THURSDAY, AUGUST 8, 1901.

GREEK PHILOSOPHY AND MODERN CULTURE.

Greek Thinkers; a History of Ancient Philosophy. By Theodor Gomperz, Professor at the University of Vienna. Vol. i. Translated by Laurie Magnus, M.A. Pp. xv + 610. (London: John Murray, 1901.) Price 14*s*. net.

THE study of the history of Greek philosophy requires no defence and, fortunately, little encouragement. Confessedly our intellectual culture can be traced to Greek origin. The subject is so engrossing, and the full comprehension so indispensable, that able minds will be ever ready to consider the problem and give it fuller illustration. How far the questions that provoked discussion in the Greek colonies on the shores of the Mediterranean were intuitive, how far they were acquired, is of small importance in comparison with the manner in which they affect us. In these days, when the spirit of inquiry is active, we may doubt whether we tap the true source of originality by questioning Greek texts and obscure fragments. The spade of the archæologist is proving itself an equally potent factor. The sandhills and tombs of Egypt have been made to reveal the secrets they have kept so well. Explorations among the ruins of ancient Babylonian or Assyrian cities have unearthed the traces of a highly developed civilisation on the banks of the Nile and the Euphrates which may have operated not less powerfully on the Greek colonists than the Greek philosophy has affected us. It may be that the student of the future, in his anxiety to trace the earliest effects on the human mind, will have to begin his criticism still farther back, but in the absence of any considerable literature we must at present be content to regard our culture as a Greek product.

Among those who have laboured diligently and with effect upon the many problems that exercised the ancient Greek, the researches of Prof. Gomperz will occupy a high place. His book entitled "Greek Thinkers," which appeared in 1896 and is now translated by Mr. Laurie Magnus, is an exceedingly welcome contribution to this subject. This work not only exhibits accuracy of scholarship and critical acumen, but is equally distinguished by lucidity of expression. Perhaps, too, we may say that Prof. Gomperz has been fortunate in his translator. It seems to us that Mr. Magnus has accomplished his part of the work with admirable skill, and that to an English reader the charm of the work is greatly increased by the ease and brightness with which the original thoughts of the German writer are expressed. Prof. Gomperz deserved a good translator. He has done much useful work himself in making his countrymen acquainted with the thoughts and philosophy of J. S. Mill through translations, and it is only fitting that a similar service should be rendered to his monograph.

The main object of Prof. Gomperz's work is, it may be assumed, to show how greatly, and in what particular directions, we are indebted to Greek thought and Greek methods. Of course, as a general principle the effect is admitted, but to trace the connection with any degree of completeness is a matter of no small difficulty. It requires a survey as a whole of the developed intelligence of the Greek mind, an appreciation of the different tendencies of ancient thought, and a very complete knowledge of modern culture. The author thinks it not impossible that in the future we may see an exhaustive universal history of the mind of antiquity. Pending the appearance of such a monumental work, we welcome with gratitude the worthy contribution that is here made to the more general scheme to which it forms an adequate introduction.

In an introductory chapter the author unfolds, as a panorama, the theatre in which all future development was generated. He dwells appreciatively on the effect colonial life and experience exercised on the intelligence and vigour of the nation, fostering, on the one hand, the hardy and courageous disposition of the emigrant; and, on the other, enlarging his horizon and stimulating his ambition by travel and contact with foreign civilisation. It was in the colonies, doubtless from the introduction of the foreign element referred to above, that the greatest intellectual vigour was afterwards found. To them more than to the parent state it was given to steep themselves in intellectual pursuits, and with whom the riddles of the world and of human life were to find a permanent home and to provoke an enduring curiosity.

The author divides his book into three sections—The Beginnings, From Metaphysics to Positive Science, The Age of Enlightenment. Such a division must of necessity be a little arbitrary, suggesting greater breaches of continuity than really existed. Also, at times, it may lead to a little confusion in chronological arrangement, but that is of small importance, since progress never exhibits the uniform onward movement we connect with time. Historical or biographical references when introduced simply play a secondary part as a background, to give effect to the ordered development. As earliest in history, but perhaps more advanced in scientific accuracy, containing, as it did, the accumulated information of the priests of Chaldea and Egypt, the Ionian school comes first under review, and well exhibits the author's general method of treatment. He endeavours to find the principle underlying the original expression, to think as these old philosophers thought, to determine the amount of truth at which each arrived, to give him credit for it, and to compare and contrast it with modern views. In the Ionian school, for instance, we have hitherto, perhaps, too much considered the astronomical teaching, a result of the commanding importance which Thales has acquired, owing to the part the famous eclipse connected with his name has played in scientific chronology. This has introduced a disproportion which is fatal to a general survey. We have forgotten that he also taught that water was the primary element. To have the true measure of the time we have to remember him as a chemist as well as an astronomer. Prof. Gomperz finds in the teaching of this school, underlying the vagueness, two of the corner-stones of modern chemistry—the existence of elements and the indestructibility of matter. At another point the "physiologists" of Ionia actually outstripped the results of modern knowledge. The bold flight of their imagination never rested "till it reached the conception of a single fundamental or primordial matter as the source of material diversity" (p. 46). Prof. Gomperz's comment is, "Here it may almost be said that inexperience was the mother of wisdom." We are inclined to agree with him, though possibly not quite in the sense in which the phrase is used. The scientific teaching of the school seems to have been best at its birth, and rapidly to have deteriorated. But while admitting and appreciating the author's wish to give credit to whatsoever things are true and of good report, difficulties and uncertainties must exist owing to the scarcity of original documents. We get the views of the great thinkers of antiquity filtered through the minds and coloured by the influence of a crowd of disciples, of collectors, of commentators. The author admits that the whole pre-Socratic philosophy is one vast field of ruins. The picture constructed from these scattered mosaic fragments may be very beautiful to look at, but it may not be the same picture that was originally drawn.

We should have liked to follow the author through each school in which he discovers the different tendencies of ancient thought or given some evidence of the discriminating appreciations that have accompanied some time-honoured name. One could linger long over the Eleatics, those pioneers of criticism who sought to rouse mankind from indolence of thought and the disposition to dogmatic slumber. For the paradoxes of Zeno we have always entertained a profound veneration, and the author is kind enough to stir these dry bones and make them live. Some of these he has clothed in a modern dress, but the difficulty does not lie in the dress, and the old problem connected with relative and absolute motion seems as elusive as ever. The tale of the arrow sped from the bow is put into this captious form: "Does an object move in the space in which it is, or in the space in which it is not?" And this seems as good a way as any to put the problem, which does not seem to have been clearly expressed in the original. Similarly with the old, old story of Achilles and the tortoise, to which we believed we could have given a satisfactory answer before reading the author's comments, but now entertain grave doubts. It is a difficult task to frame a paradox which cannot be exploded in less time than it takes to construct it, and the ingenuity of Zeno will be appreciated by those who have attempted to follow him on this thorny path.

The historians and the physicians or medical schools must also be passed over in silence, though it cannot be imagined that in a critical account of Herodotus, for example, there is not much to interest and perhaps something to qualify. The importance of the medical schools is insisted upon, since here exact observation supplied a much needed check to hasty generalisations, and many a forgotten name to whom accident has denied justice appears in this list of worthies, all contributing to build up science as we understand the term. A work of some 600 pages by a German author might be supposed by some to be a very dull work. This would certainly be an error. It is bright and lucid, free from pedantry, and occasionally epigrammatic. Prof. Gomperz promises us two more volumes; we have no doubt but that the interest will be equally well sustained, and we hope he may again meet as pleasant and competent a translator.

MEDICAL AND SURGICAL EXPERIENCES IN THE SOUTH AFRICAN WAR.

A Civilian War Hospital; being an account of the work of the Portland Hospital, and of experience of wounds and sickness in South Africa, 1900, *with a description of the equipment, cost and management of a civilian base hospital in time of war.* By the Professional Staff. Pp. 343. (London: John Murray, 1901.)

THE Portland Hospital was a hospital organised and equipped by voluntary effort in this country for service in South Africa. It was the first of several similar hospitals sent out after the declaration of war in October 1899; but it was not the first voluntary hospital ever attached to a British Army at the front, as the authors suggest in their preface. One well-known hospital, for example, the hospital which is now the British Hospital at Port Said, was originally established as a voluntary hospital for the sick and wounded of the Egyptian Campaigns. The Portland Hospital, however, has the credit of being the first example in this country of a voluntary undertaking on behalf of the sick and wounded being placed entirely in the hands of the military medical authorities for organisation, equipment and management. Formerly the promoters of such undertakings preferred to act independently and, as a matter of fact, to run counter to official medical authority, believing that their usefulness would be in proportion to the extent to which they could over-ride the restrictions imposed by military discipline and control. Continental nations have long ago recognised the folly of this conception, and the Portland Hospital has the merit of having led the way in this country towards a loyal recognition of the necessity of voluntary aid in war becoming an integral part of the military medical organisation. The dedication of the volume to the Principal Medical Officer of the Field Force and to the Officers of the Military Hospital, to which the Portland Hospital was attached, indicates the success of this more modern conception of the value of voluntary aid in war.

The Portland Hospital may, indeed, be regarded as civilian only in name and in the fact that its professional staff consisted of Mr. Anthony Bowlby, Dr. Howard Tooth, Mr. Cuthbert Wallace and Mr. J. E. Calverley, and that the cost of its equipment and maintenance was defrayed from private sources. In other respects it was a distinctly military organisation under an Army medical officer, Surgeon-Major Kilkelly of the Grenadier Guards, and was, in fact, a fifth section of the military establishment known as a general hospital at the base.

The gentlemen named are the authors of this volume, and they have achieved their task admirably. The opening chapters and several voluminous appendices form about one-third of the book and describe the personnel, equipment and interior economy of the hospital. It can scarcely be said that they open up fresh ground or present new facts for consideration. The remaining chapters contain an excellent and valuable record of the medical and surgical work done in the wards of the hospital or in the wards of other hospitals to which the staff of the Portland Hospital had access.

The medical work is recorded in two chapters by Dr. Tooth and Mr. Calverley. The first and more important of these chapters contains an account of the authors' experience of enteric fever and simple continued fever in South Africa. But most of the scientific interest attached to this subject has already been exhausted in a paper by Dr. Tooth which was read and discussed quite recently before the Clinical Society of London, and the chapter is more or less a repetition of that paper. Some interest, however, will be felt in the attitude of the authors towards "simple continued fever," which they express in the statement that a diagnosis of simple continued fever "is little more than a confession of ignorance," but "must be tolerated in the absence of more exact knowledge." In their experience, all such cases were cases of exhaustion, diarrhœa, dysentery, insolation or true enteric fever, and they consider that a medical officer assumes a rather dangerous position in diagnosing a case as "simple continued fever" simply because he does not know what the fever is and does not think it is enteric. All thoughtful physicians will readily acknowledge that there is a general lack of exact knowledge regarding fevers of this kind. In military medical practice these fevers are extremely numerous and seldom fatal, and the term "*febricula*," which was included in former editions of the "Nomenclature of Diseases," issued by the Royal College of Physicians, best indicated the type of fever described and was a less confusing term to use for what was, after all, a symptom rather than a definite disease and for what must necessarily be a provisional rather than a positive diagnosis. It is evident, however, that, in the authors' experience, a large number of these cases were considered to be mild forms of enteric fever. The Board of Medical Officers appointed to inquire into the outbreak of enteric fever in the camps of the United States Army in 1898 came to a similar conclusion; and, if it becomes the fashion to record this type of fever as enteric fever instead of as simple continued fever, we must be prepared for some remarkable variations, statistically, in the incidence and case mortality of the former disease.

The second chapter on medical subjects deals with diarrhœa, dysentery, sunstroke, diseases due to exposure, functional diseases and mental disturbances as experienced in war. It will repay perusal, but can scarcely be described as important. The facts are commonly known and have frequently been described in the medical histories of campaigns. It may, however, be interesting to note that the authors consider diarrhœa and dysentery to be synonymous. "Dysentery," they say, "is diarrhœa 'writ large,' or, in other words, the two have a common origin." Their reasons for adopting this opinion are not convincing. In fact, no reasons are given other than some vague theories and speculations regarding the probable cause of the well-known diarrhœa of campaigns.

The best feature of the volume from a scientific standpoint is the record of surgical work; and the chapters on this subject, to which nearly one-half of the book is devoted, will cause it to take a high and important place in the literature of military surgery. They are written by Mr. Bowlby and Mr. Cuthbert Wallace, and are characterised, pre-eminently, by thoughtful and careful observation of fact. Hitherto our scientific knowledge of the effects of modern fire-arms has been dependent on experiments, notably those of Prof. Bruns of Tübingen. Mr. Bowlby and Mr. Wallace have at once lifted us from the sphere of experiment into that of actual facts by a series or observations the accuracy and completeness of which are forcibly impressed upon the reader. Briefly, their facts may be regarded as confirming the observations and conclusions of the experimentalists. They had opportunities of observing side by side wounds made by the Mauser and old Martini rifles, both of which were used by the Boers. The modern "perfect" bullet, the bullet with hard mantle and small calibre, causes less shock, both local and general, than the old bullet, and the risk of sepsis is diminished. But the high velocity of the former at short ranges is disastrous and is the cause of the so-called "explosive" effect. The authors' explanation of this is that the energy of the bullet is transmitted to the tissues, and they base this explanation on the symptoms and after-effects of wounds observed by them in which the injury was not confined to the immediate track of the bullet. The tissues beyond were found to be profoundly injured, and these widely-spread effects were largely in proportion to the velocity of the projectile. Thus, in the brain the passage of a bullet at close range is found to result in the disintegration of almost all the cerebral mass, while a certain proportion of patients shot through the brain at extreme ranges made satisfactory recoveries. In bones, too, the effect of high velocity at short ranges is to produce very extensive splintering and pulverisation, whilst at long ranges cancellous bone may be simply perforated and compact bone fractured with but little comminution. These observations completely confirm Bruns' experiments, and they will be quoted as essential facts in future text-books on military surgery.

As regards another well-known phenomenon, fragmentation and alteration in the shape of bullets, the authors' observations lead them to believe that this does not occur, in the case of hard mantled bullets, except as a result of ricochet and impact with hard substances outside the body, a probable explanation which has been overlooked in some recent continental works on the effect of modern fire-arms. Another important observation is that soft-nosed or "sporting" bullets do not "set up" on impact with soft tissues, and only when they hit hard bone. Sportsmen will be inclined to disagree with this, but the authors point out that the hide of big game is compact enough to cause "setting up" of a soft-nosed bullet, whereas the human skin is not.

These are only a few of many interesting and important observations made in the chapters on the surgical work of the hospital. In pages devoted to bullet wounds of blood-vessels, nerves, joints, head and abdomen there are points of special interest and value, which throw a flood of light on many questions connected with the surgical work of modern wars, and which every surgeon, certainly every military surgeon, should study.

The volume is profusely illustrated by photographs, including some skiagraphs, which add greatly to the interest and value of the book. It also contains a useful index.

W. G. M.

A CATALOGUE OF PALÆARCTIC LEPIDOPTERA.

Catalog der Lepidopteren des Palaearctischen Faunengebietes. I Theil: Famil. Papilionidæ—Hepialidæ. Von Dr. O. Staudinger und Dr. H. Rebel. Pp. xxxii + 411; portrait; II Theil: Famil. Pyralidæ—Micropterygidæ. Von Dr. H. Rebel. Pp. 368. 8vo. (Berlin: R. Friedländer und Sohn, Mai 1901.) Price Mk. 15 (paper); Mk. 16 (cloth).

THE publication of the third edition of Staudinger and Wocke's Catalogue of Palæarctic Lepidoptera is an event of considerable importance. In the earlier part of the last century, the catalogues of European Lepidoptera most in use were those of Boisduval, who published the first edition of his "Index Methodicus," including Papilio, Sphinx, Bombyx and Noctua (in the Linnean sense), in 1829; and the second edition, to which the Geometridæ were added, in 1840. The latter edition included 1941 species, among which are enumerated the few species then known from the Caucasus and Siberia; for Continental entomologists have always treated the insects of the adjacent countries as virtually forming part of the European fauna. In 1844 Duponchel published a more elaborate "Catalogue Méthodique des Lépidoptères d'Europe" (pp. xxx + 523), including the whole Order.

Between 1843 and 1851 the German entomologist, Heydenreich, published three editions of his "Systematisches Verzeichniss der europäischen Schmetterlinge," the last of which extends to 130 pages, double columns; and the first edition of the "Catalog der Lepidopteren Europa's und der angrenzenden Länder, I. Macrolepidoptera, bearbeitet von Dr. O. Staudinger; II. Microlepidoptera, bearbeitet von Dr. M. Wocke" was issued in a nearly similar form to Heydenreich's. It was published in Dresden in September 1861, and includes pp. xvi + 192 (double columns). This catalogue includes 5250 species in all; and the 1941 species of Macrolepidoptera enumerated by Boisduval in 1840 proved to have increased, in little more than twenty years, to 2583. This catalogue was very complete and carefully compiled (especially in its earlier portion, for Dr. Wocke's work is far inferior to Dr. Staudinger's), and it at once took its place as the standard catalogue of European Lepidoptera. This edition included no localities; but those species which did not occur within the geographical limits of Europe were marked with an asterisk. The title pages and preface were duplicated in French and German.

In another ten years (January 1871) a second and greatly improved edition was issued (pp. xxxviii + 426)—this time in single pages, except that a side column is devoted to full localities of each species and variety. The number of species enumerated had now risen to 2849 Macrolepidoptera and 3213 Microlepidoptera, or 6062 in all. The catalogue includes the species of Europe, North Africa, Asia Minor, Transcaucasia, Siberia as far as the Amur, and Greenland and Labrador, but is yet very far from including the whole of the Palæarctic region; for Dr. Sclater's epoch-making paper on the geographical distribution of the class Aves was only published in vol. ii. of the *Journal* of the Linnean Society in 1858, and did not attract the attention of entomologists till some years afterwards.

This second edition of 1871 has long been out of print, and for many years Dr. Staudinger had been making preparations for a new edition, to include the bulk of the Palæarctic fauna, a work rendered much more arduous by the immense increase in entomological literature, as well as by the large number of new species discovered during the last thirty years. The work has, however, been finally carried to a successful conclusion by Dr. Rebel, Dr. Staudinger's old colleague, Dr. Wocke, having predeceased him by some years.

The present edition includes a portrait of the late Dr. Staudinger, a German preface by Dr. Rebel, chiefly relating to the preparation of the work, a tolerably full bibliography and list of geographical names, and a sketch of the system adopted, which, we may say, without being absolutely revolutionary, exhibits profound modifications from that used in the earlier editions of the catalogue. Then follows the bulk of the work, comprising (allowing for supplementary additions) 4756 Macrolepidoptera and 4963 Microlepidoptera, or 9719 species in all.

The present catalogue now includes the Lepidoptera of the greater part of the Palæarctic region and the circumpolar region. Among the most important additions to the districts included in the second edition are the Nile Delta to Cairo; Asia, to the northern frontiers of Thibet, and the lower course of the Hoang Ho to the Chingan Mountains; North Manchuria and the whole district of the Ussuri; North Japan (not southern Japan, in which case Corea and the greater part of China must also have been included); Central Asia, Palestine, Persia, &c. A few varieties of species noticed, which occur beyond these limits, have also been included. These are marked with an asterisk; but we regret that the strictly European species are not, as in previous editions, indicated by the presence or absence of any special mark.

Dr. Rebel appears to have done his work very completely, English and other works published in 1900 being quoted in the addenda. We notice references to pp. 552 and 581 of the *Transactions* of the Entomological Society of London for that year.

The two parts of the work are separately paged and have separate title-pages, but are bound in one volume. The indices are very bulky, occupying no less than 102 pages of the second volume; the index of families and genera fills sixteen pages, in double columns; and the index of species, varieties, aberrations and synonyms fills no less than 86 pages of very small type in triple columns.

We need hardly say that the work before us will be an absolutely indispensable handbook to all Lepidopterists who are working at any part of the Palæarctic fauna for many years to come—probably till it is superseded by a new edition. At the same time, we cannot expect any book to be absolutely complete or faultless. To have made the bibliography complete would have been impracticable, and we notice that some books not included in it are quoted in the catalogue. Again, we notice the omission of various varietal names; but some entomologists consider that the naming of varieties has been carried much too far of late years, both in Lepidoptera and in

Coleoptera. A certain amount of discretion as to what to include and what to omit, as well as in the selection of synonyms, must be conceded to every cataloguer. A few misprints are corrected at the end of the book, and we have noticed others; but they are not of a character to interfere in any way with the usefulness of the book, and an occasional misprint is absolutely unavoidable in a work of such an extent, and including such a vast amount of minute detail.

W. F. K.

AN EPITOME OF MODERN CHEMISTRY.

Modern Chemistry. Part i. *Theoretical Chemistry.* Pp. 126; Part ii. *Systematic Chemistry.* Pp. 203. By William Ramsay, D.Sc. The Temple Primers. (London: J. M. Dent and Co., 1900.) Price 1*s*. each.

GIVERS of inexpensive Christmas remembrances—something more than a card and less than a present—have made us very familiar with the small volumes of the Temple series, and at a first glance the title pages of the two books before us seem to promise selections from Epictetus or De Quincey rather than an exposition of modern chemistry by a living authority. In the first of the volumes Prof. Ramsay has given an extremely condensed account of the present state of chemical theory, and in the second an equally condensed account of systematic chemistry. Both books bear the marks of freshness and originality, and, it must be added, both produce a certain feeling of breathlessness. They are eminently readable to a chemist, and extremely interesting as displaying a sort of camera obscura picture of the territory of chemistry as it is presented in the mind of one of the most active, most unconservative and most distinguished of contemporary workers.

The question that forces itself most persistently upon a critic is—for what class of readers are these books intended? They are called primers, and the present writer, wishing to fortify his opinion that a primer was essentially a book for beginners, has found, on reference to a dictionary, that a primer is "a small elementary book for religious instruction or for teaching children to read." He has, further, taken the trouble to put one of these primers into the hands, not of a child, but of a friend of more mature years and not wholly strange to scientific notions, with the request that he would see what he could make of it. The answer came quickly and in unmistakable terms. The word primer has really no justification in connection with these books; they are in no wise suited to beginners. To those who are working in one little corner of chemistry with their eyes averted from all that is going on elsewhere, and to workers in other sciences who at one time have known a fair amount of chemistry, Prof. Ramsay's survey may be just what they have been wanting. Considering the limits of space imposed, he has given a wonderfully complete and connected account of the state of modern chemistry. The book on theoretical chemistry is naturally the more readable of the two, and it forms a more continuous story. The systematic chemistry exhibits and classifies the facts of chemistry in a way which is striking and interesting and well suited for retrospective purposes. Stress must be laid upon this last qualification, for it is to be feared that a reader who had not already a very good grounding of chemistry would be unable to make any headway in the subject if he started along the lines on which Prof. Ramsay has achieved his formidable task.

To those who wish to refresh their knowledge of chemistry or to look at it from a new point of view, and to those who wish to gain some idea of the very important changes which have been affecting the whole science during the past fifteen years, Prof. Ramsay's little book may be warmly recommended. Such readers will carry away some knowledge at least of "phases," electro affinity, the later developments of stereochemistry and many other innovations; and they will see, with mixed feelings perhaps, how the modern electrochemical theory is changing the whole language of the science.

A. S.

OUR BOOK SHELF.

Essays, Descriptive and Biographical. By Grace, Lady Prestwich. With a memoir by her sister, Louisa E. Milne. Pp. 266. (Edinburgh and London: William Blackwood and Sons, 1901.) Price 10*s*. 6*d*.

LADY PRESTWICH, who survived her husband, Sir Joseph Prestwich, but little more than three years, died in 1899 at the age of sixty-six. They were married in 1870, and settled at Shoreham, near Sevenoaks, in the charming house of Darent-Hulme, built by Prestwich. While he was professor of geology at Oxford, many months in each year were spent in that ancient home of learning, and there Prestwich was constantly assisted by his wife in the preparation, not only of his standard work on geology, but also of his lectures, diagrams and geological papers. Herself an authoress, she had exhibited considerable literary ability in her two novels, "The Harbour Bar" and "Enga," and in a number of essays printed in *Good Words*, *Blackwood's Magazine*, the *Leisure Hour*, &c. Some of these are here reprinted. There are "Recollections of Boucher de Perthes," being the history of the discovery of Palæolithic implements; "Evenings with Madame Mohl," or reminiscences of a Paris salon; "An Evening with Mrs. Somerville"; some account of the parallel roads of Glen Roy, and essays on physiography, all pleasantly and instructively written. One article not previously published is on the old almshouse of Ewelme, and another is on the Findhorn, especially attractive to Lady Prestwich, as her earliest home was in Morayshire, on the banks of this, perhaps the grandest of Scottish rivers.

In the memoir, which has been attractively written by Miss Louisa Milne, we have the record of the life of a good and highly cultured woman, a life comparatively uneventful, it is true, but the record will be found full of interest to those who had the privilege of knowing Lady Prestwich, while others who peruse this volume will derive instruction, always pleasantly conveyed, and make acquaintance with a charming personality. Amid her many occupations, Lady Prestwich found time for much active benevolence and for work relating to the higher education and employment of women. In her younger days she travelled much with her uncle, Dr. Hugh Falconer, and reminiscences of these journeys are extracted from her diary. An interesting essay on "our white deal box" tells the story of the trouble they had in passing this box through the custom-house at Naples, as it contained mysterious plaster casts of the head and bones of a rhinoceros. Even the letters F.R.S. after Falconer's name puzzled the officials. "Royal Society sounded well, but how was the word Fellow to be rendered in French or Italian? I had to be careful, since it could be interpreted in more than one sense. A little heedlessness on my part might bring on my uncle the same sentence as was passed in another Italian town on a Cambridge don who had 'Senior Wrangler' inscribed on his passport. The police translated it as 'inveterate brawler'! and he was in consequence denied permission to travel, and was detained eight days before being allowed to proceed."

Chemical Lecture Experiments. By Francis Gano Benedict, Ph.D. Pp. xiv+436. (New York: The Macmillan Company, 1901.)

THE days of that ancient bugbear, the "Guide to Knowledge," containing in the form of questions and answers a concise *résumé* of all "the scientific facts that a well-educated boy or girl should have learnt," are fast coming to an end. Dr. Benedict has struck another blow at them in issuing his manual of "Chemical Lecture Experiments." The aim of the book is to furnish teachers with a set of trustworthy experiments which can be carried out with ordinary, simple apparatus, all others being rigorously excluded.

It is unnecessary nowadays to comment on the value of experimental demonstrations in a lecture-room, and, as the author points out in his preface, it is unwise to neglect them and trust entirely to laboratory exercises. The latter, "however great their influence in developing the experimental side of teaching the science, have their limitations experimentally and educationally, and cannot supplant the experimental lecture, for it is in the lecture, and there only, where each experiment stands out clearly defined and unattended by the distractions necessarily accompanying laboratory exercises, that the first accurate observations of chemical phenomena can be made by students."

The testimony and example of such illustrious teachers as Bunsen, Liebig, Victor Meyer, and in our own day of Ostwald, Fischer and Moissan, are arguments strong enough to overcome any objections, and Dr. Benedict is to be congratulated on his efforts to lighten the task of the overworked and much-abused teacher. Although he may not be able to lay claim to any great originality, the field having already been pioneered by Arendt and Heumann and Newth, he has succeeded in collecting a good series of experiments to illustrate an elementary course of inorganic chemistry, which, by reason of the careful descriptions and clear diagrams, will commend themselves to all who are conducting classes with only a very limited supply of apparatus and means.

A Manual of Laboratory Physics. By H. M. Tory, M.A., and F. H. Pitcher, M.Sc. Pp. ix + 284. (New York: John Wiley and Sons, 1901.)

THE rapid extension of the study of practical physics in recent years is shown by the number of books which have been published lately dealing with this subject, but we cannot say that much originality has been shown either in the mode of treatment or in subject matter. The exercises are generally those with which teachers are well acquainted. In this book the object of the authors has been to compile notes which will save the demonstrator as much separate explanation as possible. It will therefore be of use in laboratories where funds do not permit many assistant demonstrators to be employed.

The book deals with the whole of physics except mechanics and hydrostatics. Each exercise is divided into the following sections: References to books dealing with the special phenomenon; apparatus required; theory of the experiment; practical directions; example; and a blank to be filled in by the student.

There are a few points about which a word or two may be said. We should have liked to have seen more stress laid on the necessity of students recording the precise nature of the quantities in terms of which their measurements are made. It is not well for them, for example, to see the velocity of sound expressed as 34230 cm. Some of the diagrams leave much to be desired; that of the trace left by a tuning-fork on a falling smoked plate is strangely irregular. The present writer has not tried this experiment under the conditions shown in the figure, but he would expect to get a more intelligible record. The trace obtained with the pendulum-chronograph is also very unlike what we should expect.

The simple wire bridge for measuring resistances is described as the B.A. bridge. We were under the impression that the particular modification introduced by the committee of the British Association was that in which arrangements were made for using Carey Foster's system of interchanging a pair of nearly equal coils.

A good deal of attention is given to the testing and calibration of ammeters. This is very useful to those students going on to the engineering side of physics.

It may be of interest to consider the directions in which a development of practical physics teaching may be expected. There seem to be two ways open for this to take place. The first is to make the laboratory exercises follow precisely the course of lectures, so that the student performs experiments which illustrate what he has been taught in the lecture. This is the rational way of coordinating the teaching and practical work, but it is open to the objection that a much larger stock of apparatus is required. The second direction of development is to allow the student to make the greater part of his apparatus, and this forms the best training for research. Such books as Prof. Threlfall's "Laboratory Arts" is a step in the latter direction, whilst some of the modern more elementary text-books are on the former plan.

In another way this book is of interest to us, as it shows the standard of work reached in the elementary classes in the McGill University, where the physical laboratory is one of the finest and best fitted departments. So far as one can judge, the standard is much the same as in similar classes at home. S. S.

The Story of Wild Flowers. By Rev. Prof. G. Henslow, M.A., F.L.S., F.G.S., &c. With forty-six figures in text. Pp. viii+249. (London: George Newnes, Ltd., 1901.) Price 1*s*.

THIS interesting little book contains much more than its title might seem to imply, since it treats, not only of flowers, but also of the lives and forms of flowering plants, their distribution and evolution. Though both readable and instructive, this booklet loses much in value as a trustworthy popular introduction to botany because its author has elected to saturate it with the extreme form of neo-Lamarckism, of which he is so fervid and, in this country, so isolated an advocate. Much of Prof. Henslow's treatment of the subject is refreshing, and in this respect the chapters on stipules and on vegetative sports, as well as the occasional references to horticultural operations, are especially worthy of note. The author's views on morphology do not, however, always accord with modern opinions; he writes, for instance, "The leaf usually consists of two parts, the leaf-stalk . . . and the blade . . ." (p. 64). "The homology of bracts is various. They may be *stipular* as in Magnolias, more generally are *petiolar* as in Hellebore . . ." (p. 97). Other not generally accepted views are those expressed in reference to the cause of the rosette-form of "high Alpine plants" (p. 103), the significance of circumnutation in twiners (p. 100), and the object of movements of leaves (p. 104). But most open to criticism are the explanations offered of the origin of certain structural and habitual features by the inheritance of the effects of repeated stimuli. In the second volume, on non-European flowering plants, which the author half promises, it is to be hoped that attention will be directed rather to the well-tested facts of evolution than to mere hypotheses as to the precise causes of evolution in special cases.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Hair on the Digits of Man.

THE distribution of hair on the dorsal surfaces of the digits in man, anthropoid apes and monkeys, is referred to by Romanes in "Darwin and after Darwin," but its significance seems to be overlooked. I would venture to suggest that these facts bear a Lamarckian, and only a Lamarckian, interpretation. It is clear that if acquired characters can be inherited through use, habit or environment, the loss of certain characters through habit and the like may also be inherited, and the development of characters on the one hand and the decay of characters on the other will be sufficient to prove that Weismann's great rule is not absolute. Use-inheritance and disuse-inheritance ought both to be capable of proof. It may be difficult, or impossible, to *prove* the greater cases, such as the long cervical vertebræ of the giraffe and the great horns of the elk, and indeed most of the instances brought forward by Herbert Spencer, Eimer and Cunningham. These may lie open to a selectionist interpretation. But it becomes well-nigh impossible to carry such an interpretation into the trifling biological characters to which I would briefly refer.

In man, hair is entirely wanting on the ungual phalanges of his hand and foot, very rare on the middle phalanges of either foot or hand, and always present more or less on the first row of phalanges in both foot and hand. On the middle phalanges, where it occasionally occurs, it is best looked for in early childhood, when the hair is more strongly developed than in infancy, and when it has not yet disappeared through secondary causes. I have just examined the case of a child of four and a half years old with marked hair on the middle phalanges of the four digits on the hand, and on the second, third and fourth digits of the foot, and with *none* on the fifth digit, except on the first phalanx. It is worthy of remark here that many of the facts of hair-direction, being somewhat fugitive in character, are best studied in the human subject in childhood.

Assuming that man is the child of the monkey, it follows that his ancestors possessed at one time hair on all the phalanges of both foot and hand, as is the case in all the existing monkeys of the Old World and New World that I have been able to examine; though a Chacma baboon at the London Zoological Gardens shows abundant hair on all the phalanges of the foot, and on the middle and ungual phalanges of the hand either no hair or the small amount that is present very much worn down. In the few anthropoid apes that I have been able to examine, the chimpanzee resembles the human subject in this character, and the young orang at the Zoological Gardens possesses hair like that of the lower monkeys, *i.e.* on all the phalanges of foot and hand, though on the two terminal phalanges of the hand the hair is worn down and quite bristly, even though the animal is still young.

Broadly speaking, these facts are congenital and must be acquired, either through heredity, variation and selection, or as the result of habit, such as that of friction, acting through numerous ancestors in a similar direction. We need only bear in mind how much greater is the exposure to friction, in the movements of the hand of man, of the ungual and middle phalanges than that of the first phalanx to see that the conclusion as to the Lamarckian view here put forward is difficult to resist.

This very small point seems to be more worth considering than its intrinsic importance would warrant, in consequence of the way in which a disputed biological doctrine, such as that of Weismann, is being exploited in a somewhat serious matter. It is enough to quote W. K. Brooks, of America, and Prof. J. Arthur Thomson, of Aberdeen, in support of the statement that Weismann's doctrine is "not proven." I refer to the long and somewhat heated discussion which has taken place recently in the columns of the *Lancet* on the subject of "Legislation against National Intemperance." The greater vigour of assertion and multitude of words, if not greater logic, rests with the advocates of the view that alcoholism is a selective influence of value in the evolution of man and ought not to be interfered with by legislation. The reasons for this startling contention are numerous, but their justification rests ultimately on the doctrine of Weismann carried to the bitter end, viz. that acquired characters are not inherited. I submit that if it can be shown that no other than a Lamarckian interpretation of certain small phenomena is possible, something may be done towards making a breach in a somewhat dangerous citadel. WALTER KIDD.

July.

Pseudoscopic Vision without a Pseudoscope: A New Optical Illusion.

A METHOD of securing an illusion of binocular vision wholly without instrumental aid occurred to me recently, which is interesting in connection with the study of pseudoscopic vision. It is fully as startling as any of the results obtained with the lenticular pseudoscope, which I showed at the Royal Institution in February, 1900, and which I shall speak of presently, and, requiring the aid of no optical instrument, is much more impressive.

A lead pencil is held point-up an inch or two in front of a wire window screen, with a sky background. If the eyes are converged upon the pencil point, the wire gauze becomes somewhat blurred, and of course doubled. Inasmuch, however, as the gauze has a regularly recurring pattern, the two images can be united, and with a little effort the eyes can be accommodated for distinct vision of the combined images of the mesh. To accommodate for a greater distance than the point upon which the eyes are converged requires practice, but the trick is very much easier in this case than in the case of viewing stereoscopic pictures without a stereoscope.

As soon as accommodation is secured, the mesh becomes perfectly sharp and appears to lie nearly in the plane of the pencil point, which still appears single and perfectly sharp. If now the pencil is moved away from the eyes which are to be kept fixed on the screen, it *passes through the mesh and becomes doubled*, the distance between the images increasing until the point brings up against the screen. If now the pencil be removed it will be found that the sharp images of the combined images of the gauze persists, even though the eyes be moved nearer to, or farther away from, the screen. Bring the eyes up to within six or eight inches of the plane in which the mesh appears to lie and attempt to touch it with the finger. *It is not there:* the finger falls upon empty space, the screen being in reality a couple of inches further off. This is by all means the most startling illusion that I have ever seen, for we apparently see something occupying a perfectly definite position in space before our eyes, and yet if we attempt to put our finger on it we find that there is nothing there.

It is best to begin by holding the pencil an inch or less in front of the screen. As the eyes become accustomed to the unusual accommodation, the distance can be increased. I have succeeded in bringing up the apparent plane of the mesh, five or six inches, but this requires as great a control over the eyes as is necessary in viewing stereoscopic pictures without an instrument.

The pseudoscope, which I have alluded to above, I have described in *Science* (about November, 1899), but inasmuch as the description of it which I sent to NATURE, the editor informs me, was never received, a brief account of it may not be out of place. Two lenses of about three inches focus are mounted in front of a pair of stereoscope lenses in such a way that the real inverted images formed by them in space can be combined by the stereoscope. The lenses should be mounted in slide tubes attached to the frame of the stereoscope, so that proper focussing can be accomplished. This instrument has been named the lenticular pseudoscope by the psychologists, and gives results far superior to those obtained by the Wheatstone and other forms of mirror pseudoscopes. Viewed through the instrument, a hollow bowl appears as a beautifully convex dome, and if a marble be dropped into it we witness the astounding phenomenon of a ball rolling up hill, crossing the top, descending part way down the other side and then returning to the summit, in defiance of the law of gravitation.

Johns Hopkins University. R. W. WOOD.

Markings on Jupiter.

THERE is a large, dark spot on the southern side of the S. equatorial belt (and nearly in same latitude as the red spot) which on July 24 was preceded by a number of small black dots 5° to 10° apart, according to the observations of Dr. Kibbler, of Stamford Hill, who appears to have been the first, or one of the first, to discern these interesting markings. The largest spot seems to be drifting westwards, relatively to the zero meridian (System II.) of Mr. Crommelin's ephemerides, at the same rate as the S. temperate zone of Jupiter, viz. 16 degrees per month. On August 3 I observed the spot in transit at 8h. 56m., hence its longitude was 232°·8. If the westerly drift of the object is continued and its existence sufficiently prolonged, it will arrive at conjunction with the following end of the red spot in July, 1902, the longitude of the latter being about 46°. This value has shown little variation during the last twelve months.

The new marking deserves special notice from the fact that a conspicuous spot appeared in about the same latitude in the summer of 1889 and formed the subject of an interesting paper by Mr. A. S. Williams in the *Monthly Notices* for June, 1890. This spot, when its more rapid motion enabled it to overtake the red spot, was diverted southwards and its material flowed along the southern edge of the ellipse, afterwards drifting further west, freeing itself from the red spot, and finally appearing as a well-defined red streak or short belt. The present disturbance may indicate a recurrence of the phenomena of twelve years ago, and it is desirable that its future developments be closely watched. The chief spot will be central at about the following times:—

	h.	m.
August 10	9	35
,, 12	11	11
,, 15	8	38
,, 17	10	15
,, 20	7	42
,, 22	9	18

Bristol, August 4. W. F. DENNING.

MEASUREMENTS OF SOLAR RADIATION.[1]

IT is impossible within the limits of a short notice to give any detailed description of Prof. S. P. Langley's great work, contained in his first volume of the "Annals of the Astrophysical Laboratory of the Smithsonian Institution." It is an account of his experiments with the bolometer, begun on Mount Whitney in 1881 and continued for eighteen years, first at the Allegheny Observatory and, since 1890, at the Smithsonian Institution at Washington. The volume before us deals with this last period; the results of the earlier period are contained in the Report of the Mount Whitney Expedition, published as one of the professional papers of the U.S. Signal Service Department and elsewhere. Striking as these were, their interest and importance is entirely eclipsed by the new work.

Those who were fortunate enough to be at the Oxford meeting of the British Association in 1894 heard from Prof. Langley himself an account of his researches up to that date. The details on which that account was based are given in the new volume, together with the results of a completely new set of measurements, made in 1897-98.

Probably only the few who have used the bolometer can fully appreciate its difficulties. The principle of the research is simple. A spectrum is formed by suitable means and allowed to fall on the bolometer, a very narrow strip of blackened platinum placed parallel to the lines of the spectrum; this strip forms one of the arms of a Wheatstone's bridge, the other arms being a similar strip and two equal bridge coils. A screen is interposed between the spectrum and the bolometer, and the bridge adjusted until the galvanometer is undeflected. On removing the screen the bolometer strip is heated by that part of the spectrum which falls on it; its resistance is changed and, assuming the battery current to remain constant, the deflection of the galvanometer spot is a measure of the change of resistance of the strip and hence of the energy which it absorbs from the spectrum.

The spectrum is then made to pass slowly across the strip; by noting the corresponding deflections of the galvanometer, a map can be drawn showing the distribution of energy in the spectrum. In a region of a great energy the deflection is large, but as an absorption band crosses the strip it falls towards zero. When it is stated that a variation in the temperature of the strip of less than one millionth of a degree affects the galvanometer appreciably, some of the difficulties become apparent; the very slightest changes in temperature of any part of the electrical system produce effects in the galvanometer which mask the effects it is sought to observe.

In early days the observations were made by eye. The circle carrying the prism or grating which formed the spectrum was set and its position noted; then the screen was removed and the galvanometer deflection read. The circle was then moved and the operations repeated. In 1891-92 the apparatus was made autographic; the circle was turned uniformly by means of a clock, thus the spectrum crossed the bolometer strip at a uniform rate, while the spot of light from the bolometer mirror was focussed on to a sheet of photographic paper, which was made to move vertically at a rate bearing a fixed ratio to that of the circle. On developing the sheet a bolograph was formed, a curve in which the coordinate of any point measured parallel to the direction of motion of the sheet determines the portions of the spectrum to which the point corresponds, while the coordinate measured at right angles to the direction of motion gives the energy received by the strip from that portion of the spectrum. Peaks on the curve correspond to maxima of radiation, depressions to absorption bands or minima of radiation.

A very large number of these bolographs were taken, and the work contains numerous examples. The same general features recur in them, though of course there are small variations from day to day, some of which are real, depending on the weather, while others are accidental. A very full account is given of the steps taken to determine which of the depressions were real, *i.e.* actually due to absorption lines in the solar spectrum, and which were accidental, and of the method of measuring the twenty-one bolographs selected for final examination and record.

Full tables of the wave-lengths of the lines observed and of their relative intensities are given, and the whole is summed up in the normal map of the solar spectrum, which will be found at p. 200.

The general effect is shown in Plate xx., which gives the infra-red spectrum of a 60° rock-salt prism from the observations of 1898, showing both the bolographs, or energy curves, and the line spectrum. The bolographs are, it must be remembered, continuous curves having peaks and depressions; the method adopted for obtaining photographically from these a diagram of a line spectrum as usually drawn is explained on p. 73 thus:—

"One method of obtaining a linear spectrum consists in blacking in all of the plate below the photographic plate and then photographing this through a combination of a spherical and cylindrical lens, which draws the blacked-in portion out into regions of greater or lesser shade according to the linear depth of the blacked-in portion."

". . . In the original curve the greatest elevations represent regions of the greatest heat, the greatest depressions regions of the greatest cold; and if we fix our attention on these great regions only, they can be adequately rendered into bright and dark bands respectively, but the detail is comparatively ill rendered without a special adjustment, which would in turn give a false presentation of the great masses of light and shade."

This treatment, illustrated by figures in the book, consists of blacking out the whole of the under side of the curve and most of the upper side, but leaving as a transparent spot a small area at the vertex of each marked depression, the size and shape of the area depending on

[1] "Annals of the Astrophysical Observatory of the Smithsonian Institution." Vol. i. By S. P. Langley, Director.

the form of the curve. When this plate is photographed, a series of dark lines, the intensity of which depends on the size and shape of the corresponding transparent areas, is produced. By superposing this photograph on the former one which gave the general distribution of light and shadow, a representation of the linear spectrum of the bolograph is obtained. Clearly, considerable skill and judgment are required in such a process, and the linear spectra are only introduced to show the general effect and to enable the reader to compare the infra-red with the visible spectrum; the measurements of the position of the lines are all made on the selected bolographs themselves.

Chapter vii. contains an interesting account of the variations of absorption in the infra-red spectrum, which is shown to be the seat of great terrestrial atmospheric absorption, the relative intensities of energy changing greatly at different periods of the year in some portions of the spectrum, while in others they remain fairly constant in amount.

But little space is left to refer to Part ii., subsidiary researches, which to a student of theoretical optics may prove even more interesting than the main research. The first of these deals with the dispersion of rock salt and fluorite. It is sufficient, perhaps, to say that the dispersion curve for rock salt is drawn from wave-length 0·5 μ to 6·5 μ, and the results compared with a formula —Ketteler's formula,

$$n^2 = a^2 + \frac{M_2}{\lambda^2 - \lambda_2^2} - \frac{M_1}{\lambda_1^2 - \lambda^2},$$

where

$$a^2 = 5·174714$$
$$M_2 = 0·0183744$$
$$\lambda_2^2 = 0·015841$$
$$M_1 = 8949·520$$
$$\lambda_1^2 = 3145·695.$$

This formula agrees admirably over the whole range.

Another appendix gives a full account of the construction of the galvanometer used for the research. In this instrument, various sizes of wire were used in the different sections of the coil; its resistance was 28 ohms, and the external radii of the three sections of which each coil is composed are respectively ·383, ·741 and 1·632 cm.

Two magnet systems were tried, the one being 2·4 mgs. in weight, the other 6·5 mgs. With the former, which proved too light for the work, a deflection of one millimetre at a distance of one metre was given by a current of 5×10^{-12} ampere; with the latter the current required was 23×10^{-12} ampere.

Enough, perhaps, has been written to indicate the interest and importance of the work. Prof. Langley is to be congratulated in having brought it to so successful a conclusion.

R. T. G.

SOUTH AMERICA.[1]

IN the volume under notice, Mr. A. H. Keane gives a much needed compendium of the geography of South America. Since its independence from Spain and Portugal, that half-continent has been making great commercial strides, until its trade now equals in value that of British India. The importance of its varied products, its peculiar ethnological history, its wonderful physical features, its modern political advancement, make it a region of constantly increasing interest to the merchant, the man of science, the student and the statesman; while the fact that only about five-sevenths of it have thus far been explored and partially mapped makes it a favourite field for the geographer. Mr. Keane appears to have understood exactly what the world in general required from his able pen, and instead of confining himself to geography pure and simple, as the title of his work indicates, he has taken his subject in its most comprehensive sense. He gives us, in three preliminary chapters, the physical features of the country, its orography, great plains, plateaux, fluvial systems, seaboard, fjords, outlying islands, climate, flora and fauna and a valuable dissertation upon the ethical and later ethnical and historical relations of its much scattered tribes. He holds it to be "beyond reasonable doubt that man had spread in early Pleistocene times from his eastern cradle to the New World, probably by two routes —from Europe by the still persisting land connection with Greenland and Labrador, and, from Asia, by the narrow Bering Strait." He bases this assertion upon the fossil remains of man which are found in North and South America, "representing the two primordial types, which may be called the long-headed Afro-European and the round-headed Asiatic. These, strange to say, are found in far greater abundance in the southern than in the northern division." . . . "The inference seems inevitable that South America was already in Pleistocene times peopled to its utmost limits by two primitive races that still persist in the same region"—a statement which admits of doubt. "The long-heads are believed to have been the first arrivals . . . and later the round-heads," the latter "generally keeping to the Pacific side." The former are supposed to have afterwards migrated from their early settlements in southern Brazil and Argentina over a greater part of eastern South America.

There is no more delightful and vexatious field for anthropological and ethnological research than South America. The physical alterations which it has undergone, even in very recent geological periods, the separation of its eastern from its western portion by immense inland seas, the vast denudation of the orographic system of the Brazilian and the recent uplifting of the Andean section, the formation of its wonderful rivers, all probably largely effected since the occupation of the continent by man, have woven many factors into the problem of racial development there. The few traces which forgotten peoples have left under extraordinary physical changes and climatic influences, and the fragmentary knowledge existing regarding South American tribes, make it appear venturesome to indicate the routes by which their progenitors first penetrated the southern half of the New World. The problem seems to require more study than it has yet received before its solution can be safely approached. But the somewhat extensive remarks of Mr. Keane upon South American ethnology are very valuable—doubly so from the fact that he not only summarises his views in his "General Survey," but elaborates them as he afterwards passes each country in review, thus making his work of great importance to the student of tribal origin and development on the western continent. Mr. Keane justly comments on the purity of race in the United States in comparison with Latin America, "where all the ethnical elements have, from the first, tended to be merged in a fresh division of mankind, which may eventually acquire a uniform character, but must long continue to betray its diverse origins in the heterogeneous nature of its physical and mental qualities." And yet it is not entirely improbable that in several of the Spanish American States, notably Mexico and Bolivia, the mentally and physically strong native race are reasserting themselves, and absorbing, thinning-down and gradually dissipating the blood of their conquerors.

The description of each State includes its boundaries, so far as they are claimed or defined, its physical features, hydrography, climate, flora, fauna, inhabitants, wild tribes, topography, chief towns, period of discovery, conquest, settlement, colonial rule, religion, education, natural resources, mineral and agricultural productions and a

[1] "Stanford's Compendium of Geography and Travel (new issue) Central and South America." Vol. i. By A. H. Keane. Edited by Sir Clements Markham, K.C.B., F.R.S. Pp. xxii + 611. (London: E. Stanford.) Price 15s.

historical outline, thus giving us, *á grandes rasgos*, the *data* sought by any one who desires, in a limited space, to acquire a general knowledge of the country.

Regarding Venezuela, "it is still mainly inhabited by scattered rural communities and nomad tribes, with scarcely any large industrial or commercial centres." As to the Orinoco River system, "these magnificent inland waters are at present utilised in a regular way only by a single steamer, plying once a fortnight between Trinidad and Ciudad Bolivar," which is the only town of any importance on the Orinoco. To this river Mr. Keane gives a fall of about nine inches to the mile in a distance of 1300 miles, counting from the Cassiquiare Canal, that remarkable connecting link between the waters of the Orinoco and the Amazon. It is doubtful if the average slope is more than three inches to the mile, the mistake arising from the elevation of 920 feet above sea-level, which Mr. Keane assigns to the Cassiquiare, which probably does not exceed 335 feet elevation. This is one of the most important elevations in the interior of South America, and, since remote times, it has largely governed its hydrographic conditions. There is no part of the world where there is greater confusion in altitudes and distances, and the writer on the geographical features of South America often finds his patience sadly taxed by the disagreement between travellers and explorers regarding measurements.

The States of Colombia and Ecuador form interesting chapters of the work under consideration. The former, which is just terminating a most bloody and disastrous politico-religious war, aggravated by the influx of a swarm of Philippine friars, is a land where nature seems to have overlooked no favours within her power to bestow, and Mr. Keane pictures them with graphic pen. As to Ecuador, the most dormant of all the South American States, he says :—"The backward state of the agricultural interests is no doubt partly due to the constant political ferment which drives off capital, but also in great measure to the feudal system of land tenure. The whole country belongs to a few absentee owners, whose estates are often of boundless extent." He is right in part, but the religious institutions should have been included among the proprietors of the country *and its people*. It would also have been well to add that the interior of Ecuador, since the Spanish conquest, has had contact with the outer world by only two mule-tracks, both intransitable during the rainy season, and that, behind the coast cordillera, the priest has, for more than three centuries, had undisturbed opportunity to try his theories of progress. The result has been disastrous to the morals and advancement of the people, who are sunk in intellectual and physical degradation.

Peru, Bolivia, Chile, the Argentine Republic, Paraguay and Uruguay are treated according to their relative importance ; but sometimes the reader craves greater detail upon many interesting points, probably unwillingly withheld and retained in the abundant stores of information apparently in possession of the author.

In general, the maps which accompany the work are unworthy of the text ; old geographical errors are reproduced, and the maps are in no sense up to date, except those of Chile and the Argentine Republic, *which are more than up to date* ; for the question of limits between these countries, which is now under arbitration by the English Government, is apparently decided entirely in favour of Chile, although upon what grounds does not appear, as Mr. Keane and the editor, Sir Clements Markham, have wisely avoided any expression of opinion on the subject. One must therefore attribute to the publisher the glaring inconsistencies between *his* maps and the text of the work, it being evident that the author is not responsible for them. The boundary, as laid down between Chile and Argentina, is only of value in one sense—it shows the extent to which Chile hopes the English umpires will allow her to push her claims. The line could not have been better traced by the Chilian Foreign Office. To Chile alone it is useful ; but the public expect that a map publisher of

Lake Nahuel-huapi, in the Andes of north-western Patagonia.

repute will hold an even balance where boundaries are *sub judice*.

In the case of the Chile-Bolivia boundary, it appears that the publisher also considers that Bolivia has no territorial rights which Chile is bound to respect.

Mr. Keane closes his work with an extensive and valuable chapter on Brazil, a country which occupies nearly one-half of the area of South America. His remarks upon the "ethnical elements of the population and their distribution" he considers of value in estimating the probable political future of the Republic. "The triple fusion of aborigines, negroes and Europeans is mainly confined to the Atlantic States between the Amazon estuary and Rio de Janeiro. Then follow the States of San Paulo, Paraná, Santa Catharina and Rio Grande do Sul, with which must be grouped the vast and relatively populous region of Minas Geraes. Here we have no triple fusion, the negro element being everywhere mainly absent; but, as in Spanish America, an amalgam of aborigines and whites . . . which constitute the second section of the Brazilian people, distinguished from the first by the absence of black blood. Lastly, the aboriginal element tends to disappear in the direction of the south, where the white element is continually strengthened by direct accessions from various parts of Europe, but especially Italy, Portugal and Austria."

As to the above quotation, the State of Minas Geraes is the most populous in Brazil, and the negro element is everywhere in evidence; and instead of an "amalgam of aborigines and whites," few of the inhabitants are free from negro blood. Exclusive of the aboriginal tribes, one seldom finds any traces of Indian blood among the Brazilians except in the immediate vicinity of the banks of the main River Amazon.

Notwithstanding a few details where we might disagree with Mr. Keane, he has given us a most useful work of reference; but every reader at all familiar with South American geography will regret that the maps are not more trustworthy. GEORGE EARL CHURCH.

ZONES IN THE CHALK.

ATTENTION was directed in NATURE for April 26, 1900, to Dr. A. W. Rowe's researches on the zones of the White Chalk of Kent and Sussex. Dr. Rowe has since published his observations on the White Chalk of Dorset (*Proc. Geol. Assoc.*, vol. xvii. part i. 1901). Aided in the field as before by Mr. C. Davies Sherborn, the author has made a particular study of the higher portions of the Chalk which commence with the zone of *Rhynchonella Cuvieri*.

Those who are familiar with this portion of the Dorset coast, or have read Mr. Aubrey Strahan's explanatory memoir (published by the Geological Survey), know how faulted and crushed are the strata in many places, and how difficult or impossible of access are many portions of the cliffs. Undaunted, however, by these obstacles, or by the hardness of the Chalk and the trouble in extracting and preserving the often shattered fossils, Dr. Rowe and Mr. Sherborn "have been able to fix, with varying degrees of accuracy, the limits of nearly every zone," and to record from each a characteristic fauna. While confirming the general conclusions of Dr. Barrois, they have amplified our knowledge to a remarkable extent, and have had the satisfaction of determining the presence, hitherto unsuspected in the region between White Nothe and Studland Bay, of the higher Chalk zones of *Actinocamax quadratus* and *Belemnitella mucronata*.

That zones in the Chalk are purely zoological divisions is thoroughly borne out in this paper, and although it is remarked that "nothing but rigid collecting gives one the faintest chance of obtaining the junction between the various beds," it is evident that no more definite boundary is to be expected between zones than that which in human chronology separates one century from another. Here and there particular flint-bands, the nodular character or the colouring of the Chalk afford local guides for marking approximate junctions or for tracing horizons from place to place amid the complex disturbances of the strata; and these have been carefully noted. Dr. Rowe, indeed, felt some "anxiety to find a lithological feature" whereby to permanently mark the planes of division he took, but this was seldom possible, nor could it reasonably be expected in such a comparatively uniform series of strata. Nevertheless, the results of Dr. Rowe's painstaking work have been in many instances permanently recorded in a series of beautifully executed plates prepared from photographs taken by Prof. H. E. Armstrong. Diagrams accompany these plates to show the positions of the several zones and the limits assigned to them. No higher testimony to the value of zones has, perhaps, ever been given in this country, for the authors have had a veritable geological puzzle to deal with, and they have interpreted it by means of their long experience of Chalk fossils and by assiduous collecting. By these means the knowledge elsewhere gained where the sequence is unbroken has been applied with marked success, and the progressive changes in the life-history of the Chalk have been found to correspond with a precision that could not have been expected in strata deposited under more varying conditions. While the zones are marked out within narrow limits by certain dominant species, yet where these zonal forms are absent the "zones are often as accurately defined by their associated guide-fossils." These are noted with reference to Dorset.

It may be observed that, with the exception of *Marsupites*, *Actinocamax quadratus* and *Belemnitella mucronata*, the dominant forms are not confined to the zones they characterise. The author makes some remarks on the varying position of the layers described as Chalk Rock. No doubt any type of rock may be found at any horizon, but it must be remembered that the limits assigned to Chalk zones are approximate. There is nowhere any real boundary, and even some dominant types may have existed in abundance longer in some areas than in others. H. B. W.

THE ORIGIN AND HABITS OF THE BACTRIAN CAMEL.

OF few of our larger domesticated animals is the origin so buried in mystery as is that of the camels. Till a few years ago, indeed, naturalists were in doubt whether the two-humped Bactrian species was really a native of the countries where it is now kept in a domesticated condition. The probability was, however, all in favour of such being the case; and the recent discovery of remains of fossil camels in several parts of Europe, as well as the occurrence of such remains in Asia, afford strong corroborative evidence that eastern Europe and northern Asia formed the original habitat of the wild Bactrian species.

The subject has recently been discussed in *Globus* for May 2, 1901, by Dr. A. Nehring, of Berlin, who expresses himself in favour of the view that some, at least, of the two-humped camels which roam at liberty over the wastes of the Gobi are indigenously wild animals.

Years ago the occurrence of remains of fossil camels (*Camelus sivalensis*) was recorded by Falconer and Cautley in the Tertiary strata of the Siwalik Hills of northern India. The dentition of this species is numerically the same as in the two living members of the group; and from this circumstance, coupled with the well-known affinity between the extinct fauna of the Siwaliks and that of Africa at the present day, it is not improbable that the Siwalik camel was the ancestor of the single-humped African species, since, as will be shown below, there is a probability that the ancestor of the Bactrian species had a fuller dental series.

And here it may be well to mention that in adult modern camels there are normally five pairs of cheek-teeth in the lower jaw behind the tusks, or canines. The first pair (the first premolars) are, indeed, somewhat like a canine in form, and are separated by a gap from the canine in front and from the remaining four of the cheek-teeth behind. Of the latter, the last three pairs are the true molars, while the tooth in front of them represents the last of the typical series of four premolars.

Now in the lower jaw of a fossil camel recently described from the Pleistocene Tertiary strata of Rumania, by Herr Stefanescu, under the name of *Camelus alutensis*, there are six, in place of five, pairs of lower cheek-teeth, the tooth representing the third lower premolar being developed. Evidently we have here an ancestral type of camel, and it is noteworthy that, according to Dr. Nehring, this supernumerary lower tooth occasionally makes its appearance in living camels, although it is not mentioned in which species. The remains of the Rumanian camel were discovered on the left bank of the Aluta (Olt) river, a tributary of the Danube, not far from Slatina.

Evidently, remarks Dr. Nehring, this Rumanian camel was a member of the steppe-fauna, of whose former existence in central Europe evidence is afforded by the occurrence of fossil remains of the saiga, Kirghiz jerboa and other species now characteristic of the Volga steppes. Another fossil camel has also been described, under the name of *Camelus knoblochi* or *C. volgensis*, from strata in the neighbourhood of Sarepta, on the Volga, and also at the mouth of the Tscheremschan, in the Government of Samara, the number of lower teeth in this species being apparently the same as in modern camels.

As members of the steppe fauna, these Rumanian and Russian fossil camels were almost certainly the ancestors of the living Siberian species; and since the Rumanian species has a larger number of lower teeth than the still older Siwalik camel, it is manifest that the latter cannot have been the progenitor of the Bactrian species. Hence the reason for regarding it as the ancestor of the single-humped camel of Africa. The Russian camel-remains, it may be added, were found in association with molars of the mammoth.

Remains of camels have also been found in the Pleistocene strata of Oran and Ouen Seguen, in Algeria; and certain remains from the Isle of Samos have recently been assigned to the same genus, although the reference requires confirmation. The Algerian Pleistocene camel was doubtless the direct ancestor of the living African species, which it serves to connect with the extinct *C. sivalensis*.

With regard to the camels of the Gobi, which, as already mentioned, Dr. Nehring regards as truly wild, it is interesting to note that some years ago Dr. Langkavel described them as being much smaller than the domesticated breed, not, indeed, much superior in size to a horse with relatively slender limbs. Observations in confirmation of this statement are, however, urgently required; and any travellers who may visit the Gobi neighbourhood would do service to science if they would bring back skins and skeletons of the wild camels.

Nothing is more remarkable in connection with the Bactrian camel than its capacity for standing extremes of heat and cold, provided always that the climate be dry. Herr O. Lehmann (*Zeitschr. wiss. Geographie*, 1891, p. 27), for example, writes as follows:—

"The most severe winter cold of Asia cannot prevent the presence of the camel. In west Siberia, from the Kirghiz steppe to the neighbourhood of Lake Baikal, are camels found. . . . In Semipalatinsk the mean winter temperature falls to $-21^{\circ}\cdot9$ C.; the most intense registered between the years 1854 and 1860 was $-49^{\circ}\cdot9$. During his journey Przewalski experienced the most intense cold without losing a single camel. Throughout his whole journey across the Mongolian plateau he daily encountered a temperature of -37°. . . . Again, in Zaidam, where camel-breeding establishments exist, a night temperature of $-23^{\circ}\cdot6$ was observed, which in November was intensified to $-25^{\circ}\cdot2$. In the neighbourhood of Tarai-nor, on the 50th parallel of north latitude, the Burjæts keep numerous camels, which even in winter are allowed to wander about without the slightest protection. . . . Here the camel reaches the 50th parallel, westward of Lake Baikal, on the Upper Yenisei, where the Samoyeds keep both reindeer and camels. Here, indeed, the breeding-area of the camel overlaps that of the reindeer."

In regard to its capacity for heat, the same author records the following observations:—"If the degree of cold that the Bactrian camel can withstand is wonderful, not less remarkable is the heat it can undergo. In the Gobi Desert Przewalski took the temperature of the ground in summer and found it to be $62^{\circ}\cdot5$ C." R. L.

NOTES.

WE regret to see the announcement of the death of Prof. W. Schur, professor of astronomy in the University of Göttingen.

THE Antarctic exploration ship *Discovery* was inspected by the King and Queen at Cowes on Monday. Their Majesties were received by Sir Clements Markham, K.C.B., who presented Commander Scott, who in turn presented the officers of the ship and the scientific staff. The King showed great interest in the laboratories and the instruments for scientific work, which were explained by Mr. George Murray, F.R.S., who accompanies the ship to Melbourne, and Dr. H. R. Mill, who will go as far as Madeira in order to start the oceanographical observations on the way out. The ship left Cowes on Tuesday, with hearty wishes for a voyage free from calamity and fruitful in scientific results.

WE understand from the *Irish Naturalist* that Prof. A. C. Haddon, F.R.S., intends to resign the chair of zoology at the Royal College of Science, Ireland, which he has occupied since 1880, in order to devote more time to anthropological work.

THE death is announced, at San Francisco, of Dr. H. W. Harkness, known for his contributions to entomology and botany. For several years Dr. Harkness was president of the California Academy of Sciences, to which institution he presented his large collections of specimens of cryptogams.

THE *Express* states that Profs. Haeckel, Conrad and Fraas, of Jena, Halle and Stuttgart Universities respectively, announce that the sum of 1500*l*. has been placed at their disposal as a prize for the best work on the question, "What do we learn from the principles of the theory of heredity in reference to the inner political development and legislation of States?" Manuscripts must be in German and sent not later than December 1, 1902, to Prof. E. Haeckel, Jena.

ACCORDING to a *Times* correspondent, Dr. Berson and Dr. Suering, who made a balloon ascent from Berlin on July 31 and descended near Kottbus in the morning of the following day, succeeded in reaching an altitude of more than 10,300 metres. It was impossible to ascertain the greatest altitude attained, as both the aëronauts lost consciousness in consequence of the rarity of the air. The minimum temperature registered was -40° C.

WE learn from *Science* that, aided by a special fund presented by a friend of the American Museum, Prof. Osborn recently sent out two expeditions especially in search of fossil horses—

one to Texas and one to eastern Colorado. Word has just been received at the Museum that the very first discovery made by the Texas party included a deposit of skulls of the three-toed horse, Protohippus, associated with parts of the limbs, feet and backbone. This is one of the stages especially desired in the long series leading up to the modern horse. The skulls are reported to be the best that have thus far been found, and this discovery is an auspicious opening to this special series of explorations.

THE fifth annual Fungus Foray of the British Mycological Society will be held at Exeter from Monday to Saturday, September 23–28. The club dinner will be held on September 24, after which the president, Prof. H. Marshall Ward, F.R.S., will deliver his presidential address. On September 25, Miss A. Lorrain Smith will read a paper on "The Fungi of Germinating Farm Seeds," and on the following day a paper on "Spore Formation in Yeasts" will be read by Mr. Barker.

IT has been found that one of the most effective methods for destroying locusts in humid climates is by propagating among them the well-known fungus disease. The Cape of Good Hope fungus, described by Dr. Sinclair Black, is the *Empusa acridii*. To employ it, a culture is prepared on moist bread crumbs and scattered in places frequented by the locusts. The locusts which consume the bread die, and their bodies are eaten by other locusts and thus the disease spreads. The method is less effective in dry weather.

MR. C. A. BENBOW, writing in the *Agricultural Gazette of New South Wales*, strongly recommends the introduction of the eland of Cape Colony into the scrub lands of New South Wales and Central Australia. This scrub land is almost valueless as pasture, especially in years of drought. The eland is, however, accustomed to feed on the same leguminous shrubs in South Africa which form the scrub of Australian lands. The animal is one of the largest of the antelopes, often equalling an ox in weight, is easily domesticated and produces meat of exceptionally fine quality.

IN the *Bulletin* of the American Geographical Society (No. 3, 1901), Mr. R. de C. Ward gives a note on the climate of Mammoth Tank, situated in the southern portion of the Colorado Desert, and one of the most interesting places in the United States from a meteorological point of view. The mean temperature of July is 98°·5, and of January 53°·9. The highest temperature recorded was 130°, in August, 1878, and the lowest 22°, in December, 1895, giving an absolute range of 108°; temperatures of 100° and over have been recorded in every month of the year except the four winter months, November to February. The mean annual rainfall for twenty-three years is 1·81 inches; the greatest amount in any one year was 5·48 inches, while in the two years 1897 and 1898 there was only a trace.

AN interesting paper was recently submitted to the Royal Academy of Belgium, by Dr. E. Vanderlinden, on the atmospheric conditions that accompany fog in that country. The inquiry is based upon an examination of some 200 synoptic charts, the winter and autumn fogs being studied separately from those which occur in summer. The author shows that the winter fogs are mostly connected with anticyclonic conditions, while those of summer occur during periods of shallow or secondary barometric depressions. The winter fogs rarely occur on the western side of an area of high barometric pressure. In reporting to the Academy upon the paper, M. Lancaster points out that most authors who treat of the question of the formation of fog only deal with very local areas, in which temperature plays the principal part, but that this kind of fog should not be confounded with the general phenomenon characteristic of winter fogs, which depend upon the barometric pressure. The most favourable conditions for fog formation are damp air and a temperature a little above freezing point. These conditions generally occur in winter with westerly winds and when the centre of the high-pressure area lies to the south-east of the point of observation, but M. Lancaster points out that the action of temperature alone is not sufficient to explain completely the occurrence of certain types of fog.

SINCE the article upon the recent work of the United States Weather Bureau appeared in NATURE of May 23 (p. 80), the Report of the Chief of the Bureau on the operations during the year ending June 30, 1900, has been received. In addition to the usual tables containing the results of observations made at Weather Bureau stations in the United States, Mr. E. B. Baldwin gives a detailed account of the meteorological observations made by him in Franz-Josef Land during the second Wellman expedition in 1898–1899. The lowest temperature experienced seems to have been recorded on February 1, 1899, when a minimum of forty-five degrees below zero Fahrenheit was observed. The means of the maximum and minimum temperatures recorded by the thermograph in the first three months of the year 1899 are as follows, in degrees Fahrenheit:—January, max. −10°·9, min. −24°·0; February, max. −5°·4, min. −19°·4; March, max. 16°·7, min. −26°·8. A very complete record of auroral phenomena was kept by Mr. Baldwin, and has been published in the U.S. *Monthly Weather Review* for March, 1901.

THE representation of electromagnetic phenomena by mechanical models was brought into prominence many years ago by Maxwell's well-known model of a dicyclic system representing the mutual induction of two currents. Prof. Garbasso now sends us a number of papers dealing with the construction of mechanical models representing the discharge of condensers, in particular in the case when the armatures of a condenser are connected by two wires in parallel. The most recent of his papers, dealing with the maximum value of the electrokinetic energy of mutual induction of two currents and its physical interpretation, appears in the *Nuovo Cimento* for June (5, i.)

A NOTE on some discontinuous and indeterminate functions by Mr. Charles Kasson Wead in the *Bulletin* of the Philosophical Society of Washington is rather suggestive. The treatment is based on the fact that if $u = (x/a)^\infty$, $u = 0$ or ∞, according as $x <$ or $> a$, so that if N is any positive number greater than unity, $N^{-u} = 0$ or 1 according as $x >$ or $< a$. By means of this factor the author shows how it is possible to construct equations representing broken lines or portions of plane areas within or without given plane curves. As physical applications, the author shows how to represent by a single expression the potential of a solid sphere, or the attraction of a spherical shell at points both inside and outside the sphere.

WE have received several papers by Prof. Sommerfeld, dealing with the theory of the diffraction of Röntgen rays. One of these is published in the *Zeitschrift für Mathematik und Physik*, xlvi. 1, 2, and abstracts are also given in the *Physikalische Zeitschrift*, ii. The special problem which forms the subject of Prof. Sommerfeld's work is the mathematical investigation of the results of the hypothesis put forward by Wiechert and Stokes, according to which Röntgen rays consist in an impulsive disturbance propagated through the ether. The author considers the problem of diffraction past a screen in the form of a half-plane and allied problems, and compares his results with those found by Haga and Wind and others. The single non-periodic impulse may be said to represent one extreme case of ray-propagation, while the purely periodic wave represents the other extreme. While actual Röntgen rays and light-rays probably only approximate to these extreme cases, the agreement between Prof. Sommerfeld's conclusions and experimental results affords considerable evidence in favour of the above theory of Röntgen rays.

IN the *Johns Hopkins University Circular*, No. 152 (vo . xx. pp. 79–80), Mr. C. C. Schenck gives a short description of a series of investigations undertaken with the twofold object of (1) separating the principal lines in the spark spectrum of cadmium into three groups having characteristic properties, (2) studying the constitution of the various regions of the spark and its spectrum by means of a revolving mirror. It was found that a preliminary division of the spectrum lines into groups was feasible by noting the changes produced in the spark spectrum when the period of the condenser in the secondary circuit was varied by increasing the self-induction. Kirchhoff in 1861, and Thalen in 1866, stated the effect in general terms, and Hemsalech has recently carried the investigation much further. The spark was produced by an induction coil supplied with alternating current; secondary condenser about ·016 microfarad, spark length 6–8 mm. The spectrum was photographed with a large concave grating of 21 feet radius. The three groups of lines described appear to correspond to the well-known "long" and "short" lines always seen when an image of a light source is thrown on the spectroscope slit, but no wave-lengths are given for comparison. It is stated, however, from an examination of the conditions giving rise to the three groups of lines, that the average temperature of the metallic vapours in the arc is probably *higher* in some cases than in the spark. The experiments with the rotating mirror indicated that the chief arc lines had a duration more than twice as great as that of the chief spark lines. Also that the principal spark lines (both of cadmium and magnesium) are due almost entirely to the curved streamers seen branching from the spark, while the chief arc lines are due in part to the streamers and in part to a luminosity which fills up the spark gap and persists after the streamers cease.

THE "Birds of Western New York" is the title of an article by Mr. E. H. Eaton which appears in vol. iv. of the *Proceedings* of the Rochester (N.Y.) Academy of Science. Although at first sight this may appear nothing more than an ordinary local fauna-list, it is really worth the best attention of every naturalist on account of the elaborate manner in which the subject is treated. Specially noteworthy are the diagrammatic "migration and residence tables," in which it is attempted to show graphically "the times of occurrence and relative abundance of the birds definitely recorded for this region." The essay is, in fact, an admirable example of the way in which local faunas should be recorded and described.

THE most noticeable feature in the Report of the American Museum of Natural History for 1900 is the number of expeditions which have been undertaken with the view of adding to the ethnological and palæontological collections. Although the majority of these were confined to North America, one—the Jesup North Pacific Expedition—was despatched to the Amur valley, while two were sent to South America. The former, it is reported, has brought back a valuable series of specimens illustrating the ethnology and anthropology of the Ainu of Japan; while of the two latter, the mission to Patagonia has acquired a valuable collection of the extinct mammalian fauna of that country. But the amount of strictly scientific work accomplished has not hindered attention being paid to the educational function of the Museum; and the president, in his report, calls special attention to the opening of the new and spacious "auditorium," where secondary education is to be offered to the public in the form of popular lectures.

DR. B. HAGEN gives in *Globus* (Bd. lxxix. p. 245) a beautifully illustrated account of his ascent of Kaba, in Sumatra, which is 1650 metres in height. This volcano has previously been ascended by A. W. P. Verkerk, R. D. M. Verbeek and H. O. Forbes.

THE Berlin Museum für Völkerkunde has recently been enriched by the addition of a number of wooden human effigies from German New Guinea, some of which are described and figured in *Globus* (Bd. lxxix. No. 22, p. 352) by D. Rudolf Pöch. The head appears to be hidden in most of them by a mask, which has a long beak which looks more like a snout than a bird's beak; but from the carving above its insertion there can be little doubt that the bird that is represented is the hornbill, which is a magical or symbolic bird all over the Malay region and throughout the greater part of New Guinea as well. On the top of the mask a figurine of a cuscus is often carved. We still await an explanation of these remarkable objects.

THERE is an interesting little paper by M. Félix Regnault, illustrated by numerous figures, in the *Bulletin de la Société d'Anthropologie de Paris*, 1900, No. 6, on Greek terra-cottas from Smyrna. In the hundreds of specimens in the Museum in the Louvre there are many beautiful ones after the manner of the famous figurines from Tanagra and Myrina; some are grotesque, others are ethnic types, anatomical studies and even illustrations of pathological conditions. It is with the latter that the present paper deals. Various examples of facial deformations are given, such as facial paralysis and adenoid growths. Pronounced acrocephaly and scaphocephaly, as well as illustrations of idiots and degenerates, were moulded by these observant potters. The other articles in this journal are mainly of interest to professional anthropologists.

IN his "Laboratory Outlines for use in an Introductory Course in Somatology" (*American Anthropologist*, n.s. vol. iii. p. 28), Mr. Frank Russell has hit on a very useful idea, which, however, is susceptible of improvement. For example, no indication is given of the system of head-form nomenclature introduced by Sergi; the system of the Italian anthropologist, as a whole, may be cumbersome and difficult to grasp, but his primary forms are readily recognisable and are of distinct classificatory value. Like the majority of anthropologists, Mr. Russell omits the valuable series of radial measurements that are taken from the ext. aud. meatus and which can be compared with similar measurements made on the living. The prosopic, &c., measurements should be placed in the nasal and not in the orbital category. If Mr. Russell were to reconsider his schedule in some details and were to state where the terms, measurements and indices were described in readily accessible publications, or, better still, were to republish this information, he would produce a pamphlet which would be of very great use to students of physical anthropology.

MR. JAMES STIRLING, Government geologist of Victoria, has prepared a report on the brown coal industry in Germany and Austria, which has been issued by the Department of Mines, Victoria, through the Agent-General in London (1901). The main object is to promote a similar development of brown coal production in Victoria, where such fuel would be of service on branch railway lines and for goods traffic where a slow rate of speed is maintained.

FROM Indiana we have received the twenty-fifth annual report for the Department of Geology and Natural Resources of the State geologist, Mr. W. S. Blatchley. A large part of this report is taken up with particulars about marls and limestones and the manufacture of cement; the petroleum industry is also dealt with, and Mr. Blatchley describes two new species of salamanders from Tennessee. In addition, there is a monograph on the Devonian fossils and stratigraphy of Indiana, by Mr. Edward M. Kindle. The fossils are illustrated in thirty-one plates, and some new species of Mollusca and Brachiopoda are described.

THE Eocene deposits of Maryland are elaborately described and illustrated by Prof. W. B. Clark and Mr. G. C. Martin in one of the handsome volumes issued by the Maryland Geological

Survey (1901). Materials do not exist for a detailed correlation of the strata with those in Europe, as the few identical species have a wide range in time, but there is little doubt that the Maryland deposits represent a considerable portion of the Eocene series. In the palæontological section the authors personally deal with the Echinodermata, Brachiopoda and Mollusca, and have been aided by specialists in other groups. The work is illustrated by pictorial views, maps and sections, and numerous figures of fossils.

WE have received the general report of the Director, Mr. C. L. Griesbach, on the work of the Geological Survey of India for the year ending March 31, 1901. Eight officers have been occupied in field-work. Among the regions examined are the Shan States in Burma, where great difficulties had to be encountered in the extensive forests and dense undergrowths, while frequently the actual rock is covered by a soil-cap fifty or more feet in thickness. Evidence has, however, been obtained of older crystalline rocks and of Lower Silurian or Ordovician, while the occurrence of Devonian, which had been inferred by Mr. P. N. Datta, has been confirmed by Mr. La Touche, who found *Calceola sandalina*. The presence of Triassic rocks was first recognised by Mr. Datta. In Assam, Tertiary, Cretaceous and older strata have been mapped by Mr. P. N. Bose; in Himalayan regions, Dr. A. von Krafft has been at work on Triassic rocks; and in Baluchistan Mr. E. Vredenburg has examined the complicated structure of the Chapar range, where numerous folds and overthrusts occur among Cretaceous and Tertiary strata. The subject of landslips has been locally dealt with by Mr. T. H. Holland, and special attention has been given to gold-bearing regions and to water-supply. In palæontology, aid has been received from Dr. F. L. Kitchin in England, Prof. Dr. Uhlig in Austria and Prof. R. Zeiller in France.

ONE of the recent publications of the Geological Survey of Egypt is devoted to a description of Farafra Oasis, by Mr. Hugh J. L. Beadnell. This wide depression, the "Land of Cattle" of the ancient Egyptians, lies in the Libyan Desert far west of Assiut, one of the most important towns of Upper Egypt. Although occupying a large area, the oasis appears to be of little importance from an economic point of view, being, in fact, a stretch of low desert with about twenty isolated "bubbling springs" (Farafra), most of them on the western side. The water is entirely derived from white, chalky limestone of Upper Cretaceous age, which, as observed by Prof. Zittel, forms the plain and is overlaid by Lower Eocene beds, the strata being bent into a gentle anticline. The depression has an irregular triangular shape with the apex to the north and is bounded by steep cliffs of Eocene strata on the east and west, while to the south the floor rises gradually for many miles until a distant escarpment is reached. A large part of the floor is covered with blown sand, and the action of this drifting material has eroded the chalk and left on the surface of the plain numerous fragments and masses of iron pyrites and marcasite derived from that formation. The author differs from Zittel in believing that there is a considerable break between the Cretaceous and Eocene strata. The former rocks are grouped as belonging to the Danian division, but the fossils have yet to be critically examined.

THE additions to the Zoological Society's Gardens during the past week include two Indian Wolves (*Canis pallipes*) from India, presented respectively by Colonel Lloyd and Mr. W. B. Cotton; a Rhesus Monkey (*Macacus rhesus*) from India, presented by Miss E. M. Berney; a Demoiselle Crane (*Anthropoides virgo*), a Lesser Black-backed Gull (*Larus fuscus*) from North Africa, presented by Dixon Bey; a Puffin (*Fratercula arctica*), British, presented by Mr. H. C. Price; a Cinereous Vulture (*Vultur monachus*), three Indian Rat Snakes (*Zamenis mucosa*) from India, presented by H.E. Sir H. A. Blake, G.C.M.G.; two American Jabirus (*Mycteria americana*) from South America, presented by H.E. Sir W. J. Sendall, G.C.M.G.; three Chameleons (*Chamaeleon vulgaris*) from North Africa, presented by Mr. A. Robinson; a Patas Monkey (*Cercopithecus patas*), a Green Monkey (*Cercopithecus callitrichus*), a Campbell's Monkey (*Cercopithecus campbelli*), a Bell's Cinixys (*Cinixys belliana*), an Eroded Cinixys (*Cinixys erosa*) from West Africa, a Pinche Monkey (*Midas oedipus*) from Colombia, two Springboks (*Gazella euchore*) from South Africa, two Small Hill Mynahs (*Gracula religiosa*) from India, deposited; two Common Jackals (*Canis aureus*), two White Cranes (*Anthropoides leucogeranos*), two Imperial Fruit Pigeons (*Carpophaga*, sp. inc.), a Purple-shouldered Pigeon (*Crocopus phoenicopterus*), three Andaman Teal (*Querquedula albigularis*) from India, received in exchange.

OUR ASTRONOMICAL COLUMN.

SEARCH EPHEMERIS FOR ENCKE'S COMET.—A circular from the Centralstelle at Kiel furnishes the following ephemeris for the expected appearance of Encke's Comet:—

Ephemeris for 0h. Berlin Mean Time.

1901.	R.A. h. m. s.		Decl. ° '
Aug. 8	6 16 55	...	+31 34·4
9	23 44	...	31 29·0
10	30 40	...	31 22·2
11	37 42	...	31 13·7
12	44 52	...	31 3·5
13	52 7	...	30 51·5
14	6 59 29	...	30 37·8
15	7 6 56	...	+30 22·2

VARIATION OF EROS.—In the *Comptes rendus*, vol. cxxxiii, pp. 262–265, M. André presents the results of the reductions of observations made at the observatory of Lyons since February 1901. Three observers made independent estimations of the magnitude of the planet at intervals of five minutes. It is notable that the determination of the times of minima appears much more accurate than that of the maxima, the mean errors from a single observation in the two cases being ± 3·3 and ± 7·2 minutes respectively.

From the whole of the observations the period deduced is

5h. 16m. 15·2s.

Further notes are given concerning the change in form of the light curve, consisting chiefly in the two sections becoming more nearly equal than was the case when the variability was first detected.

CELESTIAL OBJECTS HAVING PECULIAR SPECTRA.—*Circular No.* 60 from the Harvard College Observatory contains a list of 59 objects found by Mrs. Fleming from an examination of the Draper Memorial photographs, which exhibit peculiarities in their spectra. The positions are given for 1900, and accompanying notes describe the special features of the objects, which include 19 gaseous nebulæ, 6 bright line stars of Type I., and 22 stars of Type V. One of the gaseous nebulæ is noted as showing bright lines at λ5007, Hβ, Hγ, Hδ and Hϵ. A great number of these objects (28) are situated in the region of the Large Magellanic cloud.

It is also noted that the bright Hβ in the spectra of η Centauri (A.G.C. 17739), and κ Apodis (A.G.C. 20878), has been found to show indications of variability.

MOTION OF α PERSEI IN THE LINE OF SIGHT.—Prof. H. C. Vogel has responded to the appeal made by Mr. Newall for observations of the radial velocity of this star, which, from spectrograms obtained at the Cambridge Observatory, showed indications of a period of variability of 4·2 or 16·8 days. The spectra obtained at Potsdam are only about half the scale of the Cambridge plates. Photographs of the spectrum were obtained on six nights during November 1900, for preliminary testing, and others during December 1900 and January 1901, which were measured and reduced for velocity. The result of determinations from thirteen plates is given as −3·22 km., relative to the sun. No indication of variation is found, and the adopted velocity is in fair accordance with the value −2·4 km. obtained by Campbell. (*Astrophysical Journal*, xiii. pp. 320–323.)

METALS AS FUEL.[1]

A CAREFUL metallurgist,[2] writing in the eighteenth century, claimed that "every matter which is combustible either wholly or in part, is called fuel, the pabulum of fire." The word is, however, usually restricted to substances which may be burnt by means of atmospheric air with sufficient rapidity to evolve heat capable of being applied to economic purposes. The latter definition covers certain metals, though it was doubtless framed to include only carbon and associations of carbon and hydrogen, such as coal. The omission from the definition of the reference to atmospheric air would enable the list of metals which might be used as fuel to be widely extended.

It has long been known that metals will burn, and it would be easy to show that the history of inorganic chemistry is epitomised and enshrined in a mass of litharge, which is simply burnt lead. Successive generations of chemists, from Geber in the eighth century to Lavoisier in the eighteenth, studied litharge carefully before the latter proved partly by its aid the identity of respiration, calcination and combustion. Into this history I need not enter, but it may be pointed out that Sir Isaac Newton[3] had a clear idea as to the possibility of burning metals. "Is not fire," he asks, "a body heated so hot as to emit light copiously?" . . . "for what else is red hot iron than fire?" and he significantly adds, "metals in fusion do not flame for want of copious fume." He was, moreover, aware that a mixture of lead and tin "suitably heated" does emit "fume and flame," and, in fact, a mass of 1 part tin and 4 parts lead, which looks metallic, will, if it is kindled, continue to burn like an inferior variety of peat, leaving an ash-like product which may be used as an enamel.

I propose to show that metals may be burnt for the sake of the heat and light they produce, just as ordinary fuels are burnt, except that in burning ordinary fuels combustion is often effected in two distinct steps or stages, in the first of which carbonic oxide is formed, and in the second carbonic acid, the products in both cases being gaseous. When metals are burnt, the products of combustion are solid, or condense to solids, and they therefore present a marked contrast to ordinary fuels which, as has just been stated, yield on combustion gaseous products. As I shall have but little to say about the light which attends the combustion of metals, I may as well dismiss the subject by reference to a familiar application of the burning of metals for the purpose of illumination. It is easy to fire electrically a portion of what is known as a "magnesium star," and a "fire-ball" of magnesium attached to a parachute is beautifully packed in this shell, for the loan of which I am indebted to the authorities of the Royal Arsenal, Woolwich, and when the shell explodes the stars burn and illuminate the enemy's position in the darkness of night, so that guns may be laid to place projectiles in the enemy's lines.

Before proceeding further, I want to use the electric furnace as affording a basis of comparison with the method of producing high temperatures by the combustion of metals, which I shall proceed to show subsequently. A current of 100 amperes at 200 volts is passed by carbon poles into the furnace in which pig iron is being melted; directly the last piece of iron has become fluid, the temperature of the fused pool must be about 1300° C. The fluid mass is reflected on the screen merely to give some indication as to the appearance of such a mass at 1300° C., and not to afford a test of the capabilities of the electric furnace. Later on I hope to show that a far higher temperature can be produced by very simple means in a receptacle of about the same capacity as the laboratory part of the furnace.

Henceforth in the course of this lecture metals will be burnt for the sake of the heat which is the result of their combustion. From this point of view metallurgists have long used metals as fuel, often without due recognition of the fact, but case after case could be cited in which conducting definite metallurgical operations is made possible by burning portions of the metal or metals under treatment. Time will perhaps be saved if I place in sharp contrast the use of ordinary fuel and metallic fuel, even though it takes us rather far back, for I do not want it to be thought that the use of metals as fuel is new, although their adoption for this purpose has recently been greatly stimulated. Here is a mass of very ordinary iron ore picked up on a heath in Surrey, which skirts the site of what was once the ancient forest of Anderida. The pre-historic dweller on the heath who used the beautiful flint arrowheads, which are found near the iron ore, merely burnt the wood of the forest to warm himself or to cook his food. But the Britons whom Cæsar found in Andreaswold smelted iron with the wood of the forest trees, from which they prepared charcoal, and smelting iron was actively conducted in Queen Elizabeth's reign, and even survived into the last century in the district I am contemplating. But in smelting iron, carbon became associated with it and played a subtle part, rendering the iron precious for certain purposes and useless for others. Iron had therefore to be "decarburised" with a view to its conversion into steel, and in doing this metallurgists for centuries truly burnt some of the iron itself, using it actually as fuel. I will only add that the use of metals as fuel assumed magnificent proportions in the hands of Bessemer, as may be illustrated by an experiment. A few pounds of a compound of iron, carbon, silicon and manganese is melted in the wind furnace, simply used because it affords a convenient method of melting the mass, which is turned into a small Bessemer converter. A stream of oxygen is directed into the fluid mass. Air would do, but with so small a mass the free nitrogen would cool it too rapidly. In a few seconds the carbon in the fluid will be burnt away, nevertheless the mass gradually becomes hotter and hotter, notwithstanding the loss of carbon. A brilliant pyrotechnic display is the result. The metalloid silicon is now burning, and then brown fumes of iron and manganese pass freely off; these metals are truly burning and are maintaining the heat of the bath, and the presence of their fumes shows that it is time to stop the operation. The temperature is somewhere near 2000° C., but according to some recent investigations of Prof. Noel Hartley (*Phil. Trans.*, vol. cxcvi. series A, p. 479, 1901), a temperature of more than 2000° C. is attained in the converter. Bessemer gave the world in 1856 cheap steel; we therefore owe to him the inestimable benefits that are the results of that gift, and I ask you to bear in mind that his great service to the industry of which we as a nation are so justly proud rested on the possibility of using metalloids and metals as fuel. I have already promised that in the course of the lecture I will show some experiments in which the temperature will be a thousand degrees higher than in the one you have just seen. In the Bessemer process the products of combustion are both gaseous and solid, and in a very ordinary case the heat engendered by the carbon of the bath which evolves gases is only half that which results from the combustion of the silicon, iron and manganese which yield solid products. As regards the "open-hearth process," in the phase of it which is known as the "pig and ore" process, oxygen is presented and heat is produced under similar conditions to those we shall consider subsequently in the case of the action of aluminium on ferric oxide.

Heat Evolved by Burning One Gramme of the Following Elements.

Element.	Product of combustion.	Calories.
Aluminium	Al_2O_3	7250
Magnesium	MgO	6000
Nickel	NiO	2200
Manganese	MnO_2	2110
Iron	Fe_2O_3	1790
,,	Fe_3O_4	1580
,,	FeO	1190
Cobalt	CoO	1090
Copper	CuO	600
Lead	PbO	240
Barium	BaO	90
Chromium	Cr_2O_3	60
Silver	Ag_2O	30
Carbon	CO_2	8080
,,	CO	2417
Silicon	SiO_2	7830

This table, which contains the relative calorific powers of different metals and metalloids as compared with carbon, indicates the advantage which certain metals possess over carbon for use as fuel. The question at once presents itself, at what temperature will such metals as can be used for fuel begin to abstract oxygen from the air? The answer is, it depends on

[1] A Friday Evening Discourse delivered on February 22, 1901, at the Royal Institution, by Sir W. Roberts-Austen, K.C.B., F.R.S. The lecture consisted mainly of a series of experiments conducted at very high temperatures, and apart from them it is difficult to give a continuous abstract of it.

[2] C. E. Gellert, "Metallurgic Chemistry," trans. by I. S. (London, 1776), p. 74.

[3] "Optic," pp. 316–319, quoted by Shaw in his edition of the works of Boyle, vol. ii. p. 400.

the method by which the metals are prepared. If they are in a chemically active state, as lead is which has been prepared from tartrate of lead, they will, in many cases, take fire in air and burn at the ordinary temperature. This lead burns readily when shaken in air. If this mass of uranium, for which I am indebted to M. Moissan, is filed in air, the detached particles will ignite. Metallic iron which has been reduced by hydrogen from its oxide at a temperature below 700° C. will also take fire and burn in air at the ordinary temperature, a point of extraordinary interest in relation to the allotropy of iron (Osmond and Cartaud, *Ann. des Mines*, August 1900). Metals in this chemically active state are said to be "pyrophoric."

So far as I am aware, metals in this chemically active state have not been used as fuels. Neither am I aware that any use has been made of the allotropy of metals as enabling them to be used as fuel, but Prof. Graham once told me that pyrophoric iron had been suggested for warming ladies' muffs, the intention being to place the iron in a small receptacle and to admit air gradually as warmth was needed. Sir Henry Trueman Wood also remembers the suggestion, but tells me that he can find no record of it in the *Journals* of the Society of Arts. I may just mention that the burning of metallic antimony plays a very important part in roasting silver ores, and the behaviour of the metal is so peculiar while burning that I must pause to show it you. [A melted globule of antimony, if thrown on to a tray of paper, darts about and cannons from the sides, leaving a track of dark oxide on the paper.]

The metal I am going to employ as fuel is aluminium, the oxygen for its combustion being supplied by metallic oxides, which readily part with their ogxyen to aluminium if it be raised to certain definite temperatures. This question of the transference of oxygen from one metal to another, which results in the liberation of the metal attacked, is of special interest to us at the Royal Institution, for it undoubtedly originated within these walls and is due to Sir Humphry Davy. He discovered potassium in 1807, and in 1809 attempted to remove the oxygen from alumina by heating it with metallic potassium. He says (*Phil. Trans.*, part i. 1810, p. 60), "if I had succeeded in isolating the metal I should have called it *alumium*." His success was imperfect, but he certainly did obtain, by the intervention of metallic potassium, an alloy of aluminium and iron. It remained for Wöhler to prepare pure metallic aluminium from its chloride in 1827, and for Henri Saint Claire Deville, who began to work in 1854, to establish the metallurgy of aluminium on an industrial scale. As regards the reduction of metals from their chlorides, Wöhler (*Ann. der Chemie*, vol. cvi. p. 118) obtained crystalline compounds of chromium and aluminium and Michel (*ibid.*, vol. cxv. p. 102; *ibid.*, vol. cxiii. p. 248) compounds of aluminium with manganese, iron, nickel, tungsten, molybdenum and titanium. Levy (*Comptes rendus*, vol. cvi. p. 66) obtained an alloy of titanium and aluminium, Beketoff (*Ann. der Chemie*, vol. cx. p. 374) an alloy of barium with aluminium from the chloride of barium mixed with baryta. Dr. Goldschmidt (*ibid.*, May 1898) has given references to these authorities in a recent valuable paper. In 1856, Charles and Alexandre Tissier (*Comptes rendus*, vol. xliii. 1856, p. 1187) observed the fact which is the starting point of the experiments I have to show you. They found that aluminium decomposes the oxides of lead and of copper, much heat being evolved by the reaction.

They do not appear to have used aluminium in a finely divided state, and therefore failed to reduce certain metals from their oxides which are now known to be perfectly easy to reduce. It was not until comparatively recently that the use of aluminium for separating other metals from their oxides assumed serious proportions. Claude Vautin showed on June 13, 1894, at a soirée of the Royal Society, a few metals, and among them carbon-free chromium and manganese, which he had prepared, and as he undoubtedly gave the impulse that started much of the subsequent work in this direction, it may be well to give the description which was appended to the specimens he showed. It runs as follows:

Specimens of Metallic Chromium, Manganese, Tungsten Iron, &c., free from Carbon, also fused Alumina, obtained during reduction of the metallic samples.

The specimens of metallic chromium, manganese, &c., have been reduced from their oxides by means of metallic aluminium. The oxide of the metal to be reduced is intimately mixed with finely divided aluminium, and heated in magnesia-lined crucibles. The heat produced by the oxidation of aluminium during the operation is sufficient to fuse alumina, a specimen of which is exhibited.

The subject is, however, in a sense your own, for, so far as I know, the lecture on "The Rarer Metals and their Alloys" (NATURE, May 2 and 9, 1895), which I delivered here in 1895, was the first occasion on which the reducing action of aluminium was demonstrated on a comparatively large scale, and covered an extended series of metallic oxides. Since that time great progress has been made, the most noteworthy advance being in the direction of the use of aluminium for the sake of the heat afforded by its combustion as a true fuel, the oxygen being derived, not from the air, but from a metallic oxide. In order that I may be clear, let me repeat that when coal is burnt the oxygen is derived from the air. When aluminium is used as a fuel the oxygen is derived from a metallic oxide, the metals change places, the aluminium is oxidised,

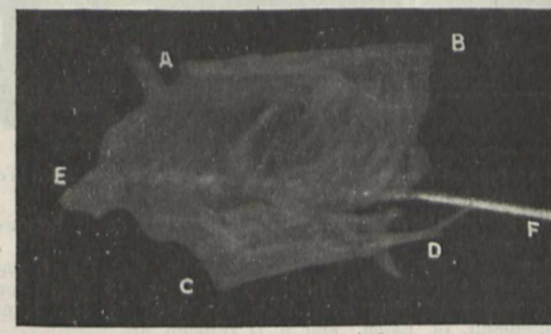


FIG. 1.—The oxidation in air of an amalgamated wire of aluminium, E F. The films of alumina, A B and C D, are those which first formed on the wire.

and the other metal set free from its oxide. This part of the subject must be carefully approached, and the question at once arises as to what extent the aluminium must be heated before it will begin to abstract oxygen from air or from an oxide. It is well known that the metal aluminium will not oxidise sensibly in the air at the ordinary temperature, but the presence of a little mercury enables it to oxidise readily. Le Bon (*Comptes rendus*, October 29, 1900, p. 707) has shown how minute the quantity of mercury may be. This wire of aluminium to which a thermo-couple is attached will, if a mere trace of mercury be rubbed on its surface, become rapidly heated by oxidation, the temperature rising to 102° C., while at the same time a fungoid-like growth of alumina forms on its surface (see Fig. 1). Aluminium foil will burn readily in oxygen if its combustion

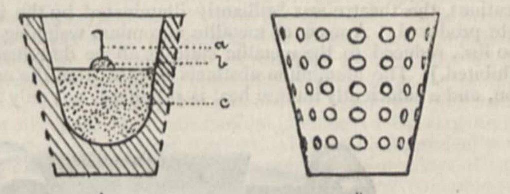


FIG. 2.—Crucible in which the reduction of metallic oxides is effected. A, diagrammatic section of the perforated sheet-iron crucible, B, lined with magnesia; *c* is the mixture of aluminium and the metallic oxide to be reduced to metal; *a* is a piece of magnesium ribbon placed in a mixture, *b*, of aluminium and some readily reducible oxide.

be started by a glowing fragment of charcoal. The temperature at which aluminium will abstract oxygen from a metallic oxide will depend on the oxide submitted to its action. Three cases may be taken: (1) Lead oxide and granulated aluminium may be ignited by a match, as may also silver oxide (Ag_2O), for it parts with its oxygen very readily. (2) Chromium oxide (Cr_2O_3) and granulated aluminium burns slowly and requires rather a high temperature to start the reaction. Oxide of iron (Fe_2O_3) and granulated aluminium also requires the presence of a readily reducible oxide to start the reaction. On the other hand, (3) a mixture of sodium peroxide, carbide of calcium and granulatedaluminium may be started by a drop of water by the mere inflammation of the acetylene. In all these cases, or in any other case, the products are solid, for if any of the reduced metal is volatilised it soon condenses, and may be collected, usually in an oxidised form.

In using aluminium as fuel the object, of course, is to produce intense heat, and returning to this mass of iron ore from the Surrey heath it may at once be stated that an oxide of iron,

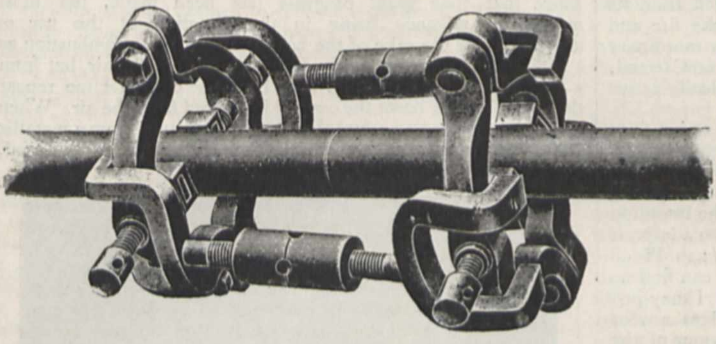


FIG. 3.—The clamps used or welding tubes up to four inches in diameter.

erric oxide, is the most convenient oxide to use, partly because it is inexpensive.

Many of my audience already know that the recent investigations having for their object the use of aluminium as a source of heat have been conducted by Dr. Hans Goldschmidt, of Essen, and it is through his labours that metallurgy enters upon an entirely new phase. It would be difficult to offer him fuller or more unstinted praise than that. You will, I trust, soon realise how much industry is indebted to him. In its simplest form his process consists in igniting a mixture of oxide of iron, ferric oxide and finely divided aluminium. To this mixture the name of "thermit" has been given, and several varieties of it, adapted to various kinds of work, are used by Dr. Goldschmidt at the works of the Allgemeine Thermit-Gesellschaft at Essen-Ruhr.

The mixture is placed inside a crucible (Fig. 2) and is ignited by a small piece of magnesium wire, which serves as a kind of wick if it is placed in a little heap of calcium sulphate and aluminium. Such a mass will now be lighted, and you see intense heat is produced. [When the operation was conducted in accordance with the above indications, the theatre was brilliantly illuminated by the intense light produced. A mass of metallic chromium weighing about 100 lbs., reduced to the metallic state as above described, was exhibited.] The aluminium abstracts oxygen from the oxide of iron, and a sufficiently intense heat is produced, not only to melt

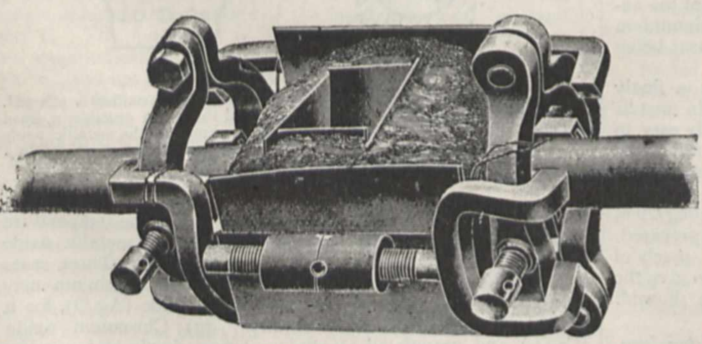


FIG. 5.—Casing packed round with moulding sand in readiness for the welding operation.

the iron which is liberated from its oxygen, but to melt up the slag and, further, to leave a considerable surplus of heat, which is available for doing other work. No known pyrometer will enable the heat to be measured. I believe it to be about 3000° C. The aluminium plays the part of a fuel, and this table shows the advantage aluminium possesses as compared with carbon for the particular work required of it.[1]

The Reduction of Fe_2O_3 *to Iron by Aluminium and by Carbon.*

	Aluminium.	Carbon.
Compound produced ...	Al_2O_3	CO
Amount of reducing agent required to produce 1 kilo. of iron ...	0·484 kilo.	0·321 kilo.
Amount of heat produced by oxidation of the reducing agent ...	3456 calories	770 calories
Heat required to reduce the Fe_2O_3	1796 ,,	1796 ,,
Heat required for fusion of the slag	548 ,,	
Heat required for fusion of iron	362 ,,	
Total heat required ...	2706 ,,	1796 ,,
Residual heat available	750 ,,	− 1026 ,,

On the aluminium side some 750 calories (units of heat) are available to do work (3456 − 2706 = 750 calories). On the carbon side there is a deficiency of no less than − 1026 calories. As regards the crucibles, they may be made of alumina, the solid product which is the result of the combustion of aluminium. They may also be made of magnesia or mended with magnesia. I shall have more to say about the solid product of the combustion subsequently. The practical

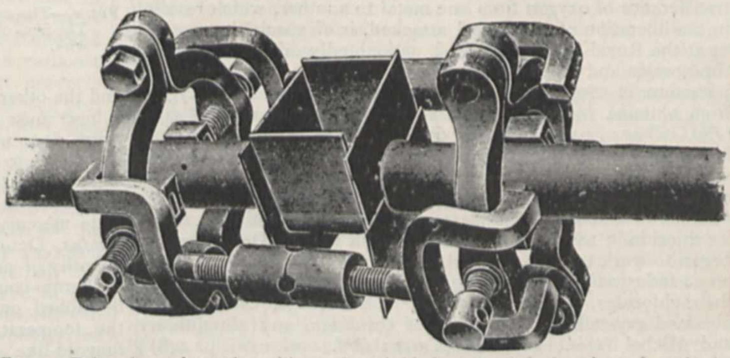


FIG. 4.—Tubes clamped together with a casing of thin iron round the junction to be welded.

application of the process is as follows. The ignited and molten mass in the crucible is so intensely hot that it may be made to unite surfaces of steel that require to be joined, such as the ends of lengths of rails. If I may use a simile which enables me to describe the method rapidly, the fluid contents of the crucible are applied as a hot bandage might be applied to wounded or severed surfaces in the human body which require medical treatment to facilitate healing or to cause them to unite. It may be objected that the fluid contents of the crucible would set as a whole round the metallic junction and give trouble, but this is not the case, for a layer of fluid alumina appears both to coat the rod, tube or rail which has to be welded, and to set in a mass which can be readily detached after the work is done. The casings (Figs. 4 and 5) are protected in the same way. The diagrams (Figs. 3, 4, 5) need but little comment, as they sufficiently indicate the method adopted in the case they represent. These figures were used to illustrate a paper by Mr. E. F. Lange (*Journal* of the Iron and Steel Institute, 1900, No. ii. p. 191). [I was indebted to him for the loan of small appliances of a similar kind to enable me to demonstrate to the audience the welding of steel tubes, and the operation was shown on as large a scale as safety would

[1] These data are from a paper by Prof. Kupelwieser, of Leoben, *Oesterreichische Zeitschrift für Berg- und Huttenwesen*, vol. xlvii. 1899, p. 145-149.

permit.] The welding of three miles of electrical tramway rails was successfully effected in Brunswick in May 1900.

As regards the comparison of the use of aluminium as fuel with the electric arc, M. Camille Matignon (*Moniteur Scientifique Quesneville*, No. 702, Juin 1900, p. 357 *et seq.*), in a very interesting discourse recently delivered in Paris, has instituted a comparison between the Goldschmidt process and the electric furnace. Quoting Moissan ("Le Four électrique," p. 19), he shows that in reducing titanic acid by carbon in the electric furnace having a "laboratory space" of 800 cubic centimetres, 300 horse-power absolute were employed, producing per second 190,500 calories by burning 1·08 kilograms of aluminium. On the other hand, by burning 3·2 kilograms of ferric oxide during one minute in a crucible of about the same

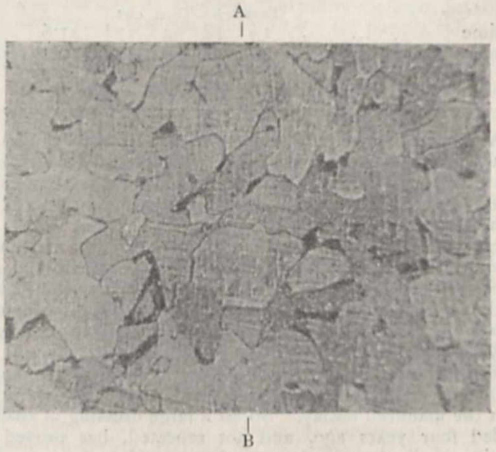


FIG 6.—Section of the welded test piece (Fig. 7), showing crystals passing across the line of weld, A B. Magnification 140 diameters.

capacity as the laboratory of the electric furnace, the rate of evolution of heat is equivalent to 375 horse-power absolute; the latter process does not, however, work continuously, but could readily be made to do so. It should be pointed out that an impure variety of aluminium can be used, and that if the heat needed to effect a given operation is but moderate, the aluminium may be diluted by the presence of an inert substance.

The photomicrograph (Fig. 6) is from a little test piece of wrought iron (Fig. 7) which was cut in two. The carefully faced surfaces were then clamped together, and I united them into an excellent weld, without any previous experience in conducting such an operation. No line of demarcation can be seen, and the crystals pass over the line A B, which I know by measurement to be that of the actual weld.

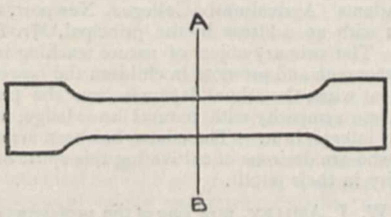


FIG. 7.—Test piece of wrought iron welded at A B. See Fig. 6 for micro-section.

The very hot molten iron may be used in a somewhat different way for repairing defective castings. In this case the slag is carefully poured off the fluid iron in the crucible and the iron is then poured into the defective part in the casting which it is required to mend, a guiding rim of some refractory material being provided. By mixing other metallic oxides with the iron oxide, the metals they contain are reduced and alloy themselves with the iron, and the composition of the defective casting can thus be matched. In connection with the repairs of fractured or defective steel castings, the possibility of producing directly steel of a suitable degree of carburisation is important. This may readily be effected by mixing fragments of cast iron with the "thermit," thus 70 to 90 grammes of cast iron mixed with 1000 grammes of thermit gives a very fine-grained and workable steel. One useful application of the process is for locally softening hardened armour plates in the positions where the bolts and screws have to be inserted through the holes drilled to admit them. This is effected by placing a little fluid "thermit" on the spot where the plate has to be drilled and the heat softens the hardened surface. It should also be remembered that, with reference to the repairs of defective parts of machinery, a suitable admixture of metallic oxides with the ferric oxide, such as those of chromium, nickel or manganese, may be reduced together with the iron derived from the ferric oxide. Richly carburised iron may be added to the molten mass, and in this way any quality of steel may be produced.

This latter reference to metallic oxides reminds us of the original use for which the finely divided aluminium was employed, namely, as a reducing agent for the rarer metals and not for the sake of the heat evolved by the reaction. This portion of the subject I dealt with at the Royal Institution six years ago, but there have been great advances since. It would have been tedious to have conducted the experiments before you, as the crucibles would have taken so long to cool; but in each of these crucibles, which will now be broken open, I hope to find a small mass of metal, which, until now, has not left the spot in which it was reduced. [About a pound of nickel and a pound of cobalt were then produced from the respective crucibles in which they had been reduced].

Manganese and chromium containing only small quantities of carbon are now produced on a large scale for industrial use. As regards the reduction of metals and alloys from their oxides by burning aluminium, the following are the most recent results that have been obtained (*Stahl und Eisen*, March 24, 1901). The use of carbon-free chromium in connection with the metallurgy of steel is an exceedingly useful development of the methods we have considered. Hitherto, the addition of ferro-chrome to steel has involved a loss of from 20 to 25 per cent. of the chromium, while with pure chromium the loss is slight. Moreover, the addition of ferro-chrome incidentally raises the percentage of carbon, and steel containing, for instance, 2·5 per cent. of chromium should not have more than from 0·15 to 0·20 per cent. of carbon, and this can only be attained by the use of pure chromium. In the manufacture, also, of tool steel, the percentage of chromium may reach from 6 to 10 per cent. and even higher, a result which is only rendered possible by the use of pure chromium. In the same way, in connection with the metallurgy of copper, the possibility of providing carbon-free manganese is important, as is also the preparation of cupro-manganese free from iron. Alloys of manganese with zinc and with tin are likely to prove of value. Many uses have been found for the alloy containing 80 per cent. of zinc and 20 per cent. of manganese, while it is anticipated that the alloy containing 50 per cent. of tin and 50 per cent. of manganese will also prove to be important. Use has also been found for an alloy of 70 per cent. manganese and 30 per cent. chromium. Ferro-titanium, with 20 to 25 per cent. of titanium, and alloys of titanium and manganese containing from 30 to 35 per cent. of titanium, have also been produced. Titanium, moreover, absorbs nitrogen, and ferro-titanium is found to be very useful in producing sound steel castings. I, quite independently o. Dr. Goldschmidt, succeeded in the preparation of alloys of iron with from 3 to 25 per cent. of boron, the alloy containing 3 per cent. of boron proving to be beautifully crystallised. Dr. Goldschmidt states that definite results have not been obtained in attempts to utilise it. I am still investigating this most interesting subject. Dr. Goldschmidt has obtained ferro-vanadium, the best results being given with steel containing 0·5 per cent. of vanadium. He has also prepared an alloy of lead and barium containing 30 per cent. of barium, which affords an example of the possibility of forming alloys of metals with those of the alkaline earths by this process.

It only remains for me to direct your attention to the nature of the solid product of the combustion of aluminium, which is alumina often of a high degree of purity, and in a specially interesting form. The alumina from the reduction of oxide of chromium, when it is allowed to cool, forms large ruby-tinted crystalline masses, closely resembling the natural ruby. I have now to show you on the screen some rubies and sapphires produced as an incident of this beautiful process. The blue sapphire mass is, however, only translucent, not transparent. The ruby crystals are often very beautiful, as these slides show. Rubies placed in a vacuum tube and subjected to the bombardment of an electric discharge are, as Sir William Crookes has taught us, beautifully phosphorescent. I have here in this tube some thin crystalline plates of artificial ruby; they become beautifully phosphorescent when the current from the induction coil is passed through the tube, and by the kindness of Sir William Crookes I can show you some true rubies treated in a similar way. The behaviour of the artificial rubies in the vacuum tube is not quite as brilliant as that of the natural ones, but hitherto no special attention has been devoted to their preparation; they are simply thin plates broken from a large crystalline mass of slag such as that on the table. I may add that this variety of corundum produced by the burning of aluminium is very hard, and may be used, not only for the same purposes as ordinary corundum, but for lining the crucible in which the operations are conducted, so that the product of combustion takes its place in conducting the process. My warmest thanks are due to Dr. Goldschmidt for lending me the beautiful specimens on the table, and to Mr. W. H. Merrett for his aid in conducting the experiments.

I have set before you the considerations respecting the use of metals as fuel simply as they appear to flow. I trust that the adoption of the title of this lecture has been justified by the evidence given as to the possibility of using metals as fuel in the strictest sense of the word. It is well to be accurate on this point because we are told that the first known appearance of the word "fuel" in the English language occurs in a poem (*Coeur de Lion*, 15th century), and seems to have been a misinterpretation of the old French word *fouaille*, and was adopted in the belief that sustenance for the body and food for the flames are synonymous. Widening our view of metals by grouping them with fuels will be acceptable because fire and flame powerfully appeal to our thoughts. We "kindle" enthusiasm, and add "fuel" to the fire of ambition, in fact we constantly use fire, flame and fuel as similes, and any prospect of extending their use to us as such by enlisting metals in the service will be welcome. An early Italian metallurgist, Vanoccio Biringuccio, might not have thought so, for I find that, writing in the sixteenth century, he quaintly devotes the last chapter of a work on metallurgy to "Fires which burn and leave no ashes."[1] In this chapter he appeals to envy, hatred, malice and other products of a kindled imagination, and traces their analogies to fuel and flame, but he speedily takes leave of his readers in alarm at the prospect such a treatment of the subject presents.

The burning of aluminium as fuel gives us sapphires and rubies in the place of ashes, and metallic fuel is burnt, not by the air above, but by the oxygen derived from the earth beneath, as it occurs in the red and yellow oxides to which our rocks and cliffs owe their colour and their beauty.

AGRICULTURAL EXPERIMENTS.

A NUMBER of reports on agricultural experiments conducted by provincial colleges have reached us, of which the most comprehensive is that issued by the Agricultural Department of the Durham College of Science. Most of the field-work that this report deals with was planned and started by Prof. Middleton's predecessor, and the results are becoming more valuable each year. It is a report that should be in the hands of every one that is interested in agricultural progress, though no one need expect to find it light reading.

In the north of England, as in many other parts of the country, the turnip crop suffers severely from finger and toe, and the work of the Durham College of Science is throwing much fresh light on this subject. Hitherto the disease has chiefly been combated by the application of large dressings of slaked lime applied a year or less before it was intended to grow a cruciferous crop. In this way the fungus and its spores are destroyed more or less effectively, but at a larger cost than agriculture can now well bear. It appeared, however, that if lime can get rid of the disease when the substance is applied only a short time before the crop that the fungus affects is to be grown, the clearance of the soil will be much more effectual—or will be accomplished at less outlay—if the trouble is attacked at its fountainhead, namely, directly after an infected crop has been grown. With this object in view, a field that had grown a much-diseased crop in 1896 was divided into five plots in the autumn of that year, one of the plots being soon afterwards treated with 2½ tons per acre of ordinary burned lime, while another plot did not receive its dressing till the autumn of 1899. Following the four-course shift the field was again under turnips in 1900, with the following result per acre:—

	Weight of roots				Percentage	
	Sound		Diseased		Diseased and destroyed	Sound
	Tons	cwt.	Tons	cwt.		
No lime	13	18	2	17	41·6	58·4
Lime applied, Feb. 1897...	20	11	0	13	10·1	89·9
,, ,, Nov. 1899...	15	12	1	13	29·2	70·8

The above figures hardly put the case so strongly as they might, for whereas when the roots were diseased to the extent of 41·6 per cent. and 29·2 per cent., such roots were practically valueless, the infected roots were far from the putrescent stage when the percentage of disease was 10·1.

The now well-known Cockle Park experiments on "manuring for mutton" are described at length in the above report, and are popularly presented in a circular issued by the Northumberland County Council. In this circular the results for each plot are shown by a diagrammatic sheep, the sections of whose body represent (*a*) the growth due to the soil in its unimproved condition; (*b*) the growth induced by manurial treatment; and (*c*) the portion of such growth as is needed to cover the manurial outlay. So far a large dressing of basic slag applied four years ago, and not repeated, has proved most effective; whereas the lowest place is taken by a moderate dressing of lime. A corresponding circular deals with the experiments on turnip manuring.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A WELL-ARRANGED calendar of the Merchant Venturers' Technical College, Bristol, showing the courses of work to be taken in the forthcoming session and the facilities for study, has been received. At the end of each syllabus a useful list of books of reference is given, in addition to the usual list of text-books. We assume that the reference books recommended are to be found in the school library, or on the laboratory bookshelf.

A VACATION course of lectures and observations connected with nature study, for teachers in rural schools, was opened at the Harper-Adams Agricultural College, Newport, Salop, on August 1 with an address by the principal, Mr. P. Hedworth Foulkes. The primary object of nature teaching is, he pointed out, to encourage and promote in children the power of observation, so that when the school days are over the pupil is in full and complete sympathy with natural knowledge, and takes an intelligent interest in it. The course has been arranged to help teachers who are desirous of cultivating this spirit of observation and inquiry in their pupils.

PROF. W. J. ASHLEY, now one of the professors of economics in the Harvard University, Cambridge, Massachusetts, has been appointed to the first or organising chair of the future faculty of commerce in the University of Birmingham. Prof. Ashley was a Brackenbury scholar at Balliol College, Oxford, and obtained a first in history in 1881, followed by a fellowship of Lincoln College. For three years he was college tutor in Oxford, lecturing in large classes in economics and history. Towards the end of the eighties he was called to a chair of economics at Toronto, and after a short time the staff of Harvard University went out of the ordinary course to enable provision to be made among them for him, and there he has occupied the chair of economic history since 1892, the chair of economics itself being held by Prof. Taussig. It is understood to be the wish of the council and senate of the University of Birmingham that the professor should devote his first year to investigation and consolidation of ideas, in consultation with men of business in this and other countries,

[1] "De la Pirotechnia," 1540, p 167. (Venice). "*Del fuo:ho che consuma et non facenere.*"

and that the faculty of commerce should not be constituted, or regular teaching begin, until the following session.

THE Royal Commissioners for the Exhibition of 1851 have made the following appointments to science research scholarships for the year 1901, on the recommendation of the authorities of the several universities and colleges. The scholarships are of the value of 150*l.* a year, and are ordinarily tenable for two years (subject to a satisfactory report at the end of the first year) in any university at home or abroad, or in some other institution approved of by the Commissioners. The scholars are to devote themselves exclusively to study and research in some branch of science, the extension of which is important to the industries of the country:—J. A. Craw, University of Glasgow; F. Horton, University of Birmingham; A. Slator, University of Birmingham; R. B. Denison, Yorkshire College, Leeds; G. Owen, University College, Liverpool; G. Senter, University College, London; F. W. Rixon, Owens College, Manchester; T. Baker, Durham College of Science, Newcastle-on-Tyne; S. C. Laws, University College, Nottingham; Alice E. Smith, University College of North Wales, Bangor; J. Hawthorne, Queen's College, Belfast; R. K. McClung, McGill University, Montreal; C. W. Dickson, Queen's University, Kingston, Ontario; G. Harker, University of Sydney; Dr. J. M. Maclaren, University of New Zealand. The following scholarships granted in 1900 have been continued for a second year on receipt of a satisfactory report of work done during the first year:—C. E. Fawsitt, University of Edinburgh; V. J. Blyth, University of Glasgow; J. Moir, University of Aberdeen; Dr. W. M. Varley, Yorkshire College, Leeds; J. C. W. Humfrey, University College, Liverpool; S. Smiles, University College, London; Alice L. Embleton, University College of South Wales and Monmouthshire, Cardiff; J. A Cunningham, Royal College of Science, Dublin; W. S. Mills, Queen's College, Galway; J. Patterson, University of Toronto; W. C. Baker, Queen's University, Kingston, Ontario; J. Barnes, Dalhousie University, Halifax, Nova Scotia; J. J. E. Durack, University of Sydney. The following scholarships granted in 1898 and 1899 have been exceptionally renewed for a third year:—L. N. G. Filon, University College, London; J. W. Mellor, University of New Zealand; F. W. Skirrow, Yorkshire College, Leeds; C. G. Barkla, University College, Liverpool; W. Campbell, Durham College of Science, Newcastle-upon-Tyne; L. Lownds, University College, Nottingham; Dr. J. T. Jenkins, University College of Wales, Aberystwyth; R. D. Abell, University College of North Wales, Bangor; B. D. Steele, University of Melbourne.

SCIENTIFIC SERIAL.

American Journal of Science, July.—Geology of the Shonkin Sag and Palisade Butte Laccoliths in the Highwood Mountains of Montana, by W. H. Weed and L. V. Pirsson.—On the manganese ore deposits of the Queluz (Lafayette) district, Minas Geraes, Brazil, by O. A. Derby.—On the bituminous deposits situated at the south and east of Cardenas, Cuba, by H. E. Peckham. On the north of Cuba there is a tract of country more than 4500 square miles in area, the springs and wells of which give indications of the existence of liquid bitumens of varying density. The oil which has been obtained resembles the oils of Russia, but it is doubtful if, in view of the enormous production which recent developments in Texas and Indiana promise, there is at present any encouragement for even experimental drilling in Cuba.—Mineralogical notes, No. 2, by A. F. Rogers. A description of new types of calcite and galena, together with a note of new localities for some rare minerals.—A new solution for the copper voltameter, by W. K. Shepard. A saturated solution of copper sulphate is boiled for a short time to expel the air and then kept for about an hour at 100° C. in contact with metallic copper in order to neutralise the solution. About ·05 per cent. of ammonium chloride was then added. Using this solution it was found that the weight of copper was practically independent of the temperature between 20° and 40° C; the solution may be used a large number of times, and the results are independent of the current density between the limits of ·02 and ·07 ampere per square centimetre.—The thermomagnetic and galvanomagnetic effects in tellurium, by M. G. Lloyd.—Additions to the avifauna of the Bermudas, with diagnoses of two new subspecies, by A. H. Verrill.—The induced alternating current discharge studied with reference to its spectrum and especially its ultra-violet spectrum, by A. W. Wright and E. S. Downs.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 23.—"Preliminary Statement on the Prothalli of *Ophioglossum pendulum* (L.), *Helminthostachys zeylanica* (Hook), and *Psilotum*, sp." By William H. Lang, M.B., D.Sc., Communicated by Prof. F. O. Bower F.R.S.

During a recent visit to Ceylon and the Malay Peninsula, the author found prothalli of *Ophioglossum pendulum* and *Helminthostachys zeylanica* as well as a single specimen, which there is reason to regard as the prothallus of *Psilotum*. This paper gives a brief account of the mode of occurrence and external form of these three prothalli.

Ophioglossum pendulum. The prothalli were found in the humus collected by an epiphytic fern. They were wholly saprophytic, devoid of chlorophyll and of a yellowish-white colour. An endophytic mycorhiza is present in them. The prothallus is radially symmetrical, the older ones consisting of a number of short cylindrical branches radiating in all directions into the humus. The surface of these branches is covered with short unicellular hairs (paraphyses); rhizoids are absent. The antheridia and archegonia, which occur on the same prothallus, resemble those of *O. pedunculosum*.

Helminthostachys zeylanica. The wholly saprophytic prothalli of this plant occur about two inches below the surface of the ground. They are radially symmetrical; the lower vegetative half, in which is an endophytic fungus, is more or less lobed and bears rhizoids. The sexual organs are borne on the upper half; the antheridia are large and sunk beneath the surface; the archegonia project slightly from it. Sometimes the prothalli are monœcious, but more often a prothallus bears antheridia or archegonia only. The ternate lamina of the first leaf of the young plant is green and appears above ground.

Psilotum. A single prothallus, presumably belonging to this plant, was found embedded among the roots covering the stem of a tree-fern. It was one-quarter of an inch long and presented a general resemblance to some prothalli of *Lycopodium*, having a well-marked primary tubercle. The sexual organs were borne on the overhanging margin of the upper region of the prothallus, between which and the lower vegetative region the meristem will probably be found to be situated.

June 20.—"The Mechanism of the Electric Arc." By (Mrs.) Hertha Ayrton. Communicated by Prof. Perry, F.R.S.

The object of the paper is to show that, by applying the ordinary laws of resistance, of heating and cooling and of burning to the arc, considered as a gap in a circuit furnishing its own conductor by the volatilisation of its own material, all its principal phenomena can be accounted for, without the aid of a large back E.M.F., or of a "negative resistance," or of any other unusual attribute.

The Apparent Large Back E.M.F.

It is shown how volatilisation may begin, even without the self-induction to which the starting of an arc, when a circuit is broken, is usually attributed; and it is pointed out that, when the carbons are once separated, all the material in the gap cannot retain its high temperature. The air must cool some of it into carbon *mist* or *fog*, just as the steam issuing from a kettle is cooled into water mist at a short distance from its mouth. The dissimilar action of the poles common to so many electric phenomena displays itself in the arc at this point. Instead of *both* poles volatilising the *positive* pole alone does. It is considered, therefore, that the arc consists of (1) a thin layer of carbon vapour issuing from the end of the positive carbon, (2) a bulb of carbon mist joining this to the negative carbon, and (3) a sheath of burning gases, formed by the burning of the mist, and the hot ends of the carbons, and surrounding both. The vapour appears to be indicated in images of the arc by a sort of gap between the arc and the positive carbon, the mist by a purple bulb and the gases by a green flame.

The flame is found to be practically insulating, so that nearly the whole of the current flows through the vapour and mist alone. It is suggested that the vapour has a high specific resistance compared with that of the mist, and that it is to the great resistance of this vapour-film that the high temperature of the crater is due, and not to any large back E.M.F. of which it is the seat.

Volatilisation can only take place at the surface of contact between the vapour-film and the positive carbon. When that surface is smaller than the cross-section of the end of the carbon it must dig down into the solid carbon and make a pit. The sides of the pit, however, must be hot enough to burn away where the air reaches them, hence there is a race between the volatilisation of the centre of the carbon and the burning of its sides that determines the shape of the carbon. When the arc is short, the air cannot get so easily to the sides of the pit, hence it remains concave. When the arc is long, the burning of the sides gains over the volatilisation of the centre, and the surface of volatilisation becomes flat, or even slightly convex.

The peculiar shaping of the negative carbon is shown to be due to its tip being protected from the air by the mist and its sides being burnt away under the double action of radiation from the vapour film and conduction from the mist, to a greater or less distance, according to the length of the arc and the cross-section of the vapour-film.

It is shown that if the crater be defined as being that part of the positive carbon that is far brighter than the rest, then the crater must be larger, with the same current, the longer the arc, although the area of the volatilising surface is *constant* for a constant current.

By considering how the cross-section of the vapour-film must vary with the current and the length of the arc, it is found that its resistance f must be given by the formula

$$f = \frac{h}{A} + \frac{k + ml}{A^2},$$

where h, k and m are constants, l is the length of the arc, and A the current. This is the same form as was found by measuring the P.D. between the positive carbon and the arc by means of an exploring carbon and dividing the results by the corresponding currents. Hence the existence of a thin film of high-resisting vapour in contact with the crater would not only cause a large fall of potential between the positive carbon and the arc, exactly as if the crater were the seat of a large back E.M.F., but it would cause that P.D. to vary with the current and the length of the arc exactly as it has been found to vary by actual measurement.

The Apparent "Negative Resistance."

As nearly all the current flows through the vapour and mist, the surrounding flame being practically an insulator, the resistance of a solid carbon arc, apart from that of the vapour, must depend entirely on the cross-section of the mist. To see how this varies with the current, images of an arc of 2 mm. were drawn, with the purple part—the mist—very carefully defined, for currents of 4, 6, 8, 10, 12 and 14 amperes. The mean cross-section of the mist was found to increase more rapidly than the current, consequently its resistance diminishes more rapidly than the current increases. As the formula for the resistance of the vapour film shows that it too diminishes faster than the current increases, it follows that the whole resistance of the arc does the same, and that consequently the P.D. must diminish as the current increases. Hence if δV and δA be corresponding increments of P.D. and current, $\delta V/\delta A$ must be negative, although the resistance of the arc is positive.

It is found, from the above measurements of the cross-sections of the mist, that the connection between m, the resistance of the mist, and the current, is of the form,

$$m = \frac{\alpha}{A} + \frac{\beta}{A^2}.$$

If m varies directly with the length of the arc, then

$$m = \left(\frac{\alpha}{A} + \frac{\beta}{A^2}\right) l.$$

Adding this equation to (1), we get

$$f + m = r = \frac{p + ql}{A} + \frac{s + tl}{A^2}$$

for the whole resistance of the arc, which is exactly the form that was found by dividing direct measurements of the P.D. between the carbons by the corresponding currents. Hence there is no reason why this ratio should not represent the *true* resistance of the arc.

Under what circumstances $\delta V/\delta A$ measures the True Resistance of the Arc.

When the current is changed it takes some time for the vapour film to alter its area to its fullest extent, and still more time for the carbon ends to change their shapes. All the time these changes are going on the resistance of the arc, and, consequently, the P.D. between the carbons, must be altering also. Both these, therefore, depend, not only on the current and the length of the arc, but also, till everything has become steady again, *i.e.* till the arc is "normal" again, on how lately a change has been made in either. At the first instant after a change of current, before the volatilising area has had time to alter at all, δV and δA must have the same sign, just as they would if the arc were a wire, but as the volatilising surface alters, the sign of δV changes. If, therefore, a small alternating current is applied to the direct current of an arc, it will depend on the frequency of that current whether $\delta V/\delta A$ is positive or negative. When the frequency is so high that the volatilising surface never changes at all, $\delta V/\delta A$ will measure the true resistance of the arc unless it has a back E.M.F. which varies with the alternating current.

The measurements of the true resistance of the arc made in this way by various experimenters have given very various results, because probably the frequency of the alternating currents employed has been too low not to alter the resistance of the arc. A curve is drawn showing how the value of $\delta V/\delta A$ with the same direct current and length of arc varies with the frequency of the alternating current, and it is pointed out that even if the arc has as large a back E.M.F. as is usually supposed, the *true* resistance cannot be measured with an alternating current of lower frequency than 7000 complete alternations per second.

The exact conditions under which the *true* resistance of the arc can be measured in this way are examined, and the precautions that it is necessary to take to ensure the fulfilment of these conditions are enumerated.

The Changes introduced into the Resistance of the Arc by the Use of Cored Carbons.

A core in either or both carbons has a great effect on both the P.D between the carbons and the *change* of P.D. that accompanies a given *change* current. It lowers the first and makes the second more positive, *i.e.* gives it a smaller negative or larger positive value, as the case may be. It is pointed out that this might be due to the influence of cores either on the cross-section of the arc or on its specific resistance, or on both.

To see the effect on the cross-section, enlarged images were drawn of 2 mm. arcs with currents increasing by 2 amperes from 2 to 14 amperes, between four pairs of carbons, + solid – solid, + solid – cored, + cored – solid, + cored – cored. Two sets of images were drawn with each pair of carbons—the one immediately after a change of current, to get the "non-normal" change, and the other after the arc had become normal again. The mean cross-section of the mist was calculated in each case, and its cross-section where it touched the crater was taken to be a rough measure of the cross-section of the vapour film.

It was found that the mean cross-section of the mist with a given current was largest when both carbons were solid, less when the negative carbon alone was cored, less still when the positive alone was cored, and least when both were cored. Coring either the positive carbon alone, or both carbons, had the same effect on the cross-section of the vapour film as on that of the mist, but coring the negative alone only diminished this cross-section immediately after a change of current, but not when the arc had become normal again. Hence it was deduced that if the cores altered the *cross-sections* of the arc only they would *increase* its resistance, and, consequently, the P.D. between the carbons. As they *lower* this, however, they must do it by lowering the specific resistance of the arc more than they increase its cross-section. The vapour and mist of the core must therefore have lower specific resistances than the vapour and mist of the solid carbon.

When it is the positive carbon that is cored, all the vapour and mist come from the *cored* carbon. When the negative, they come from the *uncored* carbon, and it is only because the metallic salts in the core have a lower temperature of volatilisation than carbon that the mist is able to volatilise these and so lower its own specific resistance.

The effect of a core in either carbon, or in both, must depend on the current, because the larger the current the more solid carbon will the volatilising surface cover, and the less, therefore, will the specific resistances of the mist and vapour be lowered. The way in which the core acts in each case is traced, and the alterations in the specific resistances and cross-sections due to the core are shown to bring about changes in the P.D. exactly similar to those found by actual measurements of the P.D. between the carbons. It is shown, for instance, how these changes entirely account for the fact established by Prof. Ayrton (Electrical Congress at Chicago, 1893) that, with a constant length of arc, while the P.D. diminishes continuously as the current increases, when both carbons are solid, it sometimes remains constant over a wide range of current, or even increases again, after having diminished, when the positive carbon is cored.

The alterations in the value of $\delta V/\delta A$ introduced by the cores are next discussed, and it is shown that the changes in the resistance of the arcs that *must* follow the observed changes in its cross-section, coupled with the alterations that must ensue from the lowering of its specific resistance, would modify $\delta V/\delta A$ just in the way that Messrs. Frith and Rodgers ("The Resistance of the Electric Arc," *Phil. Mag.* 1896, vol. xlii. p. 407) found that it was modified by direct measurement. Thus all the principal phenomena of the arc, with cored and with solid carbons alike, may be attributable to such variations in the specific resistances of the materials in the gap as it has been shown *must* exist, together with the variations in the cross-sections of the arc that have been observed to take place. Hence it is superfluous to imagine either a large back E.M.F. or a "negative resistance."

"The Nature and Origin of the Poison of *Lotus arabicus*." By Wyndham R. Dunstan, M.A., F.R.S., Director of the Scientific and Technical Department of the Imperial Institute, and T. A. Henry, B.Sc., Salters' Company's Research Fellow in the Laboratories of the Imperial Institute.

The authors have already given a preliminary account (*Roy. Soc. Proc.*, vol. lxvii. p. 224, 1900) of this investigation and have shown that the poisonous property of this Egyptian vetch is due to the prussic acid which is formed when the plant is crushed with water, owing to the hydrolytic action of an enzyme, *lotase*, on a glucoside, *lotusin*, which is broken up into hydrocyanic acid, dextrose and lotoflavin, a yellow colouring matter.

The authors have continued the investigation with the object of ascertaining the properties and chemical constitution of lotoflavin and of lotusin, and also of studying the properties of lotase in relation to those of other hydrolytic enzymes.

Lotusin.

Lotusin can be separated from an alcoholic extract of the plant by a tedious process giving a very small yield, about 0·025 per cent.

Lotusin is a yellow crystalline glucoside, more soluble in alcohol than in water. When heated it gradually decomposes without exhibiting any fixed melting point. Combustions of specially purified material gave numbers agreeing with those deduced from the formula $C_{28}H_{31}NO_{16}$.

In the preliminary notice the formula $C_{22}H_{19}NO_{10}$ was provisionally assigned to lotusin on the assumption that one molecule of dextrose is formed by its hydrolysis. The formula given above, as the result of ultimate analysis, is confirmed by the observation that two molecules of dextrose are produced by acid hydrolysis, which is therefore represented by the equation—

$$\underset{\text{Lotusin.}}{C_{28}H_{31}NO_{16}} + 2H_2O = \underset{\text{Dextrose.}}{2C_6H_{12}O_6} + \underset{\text{Prussic acid.}}{HCN} + \underset{\text{Lotoflavin.}}{C_{15}H_{10}O_6}.$$

When a solution of lotusin is warmed with dilute hydrochloric acid, hydrolysis readily occurs. The liquid acquires a strong odour of hydrocyanic acid and a yellow crystalline precipitate of lotoflavin is thrown down, whilst the solution strongly reduces Fehling's solution. Dilute sulphuric acid only very slowly effects the hydrolysis of lotusin.

When warmed with aqueous alkalis, lotusin is gradually decomposed, ammonia being evolved and an acid formed to which the name *lotusinic acid* has been given.

$$C_{28}H_{31}O_{16} + 2H_2O = C_{28}H_{32}O_{18} + NH_3.$$

Lotusinic acid is a monobasic acid furnishing yellow crystalline salts. It is readily hydrolysed by dilute acids forming latoflavin, dextrose and heptogluconic acid (dextrose-carboxylic acid):

$$\underset{\text{Lotusinic acid.}}{C_{28}H_{32}O_{18}} + 2H_2O = \underset{\text{Lotoflavin.}}{C_{15}H_{10}O_6} + \underset{\text{Dextrose.}}{C_6H_{12}O_6} + \underset{\text{Heptogluconic acid.}}{C_7H_{14}O_8}.$$

With the exception of amygdalin, lotusin is the only glucoside definitely known which furnishes prussic acid as a decomposition product.

Lotoflavin.

Lotoflavin is a yellow crystalline colouring matter readily dissolved by alcohol or by hot glacial acetic acid, and also by aqueous alkalis forming bright yellow solutions. It is always present to some extent in the plants, especially in old plants. Ultimate analysis leads to the formula $C_{15}H_{10}O_6$. It is therefore isomeric with luteolin, the yellow colouring matter of *Reseda luteola*, and with *fisetin*, the yellow colouring from young fustic, *Rhus cotinus*. *Morin*, from *Morus tinctoria*, appears to be hydroxylotoflavin.

Lotoflavin does not form compounds with mineral acids. It furnishes a tetracetyl derivative and two isomeric mutually convertible trimethyl ethers which are capable of forming one and the same acetyl-trimethyl-lotoflavin. By the action of fused potash lotoflavin is converted into phloroglucin and β-resorcylic acid.

Dextrose.

The sugar resulting from hydrolysis has been found to correspond in all properties with ordinary dextrose.

Hydrocyanic acid.

The amount of prussic acid given by plants at different stages of growth has been ascertained. Mature plants bearing seed-pods have furnished 0·345 per cent. of this acid, calculated on the air-dried material which corresponds with 5·23 per cent. of lotusin. Younger plants bearing flower buds gave 0·25 per cent., whilst still smaller quantities were furnished by very young plants and hardly any by quite old plants from which the seeds had fallen.

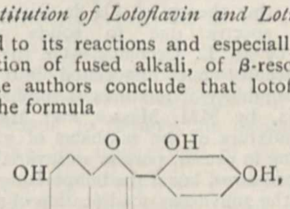
The formation of the poison, therefore, seems to reach its maximum at about the seeding period, and after this period to diminish rapidly. The Arabs are aware that the plant is safe to use as a fodder when the seeds are quite ripe, but not before. We have found that it is the lotusin which disappears during the ripening of the seeds. Old plants contain some lotase and lotoflavin, but little or no lotusin.

Lotase.

In its general properties lotase resembles other hydrolytic enzymes, from which, however, it differs in several important respects. It may be compared with emulsin, the enzyme of bitter almonds. Emulsin, however, only attacks lotusin very slowly, whilst lotase has but a feeble action on amygdalin, the glucoside of bitter almonds. Lotase is much more readily injured and deprived of its hydrolytic power than emulsin. On this account it is difficult to isolate in the solid state. Its power is not only rapidly abolished by heat, but is also gradually destroyed by contact with alcohol or glycerine. Besides lotase, the plant contains an amylolytic and a proteolytic enzyme.

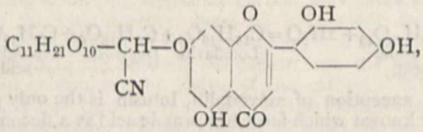
Constitution of Lotoflavin and Lotusin.

Having regard to its reactions and especially to the production, by the action of fused alkali, of β-resorcylic acid and phloroglucin, the authors conclude that lotoflavin should be represented by the formula



which is that of a compound belonging to the same class, of phenylated pheno-γ-pyrones, as its isomerides luteolin and fisetin. The peculiarity shown by lotoflavin of containing four hydroxyl groups, but furnishing only a *tri*methyl ether, is accounted for by one of the hydroxyl groups being in the ortho position to a carbonyl group.

The reactions of lotusin are best represented by the formula :



which is that of a lotoflavin ether of maltose-cyanhydrin.

This formula satisfactorily accounts for the partial hydrolysis of the glucoside by alkalis giving lotusinic acid and ammonia, and for the decomposition of the substance by acids giving lotoflavin and maltose-carboxylic acid which is immediately decomposed into dextrose and heptogluconic acid. It also accounts for the hydrolysis of lotusin, by acids, into lotoflavin and maltose, which is further changed to dextrose.

In order to definitely localise the position of the cyanogen group in lotusin, the behaviour of several cyanhydrins of known constitution have been examined with reference to the question as to whether they would furnish hydrocyanic acid when acted on by dilute hydrochloric acid. It was found that mandelic nitrile, lævulose cyanhydrin and pentacetyl gluconitrile, in which the cyanogen group is known to occupy a position similar to that assumed for it in the formula suggested for lotusin, are, like lotusin, easily decomposed by dilute hydrochloric acid forming prussic acid and the corresponding aldehyde or ketone.

The authors wish again to express their obligations to Mr. Ernest A. Floyer, of Cairo, Member of the Egyptian Institute, who has spared neither trouble nor expense in collecting in Egypt, and despatching to this country, the material required for this investigation.

PARIS.

Academy of Sciences, July 29.—M. Fouqué in the chair.—On the cooling power of a gaseous or liquid current, by M. J. Boussinesq.—On the variation in luminosity of the planet Eros; duration of the period, by M. Ch. André. As the mean result of a series of measurements carried out by three independent observers at the observatory of Lyons, the period between two consecutive minima is found to be 5h. 16m. 15·2s. It was found that the observations of the minima could be more accurately made than those of the maxima.—On surfaces susceptible of a continuous deformation with conservation of a conjugated system, by M. A. Demoulin.—On the analytical integrals of differential equations of the first order and of any degree in the neighbourhood of certain singular values, by M. Henri Dulac.—On the infinitely small deformation of an elastic body submitted to known forces, by MM. Eugène and François Cosserat.—On the vibrations of liquid films of determinate forms, by MM. Chéneveau and G. Cartaud. An experimental study by a photographic method of the wave figures produced on the surface of liquids contained in vessels of different forms.—On the radio-activity of radium salts, by MM. P. Curie and A. Debierne. A study of the conditions under which a radio-active salt can impart active properties to water. A solution of a radium salt exposed in an open vessel steadily loses its active properties, the rate of loss being proportional to the surface exposed to the air. But if this solution is kept in a sealed tube it gradually acquires its original activity.—A geographical demonstration of the terrestrial origin of the polar aurora, by M. Henri Stassano. All the facts cited are in accord with the theory of De la Rive.—On the continuity of the spectra due to solids and to incandescent liquids, by M. L. Décombe.—On the electrocapillary action of molecules not dissociated into ions, by M. Gouy.—On the solubility of mixtures of sulphate of copper and sulphate of soda, by MM. Massol and Maldès. Solutions obtained with a mixture of the sulphates of soda and copper, the two salts being in excess, possess an invariable composition at ordinary temperatures, but if the temperatures are sufficiently high to produce the anhydrous modification of sodium sulphate, the composition of the solution varies with the relative proportion of the two salts present.—On the chloride of neo-didymium, by M. Camille Matignon. Details are given of a simple method of preparation of the anhydrous chloride, and also of a new hydrate.—Study of the alloys of aluminium and molybdenum, by M. Leon Guillet. The reduction of molybdic acid by aluminium gives rise to no less than six compounds corresponding to the formulæ Al_7Mo, Al_3Mo, Al_2Mo, AlMo, $AlMo_4$, and a compound very rich in molybdenum, perhaps $AlMo_{20}$.—The crystallisation of cerium oxide, by M. Jean Sterba. The crystallisation of cerium oxide can be effected from sodium chloride, borax and potassium sulphate. It forms cubes or octahedra which are colourless and transparent.—Contribution to the study of cæsium, by M. C. Chabrié. A description of the sulphites and hyposulphites of cerium.—On the pyrogallol sulphonic acids, by M. Marcel Delage.—The action of ethyl alcohol upon barium ethylate. The synthesis of normal butyl alcohol, by M. Marcel Guerbet. By heating a strong solution of barium ethylate in ethyl alcohol in a sealed tube at 240° C., a small quantity of normal butyl alcohol is produced along with ethylene and hydrogen.—On the composition of the albumen of the seed of *Phoenix canariensis* and on the chemical phenomena which accompany the germination of this seed, by MM. É. Bourquelot and H. Herissey.—On the histological constitution of the retina in congenital absence of the brain, by MM. N. Vaschide and Cl. Vurpas.—Cultures and attenuated forms of the cryptogamic diseases of plants, by M. Julien Ray.—On the affinity of the red corpuscles of the blood for acids and alkalis and on the variations of resistance which they impress upon these reagents towards solanine, by M. E. Hédon.—On the nitrogenous nutrition of yeast, by M. Pierre Thomas.—The influence of lecithin upon the nutritive exchanges, by M. G. Carriere.

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