerce, so that their metal work was spread over all the Mediterranean. It is to be found in Cyprus, mixed with the workmanship of the Grecian Mycenæan age. Their ornamental jewellery was eagerly sought in Etruria, Greece and Calabria; for the beauty of it I may refer you to the Etruscan cup of gold in the South Kensington Museum, and the wonderful work in gold in one of the Greek rooms in the British Museum.

Commerce implies a large extension of a medium of exchange. The whole question of money is far too wide a subject for us to deal with now; suffice it to say that Herodotus attributes to the Lydians the introduction of the use of coins. The earliest were of electrum, issued in the form of oval bullets, officially stamped on one side. They date back, perhaps, to B.C. 700; but according to other authorities, silver money was coined at Ægina more than a century before that time.

The great period which has been under our consideration terminated in each country with an age of disorder and deterior-

1 See "Early Man in Britain," by Prof. W. Boyd Dawkins.

ation. The rise of the Roman Empire introduced a new era: it was in one sense an iron age—*ferrum* being synonymous with the sword. We now live in another kind of iron age, but in better and brighter times than those of Hesiod, and we may hope that our great engineering works, our iron roads and iron steam-ships may lead not to the enslaving but the brotherhood of nations.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MISS JANE CRUIKSHANK has given 15,000*l.* to Aberdeen University, to provide a botanic garden at Aberdeen in memory of the late Dr. Alexander Cruikshank.

THE University of Edinburgh has conferred the honorary degree of LL.D. upon Mr. Horace T. Brown, F.R.S., Prof. D. G. Ritchie, and Prof. J. Victor Carus, assistant professor of zoology at Leipzig.

IN order to make accessible under the most favourable conditions to university students, to teachers, and to investigators, the facilities and environment of the Illinois Biological Station, reinforced by the equipment of the biological departments of the University of Illinois, the university has decided to open, on June 15, a summer school of field and laboratory biology at this station on the Illinois River, at Havana. Opportunity is thus given for personal studies, in field and laboratory, of the plants and animals of a peculiarly rich and interesting situation, and of the methods of modern biological station work.

THE following are items concerning the extension of provision for scientific training in the United States:—Syracuse University will shortly begin the erection of a 45,000-dollar science building.—Adelbert College at Cleveland, Ohio, has a biological building under way, which will cost about the same amount.—Richmond College, Virginia, has received 5000 dollars towards a science building.—The University of Chicago has received a gift of about 150,000 dollars from an anonymous donor. Miss Gould has given a further sum of 10,000 dollars towards the endowment of the engineering school of New York University.—Mr. Chester W. Kingsley has given 25,000 dollars to Colby University.

IT was briefly noted last week that the University of Paris had taken up a loan amounting in all to 1,700,000 francs. Referring to this action, the Paris correspondent of the *Lancet* remarks:—The law which has reconstituted the universities has given to them a civil personality; they have their own budget and their own sources of income, which are definite and assured, and they are able to contract loans on the security of these sources of income. The 1,700,000 francs which the university has borrowed will be devoted to carrying out two schemes. The greater part of this sum will be devoted to the construction of buildings for the accommodation of first-year students in medicine. The other portion of the loan will be devoted to the keeping-up of a laboratory of natural history at Fontainebleau.

THE Technical Education Board of the London County Council will proceed shortly to award not less than five Senior County Scholarships. These scholarships are of the value of 50*l.* a year, together with the payment of tuition fees up to 30*l.* a year, and are tenable for three years at university colleges and advanced technical institutes. They are confined to residents within the administrative county of London, and are open only to those whose parents are in receipt of not more than 400*l.* a year. Candidates should as a rule be under twenty-two years of age, though the Board reserves the right to give preference to candidates who are under nineteen years of age. The scholarships are intended to encourage more especially the teaching of science, and to enable those students who cannot afford a university training to pursue advanced studies for a period of three years in the highest university institutions in this country or abroad. Of the seventeen students who are now holding Senior Scholarships five are studying at Cambridge, five at the Central Technical College in Exhibition Road, three at the Durham College of Science, Newcastle-upon-Tyne, two at German Universities, and two (ladies) at Bedford College and Holloway College respectively. The scholarships are awarded on a consideration of the past record and general qualifications of the candidates, and not upon the results of a set examination. Application forms may be obtained from the Board's Secretary, 116 St. Martin's Lane, W.C., and must be returned not later than Monday, May 16.

DURING his term of office, Sir A. Mackenzie, the Lieutenant-Governor of Bengal, has done much to advance the cause of scientific and technical education in his province, and a speech he delivered recently at the Indian Association for the cultivation of science is a further expression of his sympathies with the development of education on scientific lines. In the course of his address he said:—"I would have the student of the future cease to be brought up on badly assimilated *words* and on high-faluting rhetoric, and I would have him taught to observe and think, and *educate himself* in the way Herbert Spencer indicates as the great desideratum in all education. The oriental mind is only too prone to rest on authority and accept inaccuracies. Pupils trained on books and books alone are mere passive recipients of other people's ideas. They never learn the arts of observing facts and applying knowledge. The study of science cultivates the judgment as the study of language never can. Science constantly appeals to and develops the individual reason. It is no doubt the case that even in England people are only now waking up to the knowledge of a wise pedagogy, but they *are* waking up at last. The idea of development of faculty is being substituted for that of mere acquisition of knowledge. The mere cultivation of words and application of formulæ is being discredited. The ideal education is being recognised as one which multiplies the power of the eye to see, of the ears to hear, of the hand to execute; which puts a mind well stored with knowledge into active contact with faculties capable of translating it into action." In India at present science holds but a very secondary place in the curriculum of high education, and if the country is ever to advance there must be an educational revolution which will release the youth of India from the bonds of a purely literary education. The University of Calcutta has as yet done little for science culture, but the Bengal Government has within the last few years done good work for the advancement of technical education. The reconstruction of the Medical College begun by Sir Charles Elliott has been pushed on; and the Sibpur Engineering College has been expanded so as to make it a school where civil engineering, mining engineering, mechanical engineering, and electrical engineering can be and are being thoroughly taught to over 300 students. The Presidency College, having as principal Prof. A. Pedler and upon its staff Profs. J. C. Bose and Roy, has also admirable work to show. Sir A. Mackenzie concluded by saying: "As the Bengali has conquered the field of medicine, so he may conquer the field of engineering and mechanical industry, if those engaged in the instruction of the young will only shake themselves free from the trammels of a literary curriculum which, coupled with the absence of moral and religious training and the failure to impart a sound knowledge of their own country, its material wants and capabilities, is in my judgment fast ruining the youth of the country and stunting their development."

SCIENTIFIC SERIAL.

Bulletin of the American Mathematical Society, March.—The relations of analysis and mathematical physics is the translation, by C. J. Keyser, of the interesting address delivered before the International Congress of Mathematicians, at Zürich, on August 9, 1897. The writer, Prof. H. Poincaré, answers some questions which he says are often asked, as "What is the utility of mathematics, and whether its nicely constructed theories, drawn entirely from the mind, are not artificial products of our caprice?" "The end of mathematical physics is not merely to facilitate the numerical calculation of certain constants, or the integration of certain differential equations. It is more; it is, above all, to disclose to the physicist the concealed harmonies of things by furnishing him with a new point of view."—The roots of polynomials which satisfy certain linear differential equations of the second order, is a short note by Prof. M. Bôcher, following up work by Stieltjes in vol. vi. of the *Acta Mathematica*.—Inflexional lines, triplets, and triangles associated with the plane cubic curve, by Prof. H. S. White, considers the configuration of the nine inflexions of a non-singular plane cubic and the twelve lines containing them 3 and 3, from what the writer thinks to be a novel point of view. The statements are of some interest.—On the intersections of plane curves, by Prof. Charlotte Scott, brings together several passages bearing on Maclaurin's paradox (*i.e.* Cramer's so-called, but it is here carried back to Maclaurin). It is a valuable paper on curves.

and is mainly concerned with a recent paper by F. S. Macaulay, viz. point groups in relation to curves (*London Math. Soc. Proc.*, vol. xxvi. pp. 495–544).—Prof. Beman points out the use of i, by Euler, to represent an imaginary, thus disposing of Gauss's claim to priority.—The remaining matter consists of shorter notices (*i.e.* reviews), notes, and publications.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 10.—"An Extension of Maxwell's Electro-magnetic Theory of Light to include Dispersion, Metallic Reflection, and Allied Phenomena." By Edwin Edser, A.R.C.S. Communicated by Captain W. de W. Abney, C.B., F.R.S.

All media are considered, as far as their properties affect the propagation of electro-magnetic waves of frequencies as great as those of light, to consist of molecules, each comprising, in the simplest case, two oppositely charged atoms at a definite distance apart. In an electric field the positive atoms move to points of lower, and the negative atoms to points of higher potential. In doing so a molecule may be subjected to a rotational displacement, or its constituent atoms may be separated more widely from each other. Equations are determined giving the relation of the specific inductive capacity (the electric strain being steady) to the molecular displacements.

Maxwell's well-known equations are modified by adding to the total displacement current a term representing the convection current per unit volume. The existence of free ions is not considered capable of materially affecting the value of the refractive index for light waves. Subsidiary equations representing the conditions of the atomic vibrations are assumed, and the refractive index, μ, is finally given by the equation

$$\mu^2 = \mu_\infty^2 + \frac{c'\lambda_1^2}{\lambda^2 - \lambda_1^2} + \frac{c''\lambda_2^2}{\lambda^2 - \lambda_2^2}$$

μ_∞^2 represents the specific inductive capacity as previously determined.

Double refraction in a uniaxal crystal is explained by supposing the axes of the molecules to be arranged with their axes all parallel to one direction. Electric disturbances perpendicular to this direction will produce a molecular rotation, whilst those parallel to the molecular axes will produce a separation of the constituent atoms. Hence two different propagational velocities will follow. The connections of the above theory with Kerr's well-known experiments on the double refraction experienced by light when traversing a liquid dielectric subjected to electric stress, and the facts of pyro-electricity are obvious.

In order to account for the phenomena of the propagation of light in metals, a viscous term is added to the equation for the molecular vibrations. The square of the refractive index is hence derived as a complex quantity, the imaginary part being essentially positive. In those cases where the real part of the refractive index is a large negative number, it is pointed out that the velocity of propagation of light waves will be inversely proportional to the molecular viscosity (and therefore to the electrical resistance) of the metal, agreeing with Kundt's experimental relation.

Geological Society, April 6.—W. Whitaker, F.R.S., President, in the chair.—Prof. T. Rupert Jones exhibited and commented upon a series of large stone implements, sent to England by Mr. Sidney Ryan, from the tin-bearing gravels of the Embabaan in Swaziland (South Africa). Some implements lent by Mr. Nicol Brown, and analogous implements of rough quartzite, from Somaliland, lent by the Rev. R. A. Bullen, were also exhibited.—Prof. H. G. Seeley exhibited the humerus of a Plesiosaurian in which the substance of the bone was almost entirely replaced by opal. He explained that the fossil was from the opal mines of New South Wales.—On some Palæolithic implements from the plateau-gravels, and their evidence concerning "Eolithic" man, by W. Cunnington. Although at first inclined to believe that the chipping on the "Eoliths" of the plateau-gravels was the work of man, the author has been led to recant this opinion by the detailed study of specimens lent or given to him by Mr. B. Harrison. His reasons are mainly based on the facts that the chipping is of different dates, even upon the same specimen, and that it was produced after the specimens were embedded in the gravel. A further series of specimens, which, although not found actually *in situ* in the gravels, present undoubted evidence that they came from these, are considered by the author to be of Palæolithic type. One of them appeared to have gone through the following stages: first it was fashioned by man into a Palæolithic implement, then it was abraded, broken and chipped along one edge in the same fashion as the alleged "Eolithic" working; finally it was stained, marked with glacial striæ, and covered with a thin layer of white silica. This implement appears to prove that Palæolithic man lived on the Kentish plateau before or during the deposit of the plateau-gravels, and that the "Eolithic" chipping is not the work of man. A long discussion followed the reading of the paper, and was summed up by Dr. Gregory, who replied on behalf of the author. Dr. Gregory said he noticed in the discussion absolute unanimity on one point: no one denied that some of the specimens exhibited were worked by man, and that they were genuine plateau-gravel flints, which must have been flaked before the deposition of the gravels. Every speaker had therefore admitted that man lived in Kent before or during the deposition of part of the plateau-gravels. Thanks, therefore, to Mr. B. Harrison's magnificent perseverance and industry, man's age in Kent had been carried back one stage further. In the congratulations to Mr. Harrison on that achievement, no one would join more heartily than the author. But that admission did not affect the question of the specimens described as "Eoliths" or "rudes." Those who believed in these specimens still could not agree as to which are genuine and which are not. He thought the critical points of the paper had been ignored in the discussion: no attempt had been made to show that the implements were not Palæolithic, or that the "Eolithic" work was not later than the Palæolithic work. He quoted the opinions of Mr. Montgomery Bell and Mr. Harrison to show the identity of the working of the broken edge of the Palæolith with that of the Eoliths. It was only the "Eolithic" implements that the author had denied. The wide general importance of this question was the claim that the Kent plateau had been the home of a primitive pre-Palæolithic people, which, he held, the author's arguments conclusively disproved.—On the grouping of some divisions of Jurassic time, by S. S. Buckman. The author argues for an arrangement in the division of Jurassic time based upon the zoological phenomena of the Ammonite fauna.

PARIS

Academy of Sciences, April 12.—M. van Tieghem in the chair.—The President announced to the Academy the recent death of M. Aimé Girard, Member of the Section of Rural Economy (see p. 587).—Observations relative to the action of oxygen upon sulphide of carbon and to the chemical influence of light. Preliminary action determining the chemical changes, by M. Berthelot. In a mixture of air with the vapour of carbon disulphide exposed to diffused light no change was found to have occurred at the end of a year. Under the influence of direct sunlight, however, oxidation soon commences, but is by no means completed in a year. The effect produced is, therefore, not simply proportional to the luminous intensity, unlike the combination of hydrogen and chlorine, which commences in the most feeble diffused light and increases with the intensity.—On the absorption of oxygen by pyrogallate of potassium, by M. Berthelot. The principal defect of the common method of estimating oxygen consists in the simultaneous formation of small quantities of carbonic oxide. A number of experiments are described in which the influence of temperature, dilution, and the relative proportions of pyrogallol and potash upon the course of the reaction is ascertained. The author concludes that, in order that only negligible quantities of carbonic oxide may be produced, the absorption should be effected in presence of a large excess of potash and an amount of pyrogallol capable of absorbing four or five times the volume of oxygen likely to be present. From the products of the reaction an oxyquinone ($C_6H_4O_5$) may be extracted with ether, after acidification. This compound will be described later.—Flesh and starch compared with sugar, as regards nutritive value, in the case of a working subject, by M. Chauveau.—Addition to a preceding communication concerning the theory of quadratic forms, by M. de Jonquières.—Observations of Comet Perrine, made at the observatory of Algiers, by MM. Rambaud and F. Sy.—Expression of the derivatives of *theta* functions of two arguments by means of the squares of *theta* functions, by M. E. Jahnke.—On the systems of differential equations satisfied by quadruply periodic functions of the second species, by M. M. Krause.—On the equations of the theory of elasticity, by MM. Eugène and François Cosserat.—On the passage of electric waves from one conductor to another, by M. C. Gutton.—On the thermic properties of saturated vapours, by M. E. Mathias.—On a new apparatus for the raising of liquids, by M. G. Trouvé. The instrument combines the principles of the centrifugal pump and the water-spout. The liquid is given a gyratory or spiral motion by means of a revolving cone, from the larger end of which it is expelled through an orifice placed tangentially.—On the plane of magnetisation of magnetic pyrites, by M. Pierre Weiss. When a magnet is brought near a crystal of the mineral no attraction is observed when the plane of the hexagonal base is perpendicular to the lines of force, although it is very marked in any other position. Exact experiments are adduced to prove that magnetisation can only take place in one plane, the *magnetic plane*.—Rays emitted by compounds of uranium and of thorium, by Mme. Sklodowska Curie. A study of the influence of the rays emitted by various compounds of the two metals upon the conductivity of the air. A difference of potential of 100 volts was established between the two plates of a condenser (at a distance of 3 centimetres), one of which was covered with a uniform layer of the substance under examination. The current strength was measured by means of an electrometer. All the compounds of uranium and thorium are active; those of cerium, tantalum, and niobium but slightly so. Two minerals of uranium, viz. pitchblende (oxide of uranium) and chalcolite (phosphate of copper and uranyl), are much more active than uranium itself. It is to be observed that the most active elements, uranium and thorium, are those which have the highest atomic weights.—On a means of augmenting the intensity and the rapidity of action of the X-rays, by M. F. Garrigou. The rays are confined during their passage from the source to the fluorescent screen or photographic plate by a cylinder of glass or metal. They are thus concentrated, and produce the required effect in a shorter time.—On the combinations of pyridine and trimethylamine with formic and acetic acids, by M. G. André. The compounds of pyridine described in a previous communication have been further investigated, and their heats of formation determined. They were found to be completely dissociated on vaporisation. Similar compounds of trimethylamine have now been prepared, and found to be more stable than the corresponding pyridine derivatives.—Influence of wave movements upon the development of the larvæ of the frog, by M. Émile Yung. The eggs of batrachians are naturally deposited in the calm waters of marshes and lakes. The author has studied the effect of continual agitation on their development. The freshly fertilised eggs speedily die; but if the embryo be already formed before agitation commences, development continues, although the mortality is great. The surviving tadpoles are distinguished by horny formations in the buccal cavity and a remarkable development of the tail.

DIARY OF SOCIETIES.

THURSDAY, APRIL 21.

SOCIETY OF ARTS (Indian Section), at 4.30.—Recent Railway Policy in India: Horace Bell.

LINNEAN SOCIETY, at 8.—On the Structure of *Dendroceros*: Prof. Douglas Campbell.—On the Pterylosis of the Owls: W. P. Pycraft.—On the Thymus and Thyroid of Marsupials: J. Johnston.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Cost of Generation and Distribution of Electrical Energy: R. Hammond. (Continuation of Discussion.)

CHEMICAL SOCIETY, at 8.—The Carbohydrates of Barley Straw: C. F. Cross, E. J. Bevan, and Claud Smith.—Isomeric Bornylamines: Dr. M. O. Forster.—Some Derivatives of Benzophenone: Dr. F. E. Matthews.—Researches on Camphoric Acid: Dr. S. B. Schryver.—Ballot for Election of Fellows.

FRIDAY, APRIL 22.

ROYAL INSTITUTION, at 9.—The Recent Eclipse: W. H. M. Christie, C.B., F.R.S.

PHYSICAL SOCIETY, at 5.—On a Method of Viewing Newton's Rings: Rev. T. C. Porter.

INSTITUTION OF CIVIL ENGINEERS, at 8.—New Cut Swing Bridge, Swansea: M. W. Henty.

SATURDAY, APRIL 23.

GEOLOGISTS' ASSOCIATION (Paddington Station, at 1.33).—Excursion to Reading. Director: J. H. Blake.

MONDAY, APRIL 25.

SOCIETY OF ARTS, at 8.—Sources of Commercial India-rubber: Dr. D. Morris, C.M.G.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Investigations in the Atlantic: H.S.H. the Prince of Monaco.

INSTITUTE OF ACTUARIES, at 5.30.—On the Mortality in the British Navy and Army, as shown by the Official Reports: James J. McLauchlan.

TUESDAY, APRIL 26.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Exhibition of Stone Implements from Swazieland, South Africa: Prof. T. Rupert Jones, F.R.S.—Exhibition of Stone Implements from South Africa: W. H. Penning.—A Study of African Crania: Frank C. Shrubsall.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Annual General Meeting of Corporate Members.

ROYAL HORTICULTURAL SOCIETY, at 1.—Sweet-scented Leaves.

ROYAL VICTORIA HALL, at 8.30.—Motor Cars: Prof. D. S. Capper.

WEDNESDAY, APRIL 27.

SOCIETY OF ARTS, at 8.—Photography and Colour Printing: Captain W. de W. Abney, C.B., F.R.S.

ROYAL GEOGRAPHICAL SOCIETY, at 4.30.—The Possibility of Acclimatisation of Whites in Tropical Countries: Dr. Sambon.

INSTITUTION OF MECHANICAL ENGINEERS, at 7.30.—President's Address: S. W. Johnson.—First Report to the Gas-Engine Research Committee; Description of Apparatus and Methods, and Preliminary Results: Prof. Frederic W. Burstall.—Supplementary Paper and Adjourned Discussion.

THURSDAY, APRIL 28.

ROYAL SOCIETY, at 4.30.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

FRIDAY, APRIL 29.

ROYAL INSTITUTION, at 9.—Magneto-Optic Rotation and its Explanation by a Gyrostatic Medium (with Experimental Illustrations): Prof. A. Gray, F.R.S.

INSTITUTION OF MECHANICAL ENGINEERS, at 7.30.—Steam Laundry Machinery: Sidney Tebbutt.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Radiography and the "X" Rays: S. R. Bottone (Whittaker).—The Theory and Practice of Electrolytic Methods of Analysis: Dr. B. Neumann, translated by J. B. C. Kershaw (Whittaker).—Alternate Currents in Practice: translated from the French of Loppé and Bouquet by F. J. Moffett (Whittaker).—A Manual of Dental Metallurgy: E. A. Smith (Churchill).—A Manual of Dental Anatomy: C. S. Tomes, 5th edition (Churchill).—Musical Statics: J. Curwen, new edition, revised by T. F. Harris (Curwen).—A Student's Text-Book of Zoology: A. Sedgwick, Vol. 1 (Sonnenschein).

PAMPHLETS.—Tobacco Soils of the United States: M. Whitney (Washington).—Die Meteorologie der Sonne und das Wetter im Jahre 1888: Prof. K. W. Zenger (Prag).—Recent Laws against Injurious Insects in North America: L. O. Howard (Washington).

SERIALS.—Engineering Magazine, April (222 Strand).—Scribner's Magazine, April (Low).—Annales de Electrobiologie, &c., March (Paris, Alcan).—American Journal of Science, April (New Haven).—Record of Technical and Secondary Education, April (Macmillan).—Journal of the Institution of Electrical Engineers, April (Spon).—Terrestrial Magnetism, March (Cincinnati).—Journal of the Royal Statistical Society, March (Stanford).—Geographical Journal, April (Stanford).—Encyklopædie der Naturwissenschaften, Erste Abthg. 71, 72 Liefg., Dritte Abthg. 38 to 43 Liefg. (Breslau, Trewendt).—Zoologist, April (West).—Quarterly Journal of Microscopical Science, March (Churchill).—Journal of the Royal Horticultural Society, April (117 Victoria Street).—Journal of the Franklin Institute, April (Philadelphia).

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